Relief and Rehabilitation Network

Good Practice Review 1

Water and Sanitation in Emergencies

Andrew Chalinder

June 1994

This review is intended to stimulate discussion as to what constitutes `good practice' in the field of emergency water and sanitation. Comments are therefore welcomed as are suggestions of actual examples which illustrate particular contexts and practices. Comments should be sent to:

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Subsequent versions of this review will, at the editor's discretion, take account of comments and suggestions received.

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Good Practice Review

Water and Sanitation in Emergencies

Andrew Chalinder, an emergency water and sanitation programme manager who has worked for Oxfam in several relief operations, was the lead author of this review. Four other water and sanitation specialists with different backgrounds and experiences and representing different agency perspectives served as a `peer group' providing comments on the first draft of the text. The members of the peer group were: Jan Davies a consultant who recently co-authored a book on community water supplies, Georgio Nembrini, head of the Water and Sanitation Department in the International Committee of the Red Cross, Paul Smith-Lomas, Emergency Technical Adviser for Oxfam, and John Griffiths who was formerly employed by UNICEF and was involved in emergency water and sanitation programmes in Cambodia, Thailand, Bangladesh and India. A member of the technical staff of Médecins Sans Frontières – France was unfortunately unable to provide comments due to other emergency commitments. The support and helpful comments of the peer group are gratefully acknowledged. Editorial support was provided by John Borton, RRN Co-ordinator and Margaret Cornell. Véronique Goëssant was responsible for layout and production. The French version was translated by Jean Lubbock and Véronique Goëssant.

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Water and Sanitation in Emergencies

1. Objectives and Intended Audience

The objective of this review is to provide a short, accessible overview of what may be considered `good practice' in the field of emergency water and sanitation. It is aimed primarily at NGO field staff who are not specialists in water and sanitation but who may, in the context of some future emergency operation, be involved in decisions about water and sanitation activities.

The review is not therefore intended to be a technical manual. Such manuals are available and easily obtainable (see Annex 1). However their language and technical emphasis make it difficult for non-specialist personnel to use them effectively to `read into' the subject. It is assumed that readers who require more detailed technical information will make use of such manuals. To increase its accessibility to non-specialists this review incorporates the following features: the use of technical language has been minimised; points are supported where possible by actual examples drawn from recent relief programmes; and `good practice' is considered in relation to seven scenarios which have been selected to represent the range of situations likely to be faced by relief agency personnel.
These scenarios are considered in Chapter 7. Four of the scenarios involve population displacement: into arid areas, into hilly or mountainous areas, into areas of abundant surface water and into areas of existing settlement. Displaced populations invariably create acute demands in the water and sanitation field and the subject of emergency water and sanitation (as represented by the accumulated body of experience and literature in the field) has largely focused on their needs. One of the key technical manuals developed during the 1980s focuses solely on the needs of refugees and internally displaced populations[1]. The present review attempts to broaden this focus by also considering `good practice' in relation to resident populations affected by drought and other `natural' hazards and these scenarios form two of those considered. Although the majority of emergency water and sanitation activities continue to be undertaken in a rural context, experiences, such

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[1] UNHCR (1982) in Annex 1.

as in the former Yugoslavia, in Iraq and in Monrovia, Liberia, have increasingly forced NGOs to consider undertaking such interventions in urban contexts also. The final scenario therefore is that of urban areas. Additional information is provided in seven Annexes. Further documentary resources and useful contacts are provided in Annexes 1 and 2. Key technical guidelines devised by UNHCR are provided in Annex 3. Useful checklists, guidelines and other information which may not be easily obtainable by field-based personnel are also provided. A checklist for environmental needs assessment is provided in Annex 4; guidance on preventing the spread of cholera in Annex 5; a checklist for taking account of gender considerations in Annex 6; and the use of chlorine as a water disinfectant in Annex 7.

A major difficulty in preparing a review such as this lies in identifying what actually constitutes `good practice' in the field of emergency water and sanitation. Factors contributing to this difficulty include the following:

- despite having many common themes, few emergency programmes are exactly alike and it is therefore difficult to generalise about `good practice';

- the subject area is not only complex and multi-disciplinary but also has strong linkages with other subject areas, notably health, and is consequently difficult to define precisely;

- the field is highly specialised, with comparatively few individuals having developed a particular expertise in it, and with poorly developed mechanisms for the professional exchange of information;

- few agencies disseminate or publish information on their experiences and it is difficult to identify `good practice' on the basis of the limited documentation currently available.

As a result, a sense of what constitutes `good practice' in the field is still emerging and is currently only poorly developed. This review cannot therefore claim to be a definitive statement. Instead, it attempts to overcome the problems by drawing on the knowledge and experience of practitioners from different agencies and backgrounds, with familiarity with different geographical areas. It should therefore be regarded as a step in the process of stimulating discussion and encouraging the emergence of a widely shared sense of good practice, which can be reflected in subsequent versions.

2. Water and Sanitation in the Context of Environmental Health

2.1 Environmental Health

This review is concerned primarily with water and sanitation in emergencies. But agencies considering any interventions in this area ought to be aware of the wider issues relating to environmental health programmes. Environmental health relates to the impact that their environment can have on a population. Environmental health programmes include technical inputs related to water, the disposal of excreta and solid waste, vector control, shelter and the promotion of hygiene. As such water and sanitation programmes contribute only in part to the overall environmental health of a population. Consider, for example, the lack of adequate shelter in sub-zero temperatures, or the impact crowded conditions in a refugee camp can have on the transmission rates of communicable diseases. Modifying an environment to make it less favourable to disease-carrying organisms such as flies and rats (referred to as vector control), or minimising the areas of stagnant water around a populated area by means of good drainage, can play a significant role in reducing the transmission cycle of a number of diseases.

Box 1

Sanitation

The term `sanitation' is often taken to refer only to the disposal of human excreta. The concept of `environ-mental sanitation' will be used throughout this review and refers to the hygienic disposal of human excreta, solid wastes, wastewater and the control of disease vectors.

There is a growing recognition that water and sanitation needs should not be looked at in isolation, but should form part of a holistic programme attempting to address the total environmental health needs of an emergency-affected community.
Environmental health interventions should be designed to complement each other, the goal being to gain the maximum benefit from any single intervention. The success of an environmental health programme largely depends upon how the component parts relate to each other and water and sanitation can be considered as the foundation of such a programme. As a general guide it is unrealistic to expect to improve the health of a community unless there is understanding of the diseases that are most likely to affect them. Certain infectious diseases either rely on water (water-borne) or lack of adequate hygiene (water-washed) for their transmission. The aim of a water and sanitation programme in an emergency is to attempt to modify the environment in which the disease-carrying organisms are simultaneously most vulnerable and threatening to humans.

Excreta-related Disease Transmission Routes

`Hardware' and `software': ***The Hardware*** is made up of the programme elements involved in the supply of water and the construction of latrines. Thus in the water field the `hardware' elements include the logistics of tankering operations, well deepening, borehole drilling and the construction of piped distribution systems. In the sanitation field the `hardware' elements include the construction materials; digging the pits; making the squatting slabs; construction of the shelter and maintenance of the finished latrine.

The Software is made up of the human aspects of water and latrine use and hygiene practices. In the water field these include attitudes towards the location of a new source, gender aspects of water collection and use, traditional beliefs about water quality, individual and group attitudes to the maintenance of water sources, etc. In the sanitation field the `software' elements include individual and group attitudes towards defecation, the use of latrines, personal and community hygiene, knowledge of and attitudes towards the faecal-oral transmission routes, etc. The `software' elements of sanitation are particularly important to the success of sanitation programmes. Providing latrines (ie. the `hardware') is comparatively easy. Ensuring people use them in the way they are designed to be used and gain most benefit from them is much more difficult.

Box 2

Disasters do not generate `new' diseases but by altering the environment may increase the transmission of diseases which already exist in the region. (UNICEF, 1986)

Human-caused and natural disasters expose populations to considerable health risks by disrupting their established patterns of water use, defecation and waste disposal. Displaced populations are often accommodated in camps where population densities are considerably greater than in even the most densely settled rural areas. It is vital therefore that they follow sanitation practices which reduce the risk of major outbreaks of diarrhoeal disease; control of defecation practices can play a large part in this. Invariably this means the use of latrines and improving personal hygiene. Whilst some displaced populations are already familiar with latrines and others are able to adapt to their use without much difficulty, many displaced people are not familiar with them. Their arrival in a densely populated camp will force them to realise that their old habits pose a sudden threat to their health, and will require them to change their life-long defecation practices.

The `software' aspects of sanitation programmes are therefore of crucial importance, but this is not sufficiently recognised by agencies. They are too easily satisfied with counting the number of latrines they have built rather than looking at how they are used and the impact they are having on the health of the affected populations. Differences in attitude and approach to the software aspects of water and particularly sanitation programmes probably represent the greatest area of disagreement between relief agencies. Agency responsibility extends, or should extend, far beyond the construction of pit latrines, and every effort should be made to ensure that the community for whom the latrines have been provided at considerable expense derives the maximum health benefit from them. This entails a great deal of time-consuming consultation and commitment on the part of skilled primary health workers.

Box 3

Try putting yourself in the position of a person who for the whole of his/her life has either defecated in the fields, in the bush or in a very basic latrine offering nothing more than a small amount of privacy and a shallow hole. Now, after being forced to leave your home and most of your possessions and endure a long and probably traumatic journey, you are being asked to dig a deep latrine, use a dark and probably smelly shelter every time you want to defecate and also to place a cover over the hole you have just used. What is the point?

Water is the single most important provision for any population; people can survive much longer without food than they can without water. In an emergency situation, the provision of water should be looked upon as a dynamic process, aiming to move from initially providing sufficient quantities of reasonable quality water to improving the quality and use of the available water. Adopting such an evolutionary approach will go some way to helping people derive the greatest benefit from the intervention. For example, displaced people who are living in a camp for the first time may find their normal washing practices inadequate for their current densely populated living conditions. The provision of bathing facilities, and encouraging people to use them more frequently, may have a significant impact upon their environmental health in helping to prevent the spread of skin diseases.

People will always use the available water facilities if there are no alternatives; if they do not, they will not survive. Hygienic excreta disposal, on the other hand, is not fundamental to immediate survival needs. Greater difficulties will therefore be experienced when encouraging people to use sanitation facilities, and the `software' aspects of sanitation provision acquire a greater relevance than those of water.

3. The Operating Environment: General Considerations

This chapter aims to draw attention to the various contexts in which emergency water and sanitation programmes might be implemented. The circumstances in which decisions are made and the way programmes are conducted can have a significant effect on their success or failure. Being aware at the early stages of the influences and pressures which can be brought to bear on an emergency programme can go some way to smoothing the process and avoiding major interference.

3.1 The political context

The political realities within a country or region are probably the most significant external influence on an emergency programme. They are also the one aspect over which agencies can have virtually no influence, if they are to avoid jeopardising their ability to continue working in the country.

Assuming that political circumstances make it possible for refugees to enter a country or for displaced people to remain within it, political considerations can frequently influence other aspects of an emergency. Take the issue of camp location. Where a camp is to be sited can be an intensely sensitive political issue. Governments may prefer to keep refugees close to their borders and in difficult circumstances in order to discourage a lengthy stay; tribal and ethnic borders frequently differ from geographical borders and it may therefore be inappropriate for a government to allow people from neighbouring countries to settle in a camp within an area that is dominated by opposing political opinions; a government may be afraid of ethnically incited conflict spilling over into its own territory. The situation in Burundi in early 1994, where both Rwandan Hutu and Tutsi refugees and Burundian Hutu and Tutsi returnees were settled in camps amongst sometimes hostile displaced and resident populations, is an example of this; the potential for violence is enormous. Field workers should be aware that in certain circumstances, governments may have their own motives for inducing violence.

The combination of ethnic, national and international politics had a great influence on the fortunes of Somali refugees fleeing to Ethiopia in 1988. Hartisheik camp was sited where it was, because it was ethnically difficult to cross the nearby clan boundaries, and the Ogaden desert had recently been the battleground between Ethiopia and Somalia. The Horn of Africa was also strategically important during the Cold War; Soviet influence was strong in Ethiopia and US influence in Somalia. This is why water had to be tankered in from 75km away.

Limiting access to water sources can also be used for political ends. As is discussed in Section 4.1, supplying water can sometimes justify an inappropriate site; similarly the type of infrastructure constructed in a camp may be influenced by political considerations. If large-scale investment has been put into constructing a water system at one site, it makes it more difficult for the government to move a refugee camp to a less appropriate one. Agencies involved in the emergency provision of water need to be fully aware of the implications of their decisions. Water is vital in these situations and because all sides need it, it can become a very powerful bargaining tool. This has to be recognised, and agencies need to make decisions with an eye to their future relevance both in terms of provision of the service and from a political standpoint.

Political influence can be brought to bear on a water and sanitation programme by the role local authorities decide to adopt. Whilst sometimes displaying a major commitment to an emergency programme, various local authorities can also feel a widely differing degree of responsibility for it, particularly where they take over responsibility for its co-ordination. The level of commitment can differ greatly from that of the agency, and this may have a direct impact on a water and sanitation programme. For example, the speed with which a local authority conducts negotiations over the land for pipelines or treatment sites once it has agreed to do so, can have a significant impact on the operation's progress.

Agencies have to ensure that their legal responsibilities are met when they are working in emergencies. Legal restrictions can limit their options in a number of sectors. For example, when an agency wanted to form a temporary dam during the dry season across the low flowing River Atbara in East Sudan, it had to obtain permission from the authorities, because interruption to the flow of water was restricted as the Atbara was a main tributary of the Nile.

Political circumstances can make it very difficult for people to settle for any length of time in one camp or area. This raises the question of how to provide water to a transient population. One way is as the International Committee of the Red Cross (ICRC) does, namely to use mobile water treatment units, which can be towed or mounted on the back of trucks or pickups. They are self- contained treatment plants and can produce good quality water in varying quantities depending upon their capacity and the quality of the raw water. The ICRC in Geneva can be contacted for information about its field experience.

3.2 Conflict areas

Operating in conflict areas imposes peculiar limitations on all sectors of an emergency programme. Interventions in the water and sanitation sector may place staff in particularly dangerous situations. For example, if a water source is some distance away from a refugee camp and people are working in relative isolation, they will be especially exposed. This applies particularly to local staff. If a water source is close to a frontier it will be open to interference, and staff manning the installation will be at risk. When surveying possible water sources, pipelines, etc., the possibility of mines should always be considered; infrastructure such as wells, pipelines and pump houses are commonly mined.

Populations may well be unstable and frequently on the move. Some means of coping with this has to be found. Intervention in the water sector will often result in rehabilitation operations; in these circumstances careful surveys of the actual work to be done should be undertaken (see Section 7.8). It is very important that agencies are seen to be non-partisan. Working with groups of people from one side of a conflict can be construed as a political statement and can place field workers in precarious circumstances. For example, an agency working on the rehabilitation of borehole supplies in Hargeissa, Somaliland in 1992 was perceived by local clan leaders to be working with an opposing clan. The result was that staff were placed in a highly dangerous position and one engineer was expelled from the country.

Conversely, working on water programmes in conflict zones can provide access to areas which are banned to other interventions. This may be because everyone needs water, or perhaps, because, unlike food or medical provisions such as drugs, the transport of water equipment into an area may not be perceived as being directly beneficial to an opposing military force. Drugs keep wounded soldiers alive and food feeds armies. In the Luwero Triangle, in Uganda in 1984, OXFAM which was operating only in the water sector, was able to continue its work uninterrupted by the government forces. Similarly, in Lebanon in 1982, OXFAM, again working only on water programmes, was permitted access to areas which were prohibited to other agencies[2].

This gives rise to the question of the responsibility of agencies as witnesses. If an agency working on a water programme can access areas which are otherwise inaccessible, it will have an opportunity to monitor human rights issues. In such a situation, the agency and its staff will have wider obligations than just the provision of water.

Staff working in conflict situations will require good negotiating skills. It is likely that they will have to negotiate their way out of situations, into locations and around sensitive issues.

[2] P. Sherlock - personal communication.

3.3 Technological considerations

Water and sanitation infrastructure in developed countries will typically be similar to urban supplies in developing countries. It will be dependent upon a high level of technology and this has important implications for an emergency programme. However, a developing country will almost certainly be at a disadvantage when it comes to being able to sustain the provision of technological inputs, as a result of under-resourcing and financing.

A high level of technology means that specialised spare parts; high levels of skill and technical knowledge, and an existing pool of trained and skilled personnel are required, and the whole operation is dependent upon power supplies. This means that agencies will require specialists who are familiar with the technology; the rehabilitation work is likely to be expensive; alternative power sources may be required; and agencies are likely to be funders rather than directly operational.

The checklist below is put forward to help agencies assess the necessary skills and resources required to work in a situation where a high level of technology has been used:

* Are the skills required for a professional assessment available within the organisation?
* If not, can the expertise be found locally, e.g. in government departments, other agencies or local consultants?
* If not locally available, can international consultants be hired?
* Are sufficient funds available to act on the assessment?
* If not, should the agency find them or ask another agency to take over?
* Does the agency have the necessary expertise to implement and manage the proposed programme?
* Is the agency in a better position to act on its own or to advocate action by other agencies?

The emergency-affected population will previously have benefitted from the reliable provision of water and sanitation services. They will probably be used to piped water in their own homes and good individual and water sealed toilet facilities. This could well pose a problem if they are now being asked to live in a camp where they have to collect water from communal water points and to share very basic latrines with other families.

3.4 Climatic considerations

Climate will have a major impact upon a water supply system. From an emergency point of view, constructing systems during the summer months in countries that experience winter and summer extremes can prove extremely challenging. The issue of freezing is the most obvious one to address and plan for.

The Tajik refugees came into Northern Afghanistan during December 1992. Temperatures were below freezing and the wind chill made it excruciatingly cold. Burying the pipes was possible and so they were not the main concern. It was the exposed parts of the distribution network, such as the small-diameter pipes to tapstands, gate valves and pumps that were most vulnerable. Large bodies of stored water are less of a problem than smaller quantities. Ways can be explored for burying storage tanks, or providing some form of insulated cover. Roofs over storage tanks need to be designed to withstand snow. Chlorine becomes far less effective with reduced temperatures and contact times therefore need to be significantly increased (see Annex 7). Consideration should also be given to how far people have to walk to collect water. Will this exposure time be a risk to them? What about snow and ice on the paths? This is particularly relevant in hilly areas.

Emergency programmes in the former Soviet Union and the former Yugoslavia have also had to deal with these problems.

3.5 Common characteristics of displaced and resident populations

Displaced Populations. When an emergency involves the displacement of a population, the agency charged with the provision of water and sanitation is usually working from a basis of little or no infrastructure. The population will probably have settled where it feels safe and is within reasonable access to water. It is likely that the site it has chosen, or which has been chosen for it by the government or an international agency, will be remote, undeveloped and will offer little in terms of natural resource potential. Indeed, the fact that the land is available almost certainly means that the local populations have chosen not to utilise it for those very reasons. Under such circumstances an agency is faced with the enormous task of establishing appropriate water supply and sanitation systems in the shortest possible time.

The displaced population will have moved, if possible, as a unit, e.g. as a family, village, or district. Full use should be made of this factor as communities of this kind will have brought their own social structure with them, and this will be very helpful in terms of organising responsibilities, labour and the management of systems.

There will be large numbers of people in a confined area. In effect, virtually overnight rural populations are faced with living in conditions of very high urban population density. For many rural people this will be the first time they have experienced such living conditions and they will be unaware of the implications the situation has for their health.

In contrast, there are occasions when the small numbers of people settling in a particular area make it difficult to deliver, or possibly to justify the expense of, the level of service that is needed. This is most likely to be the case with people who have been displaced within their own country and who prefer to settle as near as possible to their home area. This was the situation on a large scale in the Ruhengeri region in northern Rwanda when overnight 900,000 people were displaced by fighting in February 1993. Large numbers of people settled in many small settlements.

Refugee populations typically contain a much higher than normal percentage of women and children. It is also probable that there will be a large number of sick, wounded and disabled people. All these groups will have their own special needs.

For these reasons it is crucial that there is a rapid and immediate response. Delays in making decisions, debating technical solutions and deploying staff can prove tragic.

Resident populations. Working with resident populations poses very different challenges for the intervening agency. The problem usually is that the established infrastructure can no longer provide the level of service required. For example, wells may have dried up or pumps broken down. The need therefore is to look at ways of rehabilitating, improving or upgrading systems so that they can continue to provide for the community.

There is a much greater need for sensitivity with respect to ongoing development initiatives in the area. For example, if there has been a long established community management structure for the maintenance of wells and an agency, seeing an emergency need, takes it upon itself to rehabilitate those same wells, it is probable that long-term damage can be imposed on the community management.

In the same context, it is important that any technical work should be sustainable. The village will continue to exist long after the emergency has run its course; attention must therefore be paid to the community's ability to live with the solutions that have been decided upon to address the immediate needs of an emergency.

Emergencies affecting resident populations will be either slow-onset i.e. drought or sudden-onset, i.e. natural disasters. In both instances the most important aspect is to identify the potential emergency as quickly as possible. If it is recognised early on that there is going to be a problem of water supply and/or sanitation with a resident population, there are less likely to be any negative long-term impacts as solutions can be carefully considered and more appropriate to the long-term needs of the community. In this context, early warning systems and disaster mitigation measures play an important role.

3.6 Social and economic considerations

Of particular relevance to the discussion will be the cultural practices of the community with which the agency is working. These are mainly highlighted in hygiene practices and, once again, the reader should use his/her own knowledge of local circumstances to adapt interventions accordingly.

Of relevance to all components of emergency programmes is the local, social and economic context in which the programme is taking place. Large influxes of displaced people can have a significant effect on local economies. Small trade items can generate a great deal of activity. Conversely, large numbers in receipt of food aid can have a significant effect on local food prices as they will often sell some of their ration in order to take part in the cash economy. Staples can drop dramatically in value. This can have disastrous consequences for the local residents, and can cause serious tension between the two populations, with an effect on all agencies involved with the provision of services.

Problems can also arise when the level of service being offered to displaced people is better than that received by locals. This applies particularly to the provision of water in regions where water is scarce. Wherever possible, attempts should be made to make provision for the local use of any new installations. When this is not possible efforts should be made to assist the resident populations as well as the incomers. This is not only in the interest of good relations between the two communities, but also because it is appropriate to benefit the locality for the long as well as the short term. Money is made available during emergencies, and many opportunities therefore exist to add value to local livelihoods a well as within refugee camps. In 1993 UNICEF did just this in north-east Kenya when it rehabilitated a number of local borehole supplies around Somali refugee camps; this helped to reduce tensions between the local population and the refugees.

Where refugees are amongst their own ethnic grouping, an inordinate strain will probably be placed upon local coping mechanisms. This needs to be recognised and programmes designed not only to provide a service to the displaced populations but also to reinforce local capacity to cope with the additional people. Water and sanitation programmes can play a large part here by helping to provide a better environment for the whole community.

3.7 Management considerations

Water and sanitation infrastructure installed during an emergency will always need maintenance. The requirement will be determined by how well the system has been designed and constructed, and how well it is managed. Technically complicated systems will require a high degree of maintenance.

Pumped water systems are always problematic. A regular supply of diesel or petrol must be secured. Mechanics need to be trained and workshop facilities established. Standby capability is a necessity, and reserve pumps, generators and spare parts must be budgeted for and made available.

If water is being chemically treated, stock levels need to be maintained to provide at least sufficient capacity to guarantee the provision of water until replacement orders arrive. Planned procurement and replacement of hardware must be organised. Similarly, stock levels of water fittings such as valves have to be maintained. This implies a high degree of management and a good level of stock control, and all this becomes doubly important, as donors are increasingly demanding greater accountability for the funds they make available in emergencies.

Staff employed to operate the system must be well trained not only to perform their daily tasks, but also to understand why they are doing so. This, if something goes wrong, they will be better equipped to correct it. Until this level of training has been reached, the systems will need a high level of technical supervision and staffing. All too often water systems costing considerable sums of money are installed, and the `experts', who have usually been flown in to supervise the installation, leave the project to be run by semi-trained local staff, who, through no fault of their own, have difficulty providing the service expected. Training of staff plays a vital part in the long-term success or failure of a programme.

Water and sanitation programmes use large amounts of manual labour, whether for digging pits for latrines or trenches for pipelines, for mixing concrete for water point or washing areas, for constructing storage reservoirs, for guarding installations and stock, or for operating pumps. A labour force of this size requires a great deal of management. Accurate records have to be kept of daily attendance; tools have to be provided; work needs to be supervised to ensure quality; and people have to be paid regularly. From the outset, a clear policy must be decided. How often and at what rate will people be paid? And on a daily or piece rate? Will some of the work e.g. constructing latrines be on a contract basis? What are the daily working hours? Will refugees or residents be used? Will people be working on religious days?

Box 4

As a result of inexperience, an expatriate engineer found himself threatened by a group of labourers who had been laughing and joking with him only the previous day. Local people had been employed to construct latrines on a greenfield site to which refugees were to be transferred. After the refugees arrived he continued to use local labour. It was then suggested that refugee labour might now be used. He agreed and without any warning, when the locals arrived for work the next day, they were told there was no more work. From the outset, the labour force should have been kept informed about the amount of work they would be receiving. Difficult situations can be avoided if consideration is given to actions beforehand.

Such issues need to be clear to the programme co-ordinator and to the people who are employed. It is worthwhile taking time to resolve these issues at the outset. If other agencies are working in the area, it is a good idea to have an agreed rate of pay and agreed working hours so that there is unanimity of conditions between agencies. If these issues are not resolved a great deal of time and energy can be taken up on an almost daily basis resolving personnel issues - time that should be spent elsewhere. It can also lead to problems of security for local and international, staff as was recently the case in Rwanda.

4. The Operating Environment: Needs Assessment, Co-ordination and Contingency Planning

4.1 Assessment of needs

During its assessment of a situation an agency will have to decide whether or not to become involved, in which sectors and in what way (e.g. as funder or implementer?). In any event, there are some overall guidelines which need to be borne in mind with respect to water and sanitation programmes.

When making an assessment of an emergency, staff should not only be aware of the situation as it relates to the interest/speciality of their own agency, but should also maintain a broader view of the affected population's principal needs. Considering water and sanitation needs in isolation can mean that related issues such as nutritional status and the provision of clinical services are overlooked. Providing water and sanitation facilities to a population that does not have access to adequate food cannot be expected to improve their health status significantly. Problems can be identified early on by non-specialists, who can then raise the issues with the co-ordinating body who, in turn, can find solutions.

Many factors will influence decisions about the type of water and/or sanitation programme that can be implemented. These will include the numbers of people that are affected, the type of population (internationally recognised refugee or internally displaced, resident or displaced population) and how long they are likely to be affected by the emergency. The local capacity to cope with the emergency should play a significant role in this decision-making process. Resources, expertise and skills amongst the local and the affected populations need to be explored. It is easier to obtain funding for international refugees than for a population that has been displaced within its own territory. The number of people affected by the emergency will impose a cost-benefit point of view on the agency implementing a water and sanitation programme; the more people there are, the easier it is to justify expensive water systems. Similarly, if people are expected to return to their own country or homes sooner rather than later, donors are less likely to be willing to fund expensive programmes.

In addition to local government, UN bodies and the affected population, the plans of other agencies are very important at this stage. When discussing interventions with them, it is useful to have an understanding of their capacity to provide all they may want to offer. Unfortunately, emergency relief is very competitive, and it is not unknown for agencies to want to undertake large programmes in order to get access to large funding and hence publicity. Equally, the desire to help may outweigh sound reservations about the capacity to respond. With this in mind, it is worth trying to assess an agency's ability to provide the services it has said it can offer. For example, does it have the technical resources and knowledge? At the same time, in a world of limited resources for emergency interventions, duplication of effort should be avoided.

Box 5

Knowing One's Limitations

For all the right reasons, agencies want to do as much as possible to help in emergencies. If they are present in the country when the emergency happens, it is very difficult to stand by and watch. However, agencies very often have difficulty in recognising the limits of their capacity. When technical interventions such as the provision of water and sanitation services are required, it is crucial that informed advice is taken and that limited capacity does not jeopardise the level of service that can be offered to the beneficiary population. Recognising one's limitations early on and asking for assistance will have a more positive impact on the wellbeing of an emergency-affected population than simply soldiering on because one is there.

If the population is displaced, and is therefore likely to be put into a camp, access to water should be the prime criterion, after security, in determining the location of the camp. This cannot be stressed enough. Every commodity other than water has to be imported. It is very important that an agency that is going to be involved in the provision of water should be engaged from the outset in the discussion about the siting of the camp. People have to collect water on a daily basis. Sites should therefore be selected as close to water sources as possible. If you are fortunate enough to be faced with a decision between a number of sites with abundant water, the site with the best quality water and hence the minimum requirement for treatment should be chosen.

It is important to recognise the potential for using water as a means of influencing site selection. You can easily rush into an emergency situation and start to provide water. However, once work on a particular water system has started, it is difficult to stand back and ask whether the site is appropriate. Providing a semi-permanent water system to a camp can sometimes validate a totally inappropriate site. If this is the case, there is always the option of providing the basic minimum service to meet immediate needs whilst telling the co-ordinating agency that further work on water is not appropriate and that the site ought to be moved. Such action may seem very disruptive but in fact it can be of vital future benefit to the camp population.

Experience has shown that in emergencies decisions are often taken on the basis of very little information. This can sometimes be justified on the grounds of the need to take measures to save lives. However, it can also mean that decisions which will have a major impact on the population being assisted are taken without their being party to the decision-making process. Consultation takes time – a commodity which is in short supply during the early stages of an emergency. But the principles of participation and ownership which are so strongly defended in the case of development programmes apply equally to emergency programmes and every effort should be made to involve the beneficiary community at every stage as early as possible.

In particular, the role of women should be recognised. Women are usually the collectors of water, the managers of the household and the teachers of the children.

They are therefore most directly affected by a water and sanitation programme and are best placed to help derive the maximum benefit from it. Interventions should consider ways to improve their circumstances, such as bringing the water as close as possible to shelters so as to reduce the amount of time required to collect it (see Annex 6 for a checklist on gender considerations).

Immediate needs. From experience, it is hard to reconcile immediate short-term needs with the time needed to assess the longer-term water and sanitation needs of a displaced population. It seems appropriate, therefore, to look at the assessment in two phases: immediate and long-term. The first phase is to look at immediate needs with a view to short-term interventions.

These will include assessing how much water is currently available. What are the defecation practices and are they hygienic? Are there water and sanitation- related diseases? (See Annex 4 for the expanded checklist on environmental health assessment). From this initial survey the first ideas for intervention will be formulated. Every effort should be made to obtain as much relevant information as possible. For example, are the local water sources sufficient to meet the extra demands that will be placed on them? Government departments or local administrations might have valuable data on the hydrogeology of the area; other agencies working on development programmes, in the water and sanitation sector, might have water maps, information on cultural habits, or the availability of construction materials or water equipment, and might be able to second a local technical staff member. All such information can save valuable time at this stage.

Every effort should be made to design initial responses to be compatible with future developments. For example, early systems should have the possibility of future expansion and development designed into them. Similarly, latrines should be carefully designed, particularly if space is limited and future options for resiting them are limited. Giving a little thought to such matters can save both time and money later on the programme.

Immediate responses must include the control of water sources and defecation practices. Natural sources, particularly surface sources, can rapidly become polluted directly by people contaminating rivers or lakes and indirectly by rainfall spreading surface pollution into the water source. Pollution can be minimised by keeping people away from the area immediately adjacent to the collection area and upstream of it, by keeping animals downstream of the collection point and by employing guards to maintain hygiene standards.

Longer-term needs. It is desirable to start long-term planning as early as possible and there is no reason why this cannot be ongoing whilst first-phase needs are still being addressed. The longer-term needs of water and sanitation programmes are by no means so obvious. In terms of sanitation provisions, it is very likely that washing and bathing facilities will provide a long-term benefit. Similarly, the provision of solid waste disposal facilities must be considered to help control rats, flies and other disease-carrying pests. As regards the latrines, what will happen when they are full? Is there sufficient space to resite them or will it be necessary to empty the existing ones? If so, how will the sludge be collected and where will it be disposed? With respect to water, it may be necessary to develop new sources for more sustainable long- term needs. For example, developing hand-dug wells or protecting nearby springs may be far more appropriate than using diesel or electric pumps, or chemical treatment processes.

Planning is needed when it comes to the operation and maintenance of systems. Consideration must be given as early as possible to who will be responsible for their long-term management. Some countries have line ministries with direct responsibility for refugees, and it is likely that they will want to be involved in all aspects of service provision. It is more often the case, however, that government bodies, because of lack of resources, are prepared to let NGOs get on with the service provision whilst they take on a co-ordinating role. If the intention is to hand over responsibility for water and sanitation to such a ministry this will probably involve discussion about the funding of activities and resourcing the programme in terms of skilled people. The same thing applies if local NGOs are interested in taking over.

With regard to water and sanitation programmes, the most likely agency to take over long-term responsibility is the local water department. If this is the arrangement, technical staff should be seconded to the NGO to work on the programme as early as possible. This will help avoid problems that may arise from lack of familiarity with equipment, processes or approach, and will help smooth the transition from one agency to another and go some way to ensuring continuity and maintaining standards of service.

Thought should be given to the effect the emergency is having on local populations. Displaced populations often settle in areas that are themselves poor, both in terms of natural sources and/or the wellbeing of the local population. If this is the case, the mistake of focusing solely on the needs of the displaced population is often made, and can have devastating consequences. The author has worked in a situation where growing resentment amongst the local population at being continually ignored by the relief agencies, resulted in attacks on their vehicles and the killing of a number of local and international agency staff.

Relations with local populations are extremely important and it seems entirely appropriate to consider extending services to them wherever possible. Good quality water is usually a scarce resource; when designing systems, thought should be given to providing access for the local population. Tension can also be created if high technology systems cannot be sustained or have to be moved to another site. Parallel interventions which address both low technology development needs and high technology emergency needs can be appropriately considered.

4.2 The importance of co-ordination

There is a direct relationship between the size of a population and the scale of an environmental health programme in an emergency. As population numbers rise, so it becomes more difficult for a single agency to take sole responsibility for all aspects of a programme. In a large-scale emergency this is a considerable commitment, and the logistical, administrative and technical support required is usually beyond the scope of a single agency. It is not unusual therefore for the sectoral responsibilities of an environmental health programme to be divided amongst a number of agencies. The role of inter-agency co-ordination then becomes extremely important, as does co-ordination with government departments, UN agencies and, not least, the beneficiary population themselves. Co-ordination is important throughout the emergency: from the assessment phase to the construction phase, and the operation and maintenance phase, right up to the time the installations are no longer required when people have either returned home or the emergency is over.

It is crucial that the flow of information between the relevant agencies should be free and open. This exchange of information can be interrupted: personnel may not relate well to each other; language can be a problem; disagreements become entrenched, or people may simply feel too busy to attend meetings. This must not be allowed to happen. How can an agency responsible for providing washing and bathing facilities, plan its work if it does not know where water is going to be distributed? Similarly, how can steps be taken to reduce the incidence of an outbreak of dysentery if the transmission route is not known?

Intra- and inter-agency co-ordination is fundamental to the success of a water and sanitation programme. Every effort should therefore be made to set up co-ordination meetings at local and country office level which agencies must be encouraged to attend. The host country's line ministry responsible for the emergency should also be encouraged to take the lead at such meetings. This will go some way to ensuring that people at different sites receive a similar standard of service and that, as a minimum, host government standards are maintained.

4.3 The need for contingency planning within an emergency programme

What happens if an emergency arises within the emergency? What happens if a large new influx of refugees arrives at the site, the water source suddenly dries up, or an epidemic of dysentery or, worst of all, cholera breaks out? There are no magic answers. The best course of action is to plan for such a crisis from the outset. Anticipation and contingency planning are prerequisites of any emergency programme.

Cholera is often a very real threat to displaced populations. Prevention is better than cure. Good quality water and sanitation services can offer only limited assistance in avoiding the threat of an outbreak, but with good hygiene practices they will go a long way to minimising its impact. If included from the outset, hygiene promotion can make a useful contribution to the contingency planning process (see *Waterlines*, April 1994 on the subject of cholera). A fact worth noting here is that during cholera outbreaks, more children die from other types of diarrhoea[3]. In the event of an outbreak of cholera, it is essential that additional quantities of uncontaminated water are made available to the camp and the local population. Consideration should also be given to increasing the residual chlorine in the water to provide stronger post collection disinfection. In Lisungwi refugee camp, Malawi in 1992, Médecins Sans Frontières adopted a strategy of dosing individual water containers with chlorine[4]. Treatment centres will be isolated from the rest of the camp and separate water and latrine facilities will therefore be required as well as baths for disinfecting footwear.

It will be useful for all agencies involved in the provision of water to go through a joint contingency planning process. Inventories of spare or under-utilised equipment can be drawn up so that everyone knows what is available if the worst happens. Similarly, human and technical resources can be pooled. Alternative water sources, which may be distant but are able to provide large additional quantities of water rapidly if needed, can be identified. Tankers can be on short notice standby contracts, as happened in Nepal in the case of the Bhutanese refugees. Access routes for tankers to water points can be improved to help speed up turn-around time. Sites within the camp can be identified in case additional water storage and

[3] Bartram and Howard, Waterlines (April 1994) in Annex 1.

[4] Mulemba and Nabeth, Waterlines (April 1994) in Annex 1.

distribution points are required. Piped water systems can be designed with possible expansion in mind, over-capacity is better than under-capacity.

5. Water: General Principles

5.1 Quantity and quality considerations

The general objectives of emergency water supply can be simply stated as:

IMMEDIATE
To protect water sources in order to minimise the risk of contamination.

To provide good quantities of water of a reasonable quality.

MEDIUM-TERM
To improve the physical and biological quality of the water.

To improve access to supplies through improved distribution networks and storage facilities.

These objectives are not mutually exclusive and work can be done on them simultaneously. Good practice must dictate that all work is carried out within the context of a safe working environment. All precautions must be taken to ensure the safety of people working on a construction programme. The emergency does not mean that normal safe working practices can be ignored.

Water is used or `consumed' by a population for drinking, cooking and hygiene purposes. As a general rule, the more water people can be encouraged to use for personal consumption the better. An absolute minimum of 3 litres/person/day is required for drinking and as an overall minimum 7-8 litres/person/day should be provided[5]. However, it is worth noting that if people come from an area where water has been scarce or difficult to access, it is possible that their daily consumption will be less than expected, as was the case in Rwanda where per capita daily water consumption in camps all over the country in 1993/4 averaged

[5] Mears and Chowdury (1994) in Annex 1.

out at 7.5-8 litres/day. Although aiming to increase the amount of water available and consumed, the agency responsible for the provision of water should pay special attention to the volume actually being used. If water is being brought by tanker the cost per litre will be very high, and a balance should therefore be aimed at between water available and water consumed, supported by the option to increase water availability in the camp should demand increase.

It is always desirable to have sufficient storage capacity inside a camp to meet at least one full day's demand, and this should be increased as far as funding allows. This is particularly important in the case of a water tankering operation where there are no other sources of water available. The fragile nature of a tankering operation means that often insufficient water will reach the camp. Stored reserves are crucial in such circumstances, and every effort should be made to stockpile water in the camp and to keep the stock as high as storage facilities permit. In this way, during periods of poor water delivery, volumes available to the camp population can be maintained. Where it is known that delivery of water is going to be problematic, the camp population should always be kept informed.

Difficulties will always arise in an emergency when deciding what is a reasonable or acceptable quality for water. It should be remembered that the WHO guidelines outlined in Annex 3 are in fact guidelines and, as such, desirable standards to be achieved. The overriding principle with regard to water quality must be to improve the biological and physical quality as much as possible with the means available, and to reduce the opportunity for disease transmission.

Biological and physical indicators can be easily monitored using simple analysis methods and kits. Portable kits specifically designed for this purpose are available. Reliable and relatively inexpensive water test kits, such as the Delagua, which was developed jointly by the Roebens Institute at the University of Surrey, UK, and OXFAM specifically for use in emergencies, will cost from $1,500, and are widely used.

A more contentious aspect is that of who has responsibility for water quality monitoring. Regular monitoring is very important. Frequently it is the agency providing the water which, for its own reasons, takes on the responsibility for reporting on its quality; this can be acceptable to other agencies when there are no problems, but if outbreaks of water-related diseases occur it will cause considerable friction. It is preferable that a third party should have responsibility for monitoring, recording and reporting on biological quality concerns. Local water departments may have this capacity; failing that, another agency with no direct interest in health service provision for the emergency, should be used.

Existing protected sources (piped systems) or groundwater sources (springs and wells) are likely to provide water of a better quality than surface sources (rivers, lakes).

5.2 Options for providing/increasing water supply

Broadly these fall into four types of approach:

- transporting water from existing sources to the population via piped systems or tankering;
- increasing the output/quality of existing sources by increasing pump and piping capacity, borehole/well deepening or treating surface water sources;
- creating new sources by drilling new boreholes or digging new wells;
- siting/resiting the population nearer to a better source.

Transporting water from existing sources to the population

Tankering. This is a costly and potentially fragile system. The preferred option is to move to a more sustainable supply system as soon as possible. Tankering performance can be impaired by problems related to: access in rainy seasons;

poorly maintained vehicles frequently breaking down; driver management problems – selling water can be a lucrative form of income in arid areas and drivers paid a daily rate have no incentive to make as many trips as they can; and independence of supply, e.g. regular access to the draw-off point may be limited if this is a town supply. From its origins in 1988 Hartisheik camp in Eastern Ethiopia, which at the height of the emergency accommodated 273,000 Somali refugees, experienced many such problems (See Box 6).

Box 6

Hartisheik

Water was brought to the camp from the nearest reliable source, which was the town of Jijiga, 75km away along very poor roads. When it rained, the clay soils in the camp made it impossible for the tankers to get close enough to the water storage facilities to unload; there were continuous difficulties related to managing the drivers ; because of the poor roads and unsuitability of the type of tankers used, vehicle breakdowns were frequent. Clearly the site was inappropriate from a water point of view, an issue that was recognised at the outset of the emergency. However, political constraints prohibited the movement of the camp population to more appropriate sites. The only option available for developing a water source closer to the camp was at a valley approximately 35km from the camp. Drawing water from this site released a great deal of tanker capacity as fewer vehicles could carry the same amount of water to the camp.

Continued reliance on tankers illustrates the difficulties faced when it comes to obtaining funding for developments after the main emergency has died down. From the earliest stages of the valley site development, there had been plans to pipe the water to the camp but has proved difficult to find the necessary funds and an agency willing to undertake such a large infrastructural project.

***Piping/pumping*.** Introducing a piped or pumped water system into an emergency will mean injecting a level of technology which will require design, management and maintenance. This dictates a level of technical knowledge and understanding on the part of the agency providing the water supply. In designing a technical system, making use of locally available equipment and levels of technology should be a priority. The quantities of materials locally available at the outset of the emergency may well be insufficient and relief materials will need to be imported. But the move to use local materials should be made as soon as possible; this will go some way both to ensuring the sustainability of the system and that local levels of expertise can be readily employed.

Pumping is expensive. Pumping water over large vertical or linear distances is very expensive and specialist equipment and technical knowledge are essential. Agencies involved in providing water in emergencies tend to stock, as standard response kits, pumps that are rated to a maximum of 40m. Allowing for the physics of pumping water, this effectively means a maximum height of 30m. If the decision is made to take water to the affected population, specialist equipment will therefore need to be ordered, with the inevitable time delays. As the height and distance increase, so will the water pressure, and the need for specialist engineering skills rises correspondingly.

Maintenance of pumps (diesel or electric) and generators (for electric pumps such as submersible pumps used in boreholes) tends to breakdown; motors burn out; control panels for electrical switching burn out or fail; powerlines come down and spare parts run out. A planned and adequately resourced programme of maintenance for all of these components is essential. Standby capacity for pumps and generators is needed. Pumps and generators are often imported and spare parts are not available in the country; stocks of regularly used as well as major spare parts are essential. Any generator or pump sent anywhere in the world by OXFAM will be accompanied by a spares package for 6,000 running hours. This goes some way to minimising the risk of extended breakdown due to mechanical failure. Again, good technical advice is a worthwhile investment when specifying equipment; it is very common for agencies to purchase the wrong equipment.

Increasing the output/quality of existing sources

Well-deepening. To make wells deeper, it is necessary to keep the bottom of the well dry to allow people to work there. `Dewatering' can be done by hand with buckets, handpumps, etc., or by using mechanical dewatering devices, which usually allow work to proceed faster and to a greater depth. However, it is unlikely that a village that is responsible for the maintenance of its own wells will have a dewatering pump available to it. This means that if anything goes wrong with the well in the future, it is possible that they will not be able to correct it.

If wells need to be deepened, the distribution of tools may be a more appropriate response than the provision of a dewatering pump, thus allowing the villagers to carry out their own improvements in a more appropriate and sustainable manner. In this instance, the agency involved in the programme has a responsibility to ensure quality control and to work with the villagers on the safety aspects of hand-dug wells.

If hand pumps are to be used on shallow wells, there is a responsibility to ensure that a good level of training is given to the maintenance technicians. This must be supported by adequate spare parts and technical back-up.

Springs. If there are springs in the area the problem may be one not of quantity available but of access to the water at peak demand periods early in the morning and late in the afternoon. One way of dealing with this is to provide an enclosed reservoir to catch the night-time flow which would otherwise have been wasted. From this a number of distribution points can be provided, thus enabling more people to collect water at the same time than at the previous single spring point.

Two aspects need to be considered when relying on spring sources: first their reliability as a water source, and secondly the quality of the water. Before investing a lot of time and effort into developing a spring source, the agency should be reasonably confident that the spring will continue to flow at an acceptable rate. Local information about the spring is therefore invaluable. If the spring is first identified during the dry season and is flowing well, there is a strong possibility that, with the advent of the rains, its yield will improve. The converse is true if it is identified during the rainy season. Having said this, springs can be very unpredictable and alternative sources should be kept in mind.

As with water from a borehole, unless there is a major source of contamination, spring water which is filtered as it passes through the ground, is likely to be of high quality. This has the direct benefit of eliminating the need for treatment to improve the quality. This gives rise to the question of chlorination, and whether a supply of good quality water requires the addition of chemical disinfectants.

The short answer to this is yes. The supply source may well be of good quality, as is usually the case with spring water; however, the containers used for its transport, and the handling the water receives after collection, can seriously contaminate it. In this instance, the objective of chlorination is to provide a residual of active chemical in the water which can go some way to disinfecting the way it is handled after collection. The agency providing the water can have control over its quality only up to the distribution point; thereafter it is the responsibility of the users. There is a direct relationship between hygiene practices and water-washed or water-borne diseases. It is at this point that the hardware component of a water supply system gives way to software interventions. The engineers have a responsibility to ensure that the agreed chlorine residual is present at the collection point and this is the point at which residual levels should be measured. Annex 7 discusses the chlorination process in more detail.

Using existing pipelines. When they were originally installed, piped water systems will have been designed to benefit the maximum number of people. It is probable, therefore, that there will be very little scope for increasing the numbers of people that can draw water from them. If large numbers of additional people start to take water from existing pipe systems, there can be serious impacts on the populations downstream. This needs to be taken into account when dealing with any network. There is one other drawback to relying on such piped systems. People, like water, always take the line of least resistance. If an agency relies upon piped water systems or explores ways of marginally increasing the water available through them it is possible that this may inadvertently have a negative impact on the water and sanitation related diseases in the camp, by encouraging people to wait for inadequate quantities of water at or nearer the camp rather than tapping large volume sources, such as springs, some distance away.

Treatment. From the outset it is worth stating that there is no definitive method for treating water. Every water source will display differing characteristics and there will be a number of ways of treating them. The important thing in supplying a refugee camp is to get reasonably clean large quantities of water flowing to the camp. After this, the quality can be improved and there will be the opportunity to try alternative methods of treatment with a view to simplifying the process.

The objective of any treatment system is to bring the water to an acceptable level of clarity so that the chemical used to disinfect it can be as effective as possible. The overall aim of the process is to kill all pathogens in the water and thus minimise the risk of transmitting disease through the water supply. Particulate matter can encourage the growth of bacteria and protect pathogens against the effects of disinfection. The simple chlorination of cloudy (turbid) water, for example, will require more chlorine than clear water and, even then, the water may still not be safe to drink. Water treatment, therefore, aims first to remove the pathogens and particulate matter by mechanical and biological means (settlement, filtration, etc.) before relatively clear water can be finally treated by disinfection.

It is probable that there will be a great deal of suspended solids, i.e. particles of soil, in the water. Individually, these particles are likely to take a very long time to settle. If the process of settling can be speeded up, then it should be possible to produce large quantities of clean water within acceptable time limits. A standard form of water treatment uses the system of sedimentation and flocculation to settle the solids. This process can be speeded up with the addition of certain chemicals. In emergencies, the most frequently used is aluminium sulphate, usually referred to as alum.

Used either as an independent treatment or as part of the sedimentation and flocculation process, rapid pre-filtration (often referred to as roughing filtration) can significantly reduce the turbidity of water. One or more stages of roughing filtration before flocculation can significantly reduce the time needed to treat a batch of water and hence the equipment needed for the water programme.

Another system of water filtration is known as Slow Sand Filtration (SSF). This has the significant advantage of being able to purify and filter water if it is designed and managed well, and can be a very effective means of supplying good quality drinking water. However, by definition SSF is a relatively slow form of water treatment, and volumes of water for large numbers of people require a large-scale installation. If a displaced population is in excess of 15-20,000, SSF will not be able to supply sufficient quantities of water without a very significant capital investment.

It is always worth experimenting with ways to reduce the amount of treatment required. For example, digging wells by the side of a river or lake may offer a good means of initial physical and biological filtration. If water flows freely into the wells it may be possible to supply the camp with this ground-filtered source of water. One well is unlikely to supply sufficient quantities, but drawing water from a number of wells may prove satisfactory. The riverside well is sometimes referred to as an infiltration gallery, as water passes or infiltrates from the river or lake.

Another form of infiltration gallery can draw water from under a river or stream. This is technically complex as the river will need to be temporarily diverted whilst pipes and layered gravel are placed below the river bed. Once this has been done, the river can once again follow its natural course and water will filter through the gravel and into the pipes which run out into a collection gallery which will have been dug into the river bank. This method was used successfully in East Sudan in 1986 to serve 100,000 refugees in the Wad Kowli and Sefawa camps. The infiltration galleries were constructed across the River Atbara during the dry season and saved what would have been a great deal of expense and effort in chemically treating highly turbid river water.

Creating new sources

Boreholes. Groundwater is naturally filtered and, as such, its bacteriological quality is likely to be good. This has an immediate benefit for emergency water supply as it means that little or no treatment will be required before distribution to the population. It is possible however that the water is chemically unacceptable for human consumption. Problems are frequently encountered with the level of salts in groundwater which makes the water unpalatable. In most instances, very little can be done to remedy this.

Box 7

An interesting situation arose in 1993 in Northern Afghanistan in the programme for refugees from Tajikistan. A camp was being established in desert conditions. It was known that there was a layer of water 20-30m below ground level. This would make it a very appropriate depth for hand-dug wells as a medium-term solution to the water problem. However, the water turned out to be highly saline, and so the major source for the camp continued to be the borehole supply which was drawing water from a non-saline layer at 60m.

Another common occurrence is to find high levels of iron and manganese in the water, which make it unpalatable. This can be dealt with relatively easily by employing very simple aeration techniques in the system.

As with all emergency water supply systems, attempts should be made to maximise the storage capacity. Supply from boreholes can be erratic as they are dependent upon mechanical devices for bringing the water to the surface, and at some stage will inevitably break down.

Such considerations emphasise the fact, that when water is being drawn from a deep groundwater source, the level of technology employed is high, and is usually much higher than that commonly used in the area. This has considerable implications for the continuity of supply, as it is imperative that adequate spare parts, technical knowledge and funding are available to run the system.

In the simplest form, if the groundwater is less than 50m below the surface, it may be possible to consider drilling small-diameter boreholes (sometimes referred to as tubewells) which can be fitted with a hand-pump to lift the water to the surface where it can be collected for use. Where the geology and soils of an area allow, it is possible to drill such wells by hand. This is a very common practice in countries such as Bangladesh, India and Nepal. The volumes of water that can be delivered via hand-pumps are relatively small; accordingly the only way to produce sufficient water for a sizeable population is to install many handpumps. This is a time-consuming process and is unlikely to form part of the immediate emergency response.

If hand drilling is not feasible, it will be necessary to use a drilling rig. If this is being considered, a useful starting point is to find out as much as possible about the likelihood of finding sufficient quantities of water where the drilling is to take place. Water-bearing strata below ground level are called aquifers. Information about them is most likely to be found in water departments or universities, but any agency that has been involved in water development will possess such hydrogeological information. From these data, it should be possible to estimate whether or not sufficient water can be produced to support the population. Having said that, there are no guarantees that water will be found where it is needed or that the quantities will be adequate. Drilling for water is a risky business and frequently many attempts have to be made to find it.

Knowing how deep the water is and how much piping will be used, is important when ordering pumps and ancillary equipment such as generators. An accurate estimate of the volume of water required for the population will provide an indication of the number of boreholes needed and dictate the capacity of the pump(s). It is always best to allow for increased demand when specifying this sort of equipment, to avoid the need for re-ordering larger equipment. The distance the pump has to push the water will determine the size of its motor and the power of the generator required to supply the electricity.

Informed technical advice concerning drilling rigs and boreholes can pay for itself many times over, if correct solutions are prescribed at the outset. In an emergency, it is possible that cheap, lightweight drilling rigs will be more than adequate for the job. However, those who are to be involved in taking decisions about funding or embarking on a borehole programme ought to be aware of the technical complexity of such a programme.

Where the agency is not drilling the boreholes itself, it is important that a drilling contract should be drawn up covering all eventualities. For example, who pays for the unsuccessful holes? What happens if the contractor has to abandon the well? The UNHCR *Water Manual for Refugee Situations* provides guidelines for its implementing partners regarding technical specifications for well construction (see Annex 1).

Operating a borehole-sourced supply system implies ongoing technical support. As outlined under the *Piping and Pumping* section above, managed maintenance will be necessary.

Borehole yields can reduce with time. This can be the result of the initial drilling and development process or can be associated with the chemical composition of the water and the type of materials used in the borehole. Consequently, the yield should be monitored regularly so that problems can be identified early in their evolution and remedial measures adopted.

Rainwater harvesting. Although very useful at a domestic level, rainwater harvesting is unlikely to be able to supply the needs of large numbers of people. Rainfall is erratic and unreliable. It is not therefore recommended as an emergency water supply source. However, rainwater catchment from large roofed buildings, such as medical centres, can provide a useful supplementary source for feeding centres and clinics.

6. Sanitation: General Principles

Emergency sanitation services should have the objective of providing a healthy environment for a population to live in. General objectives can be stated as:

Latrines

To isolate and contain human excrement in a culturally appropriate manner.

Other sanitation considerations

To modify the environment in which disease-carrying organisms are simultaneously most vulnerable and threatening to humans.

6.1 Latrines

When large numbers of people settle on a new site an immediate concern is how to prevent major outbreaks of diarrhoeal diseases. Control of defecation practices can play a large part in this. It is useful to think of a sanitation and latrine construction programme in two phases: first, to offer communal facilities to be used by large numbers of people; second, to provide a level of service which tries to reduce the numbers of people using a facility to family or small community structure levels such as groups of families. The two phases are not mutually exclusive, and work on the second phase can start as soon as possible and can be simultaneous with the first. The first-phase facilities should be designed to contain the volume of communal excreta that will be produced until the second-phase facilities are functional (for design criteria see Annex 3).

Immediate approaches. Quite clearly, it will be impossible to provide each family with a latrine of their own overnight. Alternative measures have to be taken. The most immediate response is to establish defecation areas. This is called managed defecation, the theory being that if as much faeces as possible is isolated to one area it will be possible to control, to a limited extent, the opportunity for faecal-oral disease transmission. People can be employed to clean the area and bury the faeces. The opportunity for disease transmission can be further reduced if people are encouraged, and given the means, to bury their own faeces. A simple `cat-hole' can have positive benefits. This simply means making a small hole into which people defecate and then cover it over; this has the direct advantage of placing a barrier between the faeces and flies which can play a role in the faecal-oral transmission route.

As its title implies, to be successful, managed defecation requires a high degree of management. It is not enough simply to demarcate an area for defecation, its use needs rigorous promotion amongst the population and concerted effort to ensure that the area is cleaned. The defecation area needs to be down-slope and downwind of the camp.

A preferred alternative to the defecation area is the trench latrine. This is simply a long, narrow trench dug as deep as possible, which may or may not have some form of shelter over it, where people can defecate. The trench needs to be managed and people employed to cover the faeces in the trench with a layer of soil on at least a daily basis. When the trench is full, another can be dug and used.

As the next stage in the development of the latrine programme, communal latrines can be provided. These are simple latrines designed to be used by large numbers of people and are usually built in rows or clusters which are segregated into facilities for men and women. As many people will use these latrines it must be recognised from the outset that they will fill very quickly and it will be necessary to make provision for either emptying them or re-siting new ones. It should be emphasised that whoever is responsible for establishing communal latrines must inspect them regularly and ensure that they are hygienic and safe to use. Poorly maintained communal latrines pose a major threat to public health. Special measures will be necessary to cater for the infirm, elderly and children who may not be able to use communal latrines.

Pit latrines. Providing communal latrines allows a breathing space whilst work on the second phase is under way. This second phase will have been decided upon early on and will be seeking to provide latrines on a ratio of at least 1:20, i.e. 1 squatting hole for every 20 people. This is UNHCR's guideline figure. A number of agencies, including MSF and OXFAM, aim to reduce this ratio further and bring it down to 1 latrine for every 1 or 2 families. The distinction between `squat hole' and `latrine' is made deliberately at this point. According to the design, it is quite possible that a latrine will house more than one squat hole. Latrine refers to the shelter and pit, whilst squat hole refers to the hole(s) through which people defecate within the latrine.

A good latrine is one which provides a barrier between the faecal matter contained in it and the outside environment. If this is achieved, human and fly contact with the faecal matter will be limited and a major disease-transmission route will have been interrupted. This implies that digging a hole and placing a shelter over it does not represent a good latrine. The pit must be completely sealed between the bottom of the shelter and the ground; the squatting slab has to be sealed, e.g if wooden planks are used, the gaps between the planks must be filled; the hole in the squatting slab should have a cover which is placed over it after every use; and the squatting slab must be kept clean of all faecal matter. By following this practice, smells will be minimised and people will be encouraged to use the latrine.

The **Ventilated Improved Pit latrine** (VIP) has received much attention in recent years. This is a latrine with a pipe coming out of the back of the shelter. If designed and constructed correctly, these latrines can be very effective at controlling flies and odours. However, in an emergency, the necessary materials are frequently not available for their construction. VIP latrines are more expensive than basic pit latrines. This usually means that the limited funding be available for a latrine construction programme will build more latrines if a basic design is adopted in preference to the VIP model[6].

Box 8

At a refugee camp site in Rwanda, much attention was given to the provision of recreational facilities for children. In itself this is to be commended. Many photographs were taken by visiting press of children playing on the swings. In the immediate background were communal trench latrines. These latrines were less photogenic since they were inadequately managed and unhygienic, offering little more then a very shallow trench, some widely spaced planks to walk on and a minimum of shelter. They almost certainly posed a health risk to the children using the swings and to the people living in the shelters close to them. There is nothing wrong with providing recreational facilities, but every effort should first be given to ensuring that good basic services are provided.

Another recent development in latrine design has been the introduction of the **Sanplat latrine**. This is the name given to a squatting slab that is designed to be easy to clean, to provide a good sanitary seal between the pit and the outside atmosphere, to use minimal amounts of construction materials and to be inexpensive. The squatting slab is dome-shaped which ensures maximum strength with minimal thickness of non-reinforced concrete[7].

6 See Morgan, 1990 for good detailed designs in Annex 1.

7 See Waterlines (April 1994) in Annex 1.

Planning. Crucially important is the planning stage when it is decided where the latrines will be sited. There are specific guidelines on this (see Annex 3), but in general consideration must be given to keeping the latrines as far away from shelters as space allows, whilst not placing them so far away as to discourage their use. Particular difficulty will be experienced when space is very limited. Latrines should not be closer than 6m to a shelter. If this cannot be achieved for the second phase of construction, shelters will either have to be moved or latrines placed at the periphery of the camp/area.

Technical constraints

Other circumstances may force decisions which dictate the position of a camp in relation to a spring source, and this means that standard practice guidelines have to be disregarded. The advice must be: if in doubt, build the latrines further away. If the camp is 100m above a spring, the chances are that very little contamination of the water will take place; if the distance is 30m, 40m, 50m or 60m the decision is more difficult. Whenever latrines are placed uphill of a spring or other groundwater source, it is absolutely imperative that the bacteriological quality of the water is monitored at regular intervals. Once a week would be a good start; this will give early indication of contamination and allow remedial measures to be taken.

Depending upon the soil type, it may be necessary to consider total or partial lining of the pit to protect against collapse. Total lining means that the pit is walled from top to bottom on all sides, whilst partial lining entails providing an apron of wall on all sides of the pit from the surface to a calculated distance below ground level. Materials that can be used for lining are normally bricks and mortar, concrete or wood. In areas where bamboo is in plentiful supply, this can be used as a substitute, although it should be considered as a short-term lining since the sludge in the pit will quickly destroy the bamboo. The decision to line pit latrines has significant implications for the cost and speed of construction and should be taken from an informed standpoint. Advice can be sought from civil engineers or people with experience of excavations in the relevant area.

Some labour force issues. First-phase latrine construction will usually have to rely on paid labour to do the manual work. Whilst it is desirable to use voluntary labour throughout the programme, the rapid provision of early communal facilities is of prime importance, and organising and motivating voluntary labour can become a major bottleneck. Paying people helps to bypass this problem. However, for the second phase, where families or well defined groups will receive their own latrine, every attempt should be made to use voluntary labour, especially for digging the pits, carrying materials and any other unskilled tasks associated with the construction. Each social unit to receive a latrine should be encouraged to participate in the construction process. If things are well organised, sufficient pits should be available each day to allow the team building the shelter and squatting plate to follow on without waiting. From the view point of quality control, it is usually preferable to retain teams of skilled labour, which can be voluntary or paid, to build the shelters and squatting plate.

This Section gives an indication of the scale of work required at the beginning of a latrine construction programme. It has all been considered without specific reference to the cultural habits of the population to be assisted. This can have major implications for the programme and may mean that traditional thinking on the part of the agency may be inappropriate (see Box 9) .

Box 9

When 70,000 Hindu refugees from Bhutan arrived in eastern Nepal in 1992, a standard sanitation approach was adopted by the agencies present. Communal latrines were provided whilst planning got under way for family-level latrines. It soon became clear that the communal latrines were totally inappropriate for the population. Hindu culture poses some very difficult problems for sanitation work so far as communal facilities are concerned. With this particular community, privacy and hygiene were very important. When at home, people would use the fields for defecation, but would go to great lengths to ensure that they did not use an area which had previously been used. The idea of stepping in an area where people had defecated was abhorrent. Thus the notion of communal latrines and defecation areas was repugnant to them and represented all that was unhygienic.

Another problem was that talking about personal hygiene practices was virtually taboo. It was absolutely essential that men and women had separate facilities. Most of the camps were densely populated and siting latrines proved very difficult. From a sanitation perspective a number of the camp sites were inappropriate but when it came to allocating space for the refugees the local authorities were constrained by enormous land pressure in a densely populated area.

What could be done? Dysentery was escalating, cholera was endemic in the region and there was a real threat of an outbreak. The obvious thing was to provide family-level latrines as quickly as possible. However, optimistic estimates put a timescale of 16 weeks on the construction of the 5,000+ latrines. Short-term measures were needed. It was decided to establish sanitation committees in each camp. These provided a forum for discussion of sanitation issues, a body of people with responsibility for promoting good hygiene practice and a means of helping to organise the labour for the latrine programme. The eventual outbreak of cholera forced the refugees to reconsider the approach of the agencies, and communal latrines were constructed after major consultation with the committees about their location and design. People were employed to keep these latrines clean (these people were not from the camp populations, but were drawn from the Untouchable class in the nearby villages as no-one else would do the work).

6.2 Other sanitation considerations

A number of issues including children's needs; solid waste disposal; drainage; provision of services at market areas; the burial of dead bodies and disposal of waste from medical facilities fall into this category.

Children's needs. Children are a very important category in a sanitation programme. This faeces contain far more pathogenic organisms than those of adults. It is therefore essential to keep to an absolute minimum the amount of infant faeces on the ground. Children do not like dark latrines. Special features can be designed into the latrines to help this. The squat hole should not be so large that children can fall in or be intimidated by it. A successful innovation to a standard double latrine in Rwanda involved constructing a third squatting hole over the pit for use by children. Unlike the other squat holes, it was not sheltered; a cover was provided for the hole and a wooden support to hold on to was placed around the squat plate. This design proved to be very effective and children could be seen helping each other whilst using the latrine.

Box 9 (continued)

It had been agreed with the camp population that the second-phase latrines should be shared family latrines i.e. 1 latrine for 2 families. It was acceptable for people to share facilities on this scale and take the full responsibility for cleaning and maintaining them. Two years on, these latrines are reported to be functioning well, people are using them and they are being kept clean.

The emergency phase of the sanitation programme was far from successful, and it could be argued that the initial inappropriate programmes created a separate sanitation emergency. However, this was the first Hindu refugee population that any of the agencies involved had encountered and was a particularly difficult community to work with on sanitation issues. Salutary lessons can be learnt from this experience, the most obvious being to work with the population, not in isolation from them.

Other measures should be undertaken to ensure that when children defecate in the open their stools are cleaned up and buried. Any hygiene education initiative should raise this issue with parents, and persuade them to consider safe and practical methods of disposal of their children's faeces.

Dealing with solid waste. Solid waste disposal is unlikely to be a serious problem during the early stages of an emergency, as very little solid waste is generated at this time. However, as part of a vector-control programme, it is an issue that needs to be addressed sooner rather than later. The basic principle is to contain the solid household waste and prevent contact with humans, flies and vermin such as rats.

A number of approaches can be adopted. The first, and simplest, is to provide each sector of a camp with a hole which is centrally located, into which all families in that sector deposit their waste and then cover it with soil. This has the advantage of being simple but the disadvantage of needing to dig fresh holes every time one fills up. An alternative approach is to consider a waste collection system. It may be possible to provide rubbish bins e.g. old oil drums, within each camp sector, into which waste is deposited. These bins can then be emptied regularly on to small hand carts which transport the waste to a burial pit outside the camp. This system has the option of burning the waste, something which should not be encouraged in the first alternative because of the high risk of in-camp fires.

Drainage is something which again needs to be considered in the context of vector control. Standing water provides an optimum breeding ground for mosquitoes, and the aim of a drainage programme is to prevent this occurring. If the camp or settlement site is on a slope, the drainage should be designed to take advantage of this and the water carried away down-slope. A perfectly flat surface is very rare and just about any slope can be utilised for drainage purposes. The water should be carried some way from the site to an area where it can either drain freely away or soak into the ground. Conversely, if the problem is standing water as a result of depressions in the site, it may be necessary to consider filling in these depressions to prevent future collection of water.

The drainage system should be designed to channel away water from large rainstorms. Intense rain can do a great deal of damage to makeshift shelters, if it is not adequately diverted away from them. A network of large drains should be provided for the whole camp, with feeder drains channelling into them from shelter, sub-sector and sector levels within the camp.

It is important that drainage activities are co-ordinated with other infrastructural developments in a camp. Roads, in particular, can cause problems for drainage works. Elevated roads which are designed to be free draining and quick drying, and are on the down-slope side of a camp, need to have culverts built in, otherwise they will act like a dam, and shelters close to the road can be flooded very quickly in heavy rainfall.

Special consideration should be given to the waste water produced by water collection areas. The design of these areas aims to minimise the loss of water and prevent puddling. One solution is to provide a concrete apron around the water point, which channels the water away. Inevitably considerable amounts of water are spilled around the water points. If possible the water should drain into the larger camp-level drainage system, but if the terrain does not permit this other solutions need to be sought. One of these is to dig soak pits (sometimes referred to as soakaways). A soak pit is simply a hole in the ground which is filled with gravel to support the walls against collapse. How well the soil absorbs the water will determine the size and number of soak pits that are required.

If there are livestock in the area, an appropriate means of disposing of drainage water may be to channel it to watering troughs for the animals.

Waste from health centres is particularly dangerous. It should be handled carefully and preferably should be destroyed on a daily basis in an incinerator. Failing this, an incineration pit can be used and the residue comprehensively covered. *Important Note: it is always good practice to bury incinerated waste as temperatures may not have been high enough to kill all pathogens.* Special care must be taken with drainage water from cholera isolation units. Large quantities of water are used at these centres and good drainage must be ensured to a soakaway, which must be well protected and guaranteed not to discharge into any water source.

Market Areas are particularly difficult from the point of view of sanitation. They are notorious for posing public health risks, especially when food and drink are for sale, but they are also important trading and social facilities for camps. If possible the market area should be sited outside the camp. In view of the health risk, it may be desirable to create a number of small market areas rather than a single large one. Latrines should be provided at these sites and some form of cleaning, almost certainly entailing paid labour, should be organised. Whether or not it is possible to provide water at the marketplace will depend very much on the design and capacity of the water system. However, in general it is best to keep water out of the immediate area, and, where possible, to have a distribution point nearby.

Solid waste from a market area should be collected and buried or burnt.

6.3 Hygiene awareness

The example of the situation in Nepal spelled out in Box 9 illustrates very positively the need to take time to collect information about a population's hygiene practices. In addition, it is useful to try to determine the level of understanding that exists about the relationship between water, sanitation and personal hygiene. Depending upon how good the understanding is, it may be necessary to consider undertaking a hygiene awareness or education campaign. In some cases where the understanding is good, it may be helpful to inform people about the unusual risks they face because of their densely populated living conditions. In others, the emphasis may need to be more basic, with a concerted effort to educate people about good hygiene. Whichever the case, time spent early on trying to understand the affected population and designing into the programme a component dedicated to helping them organise themselves to obtain the maximum benefit from the infrastructure being installed for them, will play a significant role in their future wellbeing.

It is highly likely that there will be skilled and educated health professionals within the population. Such people are invaluable to an education programme as they can not only bring the required expertise, but also share a common language and cultural background with the population. The latter aspect is irreplaceable and every effort should be made to involve these people.

Helping people to understand the risks of their new environment is the first step towards improving hygiene practices. However, unless modified practices can be facilitated the impact will be negligible. In this context, it is important that basic non-food items which are directly related to hygiene behaviour, such as soap, cooking pots and utensils and water containers, are distributed. It is futile discussing improved water storage and handling practices in the home if people do not have suitable storage containers.

Agency staff should be equally aware of the importance of hygiene. This particularly applies in the case of cholera. Measures should be taken to ensure that staff are aware of the risks not only to themselves, but to the community with whom they are working (see Annex 5).

7. Typical Scenarios

7.1 Introduction

This Section presents seven scenarios which are broadly representative of the majority of emergency water and sanitation situations faced by relief personnel. It also indicates the particular considerations that need to be taken into account in these situations.

The principal benefit of such an approach is that information can be conveyed in a way which is more accessible to non-specialists than would be possible using a more generalised approach. However, there are drawbacks to the approach and it is important that readers should be aware of them. First, a few `typical' scenarios cannot cover all possible types of situation likely to be faced by field staff. Second, scenarios which are typical are not necessarily mutually exclusive. However, it is hoped that readers may be able to find information relevant to their own circumstances which will help them to participate in discussions on the design and implementation of emergency water and sanitation programmes.

7.2 Population displacement into arid areas

Water Characteristics. Arid regions often pose the greatest difficulty for emergency water supply to displaced populations, for by definition the areas are dry. The long-term options are either to move the camp closer to a reliable water source or to develop an independent water source close to the camp. Both are likely to be slow processes. The short-term options may include bringing the water to the camp by lorry (water tankering) and maximising the use of local sources found in the area.

Section 5.2, under the heading *Creating New Sources,* discussed the technical complexities associated with developing a borehole supply. Nevertheless, borehole sources can and, all around the world, do provide good quality and reliable quantities of water in emergency situations. However, some other issues arise from the use of boreholes, which can be particularly important for the resident population. An illustration from the Twareg refugee programme in Mauritania in 1992 illustrates this point very well (see Box 10).

Box 10

Borehole Sources in Mauritania

In a very arid area the only option for supplying water to the refugees was from deep boreholes. The boreholes were 125m deep. Near to Fassala Nere camp, there were some traditional hand-dug wells of 60m depth, which were used by the local population. Within a few months of the boreholes being operational, locals within a few kilometres radius of them started to complain about their wells drying up. This was almost certainly as a direct consequence of the rate of borehole extraction. In such instances, the volume of water being drawn from the aquifer is greater than the rate at which it is recharging. This inevitably leads to the water level dropping. Hence, the local wells were drying up. The only thing that can be done to the wells is to deepen them. At 60m below ground level, this is a complicated task.

Establishing a high volume water source in an arid area can also interfere with local agricultural systems and cultural practices. Again in Mauritania, local nomadic practices were interrupted by the borehole water. The opportunity of reliable volumes of water all the year round acted like a magnet drawing large herds of livestock to the area. This had disastrous effects on the vegetation. Animals were grazing the same area for prolonged periods and, whereas previously, grasses would be grazed to ground level, roots were now being eaten, with direct consequences on soil erosion and stability. By relying on a single water source, people were jeopardising their future ability to sustain their traditional agricultural practices.

Sanitation characteristics. Much of the discussion in sections 6.1 AND 6.2 will be relevant here. From the point of view of sanitation, arid areas are well suited as space is not usually such a limiting factor and hot, dry climates are naturally better at inhibiting the transmission of faecal-oral diseases when open defecation habits are practised. Unless the soils are rocky and/or shallow, the scope for digging pit latrines is also good. If it is a desert environment, it is probable that construction materials such as wood, sand, gravel and cement will be in short supply. Reliable sources for the supply of these materials will need to be found.

7.3 Population displacement into hilly or mountainous areas

Water characteristics. Very often in mountainous or hilly terrain the issue is not so much where the water is to come from, but how to get it to the population. As always, it is very important to consider the proximity of water when choosing a camp site.

Water is usually found in the valley bottom in the form of a river, lake or as groundwater. Sometimes it will surface through a spring-line, i.e. above ground level where it is forced out of the hill side because an impermeable layer prevents further downward flow. If luck is on your side, a spring-line may exist above the level of the camp site. This will allow the water to flow by gravity through pipes to the camp. However, such a situation should by no means be taken for granted and every effort should be made to identify a reliable water source before the site is chosen.

If a hilly area is populated, it is the valley bottoms that will be either cultivated or inhabited. In either case, there will be enormous competition for land, and it is unlikely that land for a camp site will be able to be negotiated with the local inhabitants. This will dictate that the site is either on the slopes of the hill or at the top. Its exact location will depend on the slope, which is important because if it is very steep people will not be able to live there, and access for agency vehicles might be difficult.

When people are living at a significant height above a water source the agency is faced with a major decision: should it pump the water up to the people or ask the people to walk down to the water? Before making this decision, what is entailed in taking water to the camp should be clearly understood, as significant pumping will be required. It is not impossible to pump water to considerable heights but the system is difficult and expensive, and it does take a long time to install. The running costs are also high and generous budgets should be allowed for this.

On the other hand, asking people to walk long distances down steep slopes to collect their water is also far from ideal. The extent to which this can be expected of them will depend upon how they usually collect their water. If they are from a region where they normally walk downhill for their water, this will be nothing new to them; if they are not, then problems will be encountered when trying to persuade them to collect sufficient water on a daily basis.

If people are being asked to collect their water from difficult access points, it is more important than in other situations to ensure that they have adequate means of transporting it. The emphasis is always on increasing the amount of water used and so, if people are to walk long distances for their water, it should be worth their while. In the same way, means should be made available for storing water within the shelter so that there is always the opportunity to have one vessel available just for transporting water, whilst another is used for storage. This usually means providing jerry cans and they may not be readily available in the particular country or region. Local alternatives, such as clay pots, will be in use and may be available on a reasonably large scale. Narrow-necked containers are preferred as they help prevent the ingress of air- or hand-borne contamination.

Box 11

The Central African states of Rwanda and Burundi have a topography and population densities which typify all that is difficult about providing water to displaced and resident populations in hilly conditions. Since February 1993 and until the outbreak of civil war in April 1994, a great deal of effort has been devoted to providing water to hundreds of thousands of internally displaced and refugee populations in Rwanda. There is virtually no free land available for displaced persons' camps in the most densely populated country in Africa. The problem was always how to get water to the people and almost always the answer was to provide better collection and distribution points close to the spring site, whilst encouraging increased use and collection of water. Important in this context is the role of hygiene awareness amongst the population. There needs to be a valid reason in their own minds as to why they are being asked to expend huge amounts of time and energy collecting more water than they may have been used to.

Obviously the decision about pumping water a long way uphill will be influenced by a number of factors, including the predicted length of stay and the number of camps being considered. In Rwanda, for example, during the Burundese refugee influx in October 1993, there were up to 30 camps needing water. Funding for this was limited and would not have met the full cost of pumping water into all the camps. This gives rise to another question. If there are large numbers of people and providing water is going to be a problem, is it better to leave people in small settlements near to water sources such as springs, or to gather them into a large camp where substantial expenditure on a water system can be justified? If small settlements are preferred, this may mean that the provision of other services such as health care may be more complicated than in a large camp, but note should be taken of the fact that people have to collect water daily and the effort required to do this should, where possible, be kept to the minimum.

Sanitation issues relate to the slope of the ground and the influence latrine siting can have on water quality, and also the depth of soil.

Digging a hole for a pit latrine can be a more complicated procedure on a slope than on flat ground. The ground needs to be levelled off so that a squatting plate can be installed, and care must be taken to ensure that the risk of pit collapse is minimal; good drainage around the latrine structure is also essential. Water must be diverted away from the pit, not only to prevent pit collapse, but also to ensure that rainwater does not prematurely fill the pit and cause it to overflow.

The depth of the soil is another important factor. The sides and tops of hills often have very little soil cover. This will cause problems, as it will not be possible to dig sufficiently deep pits. Alternative sites can be identified, but other local constraints may limit the possibilities. In this case, engineering solutions need to be explored. The most readily achievable solution will probably be to dig the pit as deep as possible and then to add extra storage capacity by extending the structure above ground level. In other words to create a sealed chamber above ground level. Another option might be the regular emptying of shallow pits – known as desludging – and transportation of the material to other disposal sites.

If defecation areas are to be used during the first stages of the camp's development, consideration must be given to the relationship of the areas to the camp and water source. If a defecation area is sited above a camp, when it rains all the faecal matter will be washed into the camp. Similarly, if an area is above an open water source, such as a river or lake, the excreta will be washed directly into the water that people are collecting for domestic use. This will severely affect the health status within the camp. During the Burundese refugee influx into Rwanda in 1993, at the very early stages of the development of one camp, open defecation was the practice both inside and around the camp. The camp was on a very steep slope. The only water source nearby was a marshy area immediately below the camp, which in itself offered a poor and polluted source of water. The rainy season had just started and every time it rained, excreta were washed directly into the marsh. This camp was to have the highest incidence of dysentery amongst all the refugee camps.

Care must also be taken when siting latrines if the camp is above a spring or springs which are being used for the provision of water. Just as excreta can be washed down a hill and into an open source, so they can move through the soil and into spring water. Exactly how water will move below ground level in any given area is very difficult to predict. However, to minimise the risk of contamination, the maximum possible distance should be maintained between the latrines and the spring. It is difficult to be more specific than this. Text books always say that latrines should not be sited uphill of a water source and should be at a minimum linear distance of 30m. This allows a margin for natural sub-surface filtration and bacteriological activity to act on the liquid from the latrine.

7.4 Population displacement into areas of abundant surface water

Water Characteristics. Surface water sources can offer good scope for supplying large quantities of water of acceptable quality very quickly. However, it needs to be recognised that introducing a technology aimed at treating a surface water source will make the system fragile, vulnerable to disruption and reliant upon expensive chemicals. It is highly improbable that a community will be able to sustain a water supply from such a source once the emergency is over or after the relief agencies have left the area. As such, notions of providing a resident population with a water supply after the emergency has ended are unrealistic. If local conditions allow, it may be appropriate to look at the options for a two- or even three-phase water supply programme.

The first phase may be tankering water from a good quality source. This can be done, whilst second-phase surface water installations are being developed closer to the camp or settlement. The third phase might involve developing alternative sources such as hand-dug wells or tubewells for a long-term water supply. The ability to move on to the third phase will be totally dependent upon the nature of the soil and the groundwater in the area.

If water is to be drawn from a river, it is very important that it is drawn upstream of the nearest centre of population. This will reduce the chance of high levels of human contamination in the raw water.

Box 12

Slow Sand Filtration (SSF) was used on the Rohinga refugee programme during 1992 in Bangladesh, where its use was of particular interest because the normal method of water supply in the region was via tubewells. The geology around the Dumdumia camps prohibited tubewells and so alternative surface water sources had to be used. SSF provided water to one of the camps whilst sedimentation and flocculation of water drawn from behind a purpose-built dam supplied another camp. The dam was constructed to capture the flow of a small stream and additional flood waters and illustrates how the maximum use can be derived from a small flow of water if the surrounding topography permits.

The methods discussed above can apply equally to lake water. In Burundi water from lake and marsh sources is currently supplying refugees and returnees.

As discussed in Section 5.2 under *Treatment,* infiltration galleries can be very effective at cleaning a turbid lake or river source. However, this is a time-consuming operation and caution needs to be used when planning the exercise, as experience in Rwanda in 1993 illustrated. It was only after the work had been completed and water was flowing into the collection gallery that it was realised that the gravel which had been used as the filtering medium had a very high iron content and was affecting the taste of the water, making it unpalatable. This was not crucial at the time as there were alternative sources of water available to the camp of 80,000 people and the fall-back option was to flocculate the river water. As stated earlier, experimentation should be encouraged.

Water supply systems will always require maintenance and therefore management. The more complicated a system is, the more management it will require. Treating surface waters is a complicated means of providing water and demands considerable managerial and logistical support. This must be recognised before responsibility for the construction and operation of such a system is accepted. Efforts should be made to standardise the equipment. For example, if diesel-powered centrifugal pumps are being used, the type and specification should be standardised as much as possible across the programme. This will assist with maintenance programmes as central workshops can be established for a number of camps, and when ordering spare parts. A record should be kept of engine and pump serial numbers to help with spares orders, and a record of each pump's service history will assist when planning replacements. Whenever possible, the preference should always be to standardise on equipment that is installed and available locally. This may mean that equipment which was initially imported for the emergency will be replaced by local purchases.

Box 13

An extreme example of the problems created by a high watertable dictated a very complicated latrine design for the Bhutanese refugee camps in South-Eastern Nepal. In a number of the camps the watertable was less than 1m below groundlevel during the wet season. Latrines were to be provided at a ratio of 1 latrine for every two families. Space was limited in the camps and so it was not possible to gain the required storage capacity by making wide shallow pits. One suggestion was to install a piped sewage system which would deliver waste to treatment ponds, but this was considered inappropriate in the circumstances.

The solution adopted was to provide fully lined twin-pit latrines. Each of the two pits under every latrine was designed to contain storage capacity for the number of users adequate for one year's use. The principle was to use one pit for a year, seal it over and use the other the next year. During the time when the first pit was sealed, the sludge was to be rendered safe for handling and at the end of the second year was to be emptied; the first pit was then reused for the third year and so on, in theory indefinitely. In order to provide the capacity for one year's storage whilst keeping the pit out of the watertable, it was necessary to raise the pit lining above ground level. This is the key to gaining additional storage capacity for pit latrines when either high watertables or shallow soils limit the depth to which the pit can be dug.

Sanitation Characteristics. In areas where surface water is prolific, the position of the watertable below ground level is of special relevance. If the watertable is close to the surface, work on a sanitation programme may have to pay particular regard to this. Clearly if the watertable is 4m below ground level, digging pits for pit latrines to this depth will contaminate the groundwater; this must be avoided. As a guideline figure, 1.5m between the bottom of the pit and the highest level of the watertable should be sufficient to prevent contamination of the groundwater in fine soils. These limitations will reduce the storage capacity of the pit and hence its design life. This in turn may have implications for the design of latrine to be used, as consideration may need to be given to the possibility of resiting latrines or regular desludging because of lack of capacity.

7.5 Population displacement into existing settlements

Water Characteristics. When there is a movement of people into an existing settlement there will inevitably be an additional burden on the existing water supply. The capacity of the system to cope with this demand will determine the need for assistance measures. The most obvious intervention is to look at ways of expanding the existing system or obtaining the maximum yield from it. In the case of a pumped water supply, this may simply mean increasing the hours that the pump is run. If it is a gravity flow piped system, it may be possible to consider additional storage to capture flow that is wasted. Simply providing extra collection points will have the effect of reducing waiting time, particularly during peak demand hours. If the regular supply is from wells, there may be wells in the area that have fallen into disrepair; it is not uncommon for open wells to become redundant simply because stones have fallen, or been thrown, into them. If this is the case, simply clearing the obstacles could make the well serviceable again.

If the existing system clearly cannot cope with the additional numbers of people, it will be necessary to find short- and medium-term alternatives. Tankering water can provide an immediate response, whilst medium-term options are being surveyed and installed. In the situation of an existing settlement, there is an even stronger case than elsewhere for making the emergency water system as appropriate as possible so that it can offer the resident population new opportunities once the emergency is over. Thus, for example, if a village is dependent upon wells, providing additional wells would be an appropriate and, and it is to be hoped, sustainable solution. The opportunity can be taken to reinforce local management structures by offering training on maintenance, and by incorporating community management systems into the new programme.

In these situations, it is very important to be sensitive to the local population's needs. It seems only reasonable that, if systems can be provided that offer them something in the long term, those options should be chosen.

Box 14

In North Kivu Province in Zaire, the region currently hosting 1 million Rwandan refugees, the displacement of 200,000+ people in May 1993 caused particularly difficult problems. Most of the displaced people moved into villages of the same ethnic background where they felt safe. Consequently there were large numbers of small clusters of people in villages which themselves had serious water supply problems. Apart from a few large piped water schemes, the Province had attracted very little in the way of water supply development programmes. At a village level, water was typically collected from unprotected spring sources or streams. To exacerbate the problem, many of the villages to which people had fled were on volcanic rock where water retention is poor, and unprotected spring sources posed a major health hazard since very little sub- surface filtering takes place.

A number of agencies saw a spring protection programme as offering the fastest response to the large number of settlements. One agency also decided to integrate the spring protection with a hygiene awareness programme which included community mobilisation to construct and use improved latrines, the promotion of basic hygiene practice, and the use of community health workers – all very important in an area where cholera is endemic. This is an example of a response to an emergency situation where an attempt was also made to address longer-term community needs as part of the same programme.

Sanitation Characteristics. When displaced people move into existing settlements, they will frequently occupy public buildings such as schools. These will usually have some sort of basic or improved latrine provided, but the large number of additional users will almost certainly result in overfull pits or septic tanks. In these circumstances, it is not uncommon to see effluent from the latrines washing over areas around the buildings. This is totally unacceptable. Measures need to be taken to clean this up and prevent it happening in future. One option may be to undertake a regular programme of desludging, as was done in Mazar-i-Sharif in northern Afghanistan in 1993 when people displaced from Kabul occupied schools and university buildings in the city. If a piped sewage system exists in the area it may be possible to connect the latrines from the public building to this, as is currently being explored in Bujumbura in Burundi where people displaced by fighting in October 1993 have occupied schools which were not connected to the city's sewage system.

7.6 Resident population affected by drought

Droughts result in a reduced yield and the possible drying-up of traditional surface and sub-surface water sources. Households (usually the female members) have to travel longer and longer distances to obtain water from reliable sources. As yields are reduced and the remaining sources are overused, so the quality of the available water tends to deteriorate. Ultimately, households and communities are obliged to migrate to better quality and more reliable sources. The use of poor quality sources, the stress of the move to better quality sources and the concentration around them often result in increased morbidity. National and international responses to drought invariably focus on the provision of food and it is often difficult to mobilise resources for water sector activities.

Water Characteristics. A broad range of interventions is available when responding to drought in rural areas. In considering the most appropriate intervention, it is important to bear in mind its likely time-lag and the chances of its relieving water stress in the affected communities before the start of the next rains which will herald the end of the drought. Some interventions are unlikely to have an impact during the drought but may, if managed properly, improve the reliability of water sources during subsequent droughts.

In situations where water is normally head-carried and the drought necessitates the use of more distant sources an appropriate intervention may be to *assist communities with the transport of water*. This might involve the provision of animal-drawn water carts and, if necessary, the animals to pull them. This action would enable one individual to collect water for several families and thus save the time and effort of the women who would normally head-carry the water. In more difficult terrain, wheeled carts may be inappropriate and the provision of animals and water containers which can be strapped to their backs may be more appropriate. Such interventions need not entail the free provision of animals and equipment but could be managed on a loan basis or credit should be provided to water traders to enable them to expand their activities. Care would need to be taken in selecting those to receive the loans and in ensuring that they did not unduly exploit their position by overcharging for the water transported.

Where institutional capacity permits and the affected communities are many miles from reliable sources, it may be more appropriate to *tanker water to them* either by lorry or by tractor-drawn water-bowsers. Such interventions were undertaken by District Councils in Botswana during the extended drought of the 1980s for those villages where boreholes had dried up. The advantage of bowsers is that they can be left standing in a central location for use by the affected community whilst the tractor or lorry goes off to pull other bowsers to other affected communities, returning to the first community with a full replacement bowser a few days later. It would be uneconomic to leave tanker lorries standing for several days, and for communities serviced by tankers a centrally located reservoir will need to be constructed serving adjacent standpipes which can be regularly replenished by the tankers. Butyl rubber water bags (known as bladder tanks) on raised platforms or earth banks are well suited to this arrangement. Such a system was used in Lesotho during the response to the 1991/92 drought. (Section 5.2 provides additional information on tankering problems)

The yield of wells which are drying up as a result of the drought may be increased by *well deepening*. This may involve the provision of tools to villagers or the employment of local well-construction companies/artisans. (see Section 5.2).

In countries where government agencies are responsible for the maintenance of water supplies and where capacity has been in decline as a result of broken pumps and lack of spare parts, the *rehabilitation of faulty equipment on existing sources* would be more appropriate than embarking on the drilling of new boreholes. Supporting the responsible government agency by the provision of the required spare parts, transport for technicians to visit and repair the faulty equipment and perhaps technical assistance would be appropriate. In some instances it may not be possible to work with the government agency and the relief agency may have to undertake the rehabilitation work itself.

Finally, there is the option of drilling and equipping boreholes. This represents a high tech approach which might be attractive to donors. Borehole drilling programmes as a response to drought related emergencies have been of limited success but continue to be a commonly employed response to water problems in drought affected areas. Relief agencies need to be aware of the technical and institutional reasons why this may be the case and to ensure that all other options have been considered before resorting to a borehole drilling programme.

New drilling rigs are unavailable in most developing countries and therefore need to be imported. This may take months, with the result that the drought will have ended by the time the rigs begin operation, and it will be even longer before successful boreholes are equipped and functioning. The rigs are usually enormously over-specified and consequently very expensive. Rigs capable of drilling to depths in excess of 200m may be ordered for situations where it is only necessary to drill to less than 100m. (See Section 5.2 for more information on borehole drilling and equipping.)

Over the last few years a number of small, portable rigs have become available. Lightweight rigs manufactured in Thailand are currently working successfully in Cambodia. Similar rigs available in the UK cost from (approximately) $15,000. Their small size means that they are transportable by air. As with all drilling rigs, spare parts, consumables such as drill bits, casing and technical support need to be readily available to ensure sustained drilling.

Box 15

An evaluation conducted by a bilateral donor of its response to the Southern African Drought of 1991/92 found that most of the expenditures in the water sector in three of the affected countries had no impact on the water stress being experienced before the start of the next rains. The only activities to have had an impact before the rains were tankering operations. None of the well-deepening and borehole-drilling activities which had accounted for the bulk of expenditures had any impact before the next rains.

Low success rates should be expected in emergency drought relief programmes because of the difficulty of finding sufficiently productive boreholes in terrain that is probably hydrogeologically difficult and often problematic for drilling. For instance, in a programme in the Lebowa area of South Africa during the 1991/92 drought 73 boreholes were drilled over a 6 month period but only 25 were successful – a success rate of only 34%. The drilling of new boreholes may also be inappropriate because the pressure of the emergency reduces the quality of the work, resulting in sources which are poorly sited and equipped. In the Lebowa example engineers had to grapple with problems inherited from water systems constructed during a previous drought. At that time the government had imposed time limits on the use of emergency funds, the work was rushed and the systems were poorly designed and constructed and required remedial maintenance and repair[8].

From the above it would appear that the use of *temporary, stop-gap measures* such as transportation and *pre-drought mitigation measures* aimed at improving the reliability of water sources during drought periods are to be preferred to `quick-fix' solutions. A planned programme of infrastructural improvements in a drought-prone area is more likely to produce better supply systems at a lower cost than quick-fix emergency remedies.

8 J. Davis - personal communication.

Sanitation Characteristics. The reduction in water quality and availability associated with a drought means that people's consumption of water will decline, and this reinforces the need for good hygiene practices. People need to understand the relationship between personal and communal hygiene and the incidence of diarrhoea if they are to take measures to protect themselves. Agencies responding to the drought should complement their efforts to relieve water stress by running community-based educational programmes emphasising the importance of good hygiene practices. Such programmes may have as much, or greater, impact on the morbidity and mortality associated with the drought than more costly efforts to increase the volumes of water available.

7.7 Resident population affected by sudden-onset disasters

There are a wide range of natural hazard types in the `sudden-onset' category and thus considerable variations in impacts in terms of water and sanitation. The principal sudden-impact hazards, in terms of mortality and numbers affected, are floods, cyclones and earthquakes. These are dealt with briefly here as the wide variation in context and impacts serves to discourage the development of notions of good practice, and it is likely that relief agencies and communities in known hazard-prone areas have experience of previous hazard events and are aware of most of the appropriate interventions.

The principles of providing people with safe drinking water and a safe means of disposing of their excreta apply equally to these situations. The population affected by such disasters will want to stay as close as possible to their homes; it is unlikely that camp situations will spontaneously occur and so the need for concentrated services will be less pressing. This will impose a different kind of burden on the agencies providing the service as they will have to start up a number of separate programmes in a number of discrete locations aimed at meeting the needs of disparate groups of people. This will obviously have staffing and resource implications.

Floods

Flash floods can cause intense damage on hill sides in hilly areas but the impact is usually localised. Floods are generally confined to valley bottoms and low-lying areas, where they prevent access to existing water sources and pollute them. People are forced to seek temporary shelter on raised ground where they will be obliged to use the polluted flood water for drinking and where the observance of minimum sanitation standards will be difficult. When the flood waters retreat the priority needs are to clean and rehabilitate the traditional water sources.

Water and sanitation. Providing all the groups on the raised ground with good quality drinking water for the period of the inundation will be extremely difficult unless the affected area is small, reliable water sources are available within or near to the affected area, and the relief agencies possess the means of transport (fast small boats, helicopters) for moving quickly between the concentrations of population. Where these conditions do not apply, it will not be possible to reach large sections of the population before the floodwaters retreat. In areas which are highly flood-prone, it would be desirable to protect traditional sub-surface water sources from the floods. In Bangladesh, for instance, many tubewells have been equipped with sealed raised plinths on which the handpumps are placed in order to raise the pump above the expected flood level and prevent the ingress of polluted flood water into the borehole. A complementary preparedness measure would be to equip the population for such events by providing them with the knowledge and means of treating drinking water drawn from polluted floodwaters. Fast-dissolving chlorine tablets are often distributed but their impact upon morbidity statistics is unclear, illustrating the difficulties faced when trying to educate people about water treatment methods employing chemicals.

The populations on the raised ground should be encouraged to observe basic sanitation standards and to adhere to the principle of burying their faeces. Even if defecation areas are sited above the floodwater levels, rain storms will wash faeces into surface water sources and inundated groundwater sources such as wells and boreholes. If sufficient land is not available for managed defecation, then defecation should be strongly encouraged at the furthest downstream point on the raised land.

Once the floodwaters retreat and people are able to return to their homes it will be necessary to rehabilitate the traditional water sources by cleaning polluted sources and repairing any damaged pumping equipment. Boreholes may be cleaned by flushing out the polluted water with water from a clean source or by repeatedly disinfecting the borehole and pumping it out. The quality of water in ponds used for household activities other than drinking can be improved by emptying the polluted water and allowing recharge from rain and through the restoration of the watertable.

Cyclones

Cyclones affect water sources in several ways. Surface instillations such as pumps may be damaged by the high winds and flying debris and electrical pumps will be rendered ineffective by the disruption of power supplies. In low lying coastal areas cyclones frequently cause flooding and saline incursion.

Water and sanitation. It is likely that survivors will want to stay as close as possible to their homes and villages; large concentrations of displaced people are therefore unlikely. The priority is to rehabilitate the damaged and polluted water sources, by repairing/replacing the pumping equipment and cleaning out the polluted/saline boreholes. Whilst this is being done, efforts should be made to ensure that the water being consumed is as clean as possible. Options include the distribution of fast-dissolving chlorine tablets; setting up filtration systems; transporting drinking water to the affected communities by tankers or tractor-bowsers; and ensuring that the risk of additional pollution to the water sources being used is minimised through the use of upstream and protected sources. If the area is highly cyclone-prone, preparation measures may have included training people in the correct use and application of treatment methods, the simplest of all being to boil water. Dead bodies and animal carcases should be buried and where populations have congregated pit latrines should be constructed.

Earthquakes

Earthquakes make large numbers of people homeless on a temporary or longer-term basis, rupture piped water supply and sewage systems, and damage reservoirs, pumping equipment and boreholes.

Water and sanitation. The population rendered homeless will probably settle spontaneously on the outskirts of the village/town or in camps. The priority will be to provide them with clean water (either through tankering, the repair of the damaged supply system or treatment of polluted sources) plus the usual sanitation measures such as establishing managed defecation sites, latrine construction and hygiene awareness training.

Earthquakes can damage household latrines and, in towns, rupture sewage pipes resulting in sewage flowing into the streets. These areas should be cordoned off and steps taken to prevent or reduce the pollution of surviving water supply systems.

Water treatment activities may involve the construction of temporary water treatment stations and the distribution of quick-dissolving chlorine tablets. If the region is highly earthquake-prone, preparation measures may have trained people in the correct use and application of these tablets.

Once the immediate objective of providing people with good quantities of reasonable quality water has been met, the water programme must then facilitate the return of people to their normal supply source as soon as possible. Immediate and medium-term needs are not necessarily mutually exclusive and work on both can be simultaneous if resources allow. If communities previously relied upon piped water supplies, a quick solution is unlikely and medium-term reconstruction programmes will be required. Earthquakes will cause major land upheaval and it is highly probable that groundwater sources will also have been affected. Spring-lines may have been altered, wells can be irreparably damaged and boreholes can collapse. In such circumstances a speedy return to normal supplies is unlikely and the emergency solutions may need to be continued for a period of months or even longer. The planning of emergency interventions should anticipate the period over which they are likely to be required.

7.8 Emergency water and sanitation programmes in urban areas

The question of emergency water and sanitation responses in urban areas is raised regularly. In recent years the problems in the former Yugoslavia, the former Soviet Union and Iraq have been very high-profile. This Section briefly reviews some of the issues which NGOs need to consider in deciding whether or not to become involved.

Probably the first thing to consider is the scale of the problem. Providing water and sanitation facilities to 200,000 people in a camp easily is more achievable than trying to provide them to 200,000 people spread across a town or city. The level of technology employed in any urban system is likely to be high. As discussed in Section 3.3, the technical knowledge of how urban water and sewage systems operate needs to be available to the agency. Large-scale funding will be required as specialist equipment will need to be replaced and, pipelines may have to be reinstated or rerouted. Previous experience in these situations has shown that technical problems which at first seem to be easily reconcilable and possibly the direct result of recent conflict, bombing, etc., are in fact long-standing problems due to poor maintenance and under-funding of local departments charged with managing the systems. OXFAM has learnt this the hard way in Iraq.

During the Gulf war, the approach adopted by the International Committee of the Red Cross and UNICEF in Iraq concentrated on serviceable installations. Both agencies made essential items available to the water boards which meant that most of the major treatment stations were able to continue to function[9].

When an agency embarks upon an urban rehabilitation programme, it must recognise the scale of the task it is taking on. The problems of a poorly maintained urban water or sewage system cannot be resolved by a small NGO as an emergency response. OXFAM was involved in the rehabilitation of the Phnom Penh water system, and spent 12 years working on it.

Involvement originally intended to be restricted to the water system may inevitably have to be extended to the sewage system also. Bombs do not discriminate between water or sewage pipes. Both will be broken. This will mean that as people continue to use their toilets, sewage will flow not only into the streets but also into the water mains.

It can be argued that the best emergency response in an urban situation is to provide water storage facilities around the town and bring clean water to them, probably by tanker. This will afford the opportunity to survey and take in the scale and complexity of the work which is needed.

In Monrovia, Liberia, the ICRC initiative decided that the city's piped supply system was too big for them to deal with. They have adopted the alternative approach of digging wells for people to use around the city, which has gone some way towards meeting the drinking water needs of the inhabitants. People also acknowledge the fact that they may have to boil or otherwise disinfect their water.

One aspect of providing water in urban areas that has not previously been mentioned is that of pollution. Unlike rural areas, surface water sources in urban areas are likely to be chemically polluted. If the use of such sources is being considered, simple treatment processes such as those outlined above will be

9 G. Nembrini, ICRC - personal communication.

effective only on microbiological and not on chemical pollution. Specialist advice will have to be taken for every situation encountered.

Most NGOs can only hope to provide temporary answers or to patch up the problems of urban rehabilitation. Alternative ways of addressing the emergency will probably have to be sought until large and better resourced agencies can resolve the large-scale needs of rehabilitation.

Annex 1

Further Resources

Emergencies

UNHCR (1982) Handbook for Emergencies Geneva, UNHCR.
Copies available from: Palais de Nations CH-1211 Geneva 10
Switzerland.

UNICEF (1986) Assisting in Emergencies: A Resource Handbook for UNICEF Field Staff, New York: UNICEF, 3 UN Plaza New York NY 10017 USA.

MSF (1992) Technicien Sanitaire en Situation Precaire, Paris.
Copies available from: 8, Rue Saint Sabin 75544 Paris Cedex 11 France.
Tel: +33 1 40 21 29 29
Fax: +33 1 48 06 68 68

OXFAM Emergency Water Supply Scheme for Emergencies (Set of Manuals)
Copies available from: OXFAM HOUSE Emergencies Department Public Health Team.
274, Banbury Road Oxford OX2 7DZ
Tel: +44 865 311311
Fax: +44 865 312600

Mears, Catherine and Chowdury, Sue (1994) Practical Health Guide No.9: Health Care for Refugees and Displaced People, Oxford: OXFAM.

Environmental Health

Cairncross, S and Feacham, R (1993) Environmental Health Engineering in the Tropics: An Introductory Text. 2nd Edn. Chichester, UK: J Wiley & Sons.

Water

General

Arlosoroff, S (1987) Community Water; The Handpump Option, Washington DC: World Bank, 1818 H Street NW Washington DC 20433 USA.

Davis, J. and Garvey, G. with Wood, M. (1993) Developing and Managing Community Water Supplies - Oxfam Development Guidelines No. 8, Oxford, UK: OXFAM.

IRC (International Reference Centre) (1987) Small Community Water Supplies: Technical Paper No.18. The Hague, The Netherlands: IRC - Water and Sanitation Centre, PO Box 93190 2059, Tel: +31 70 814911.

Jordan, T (1984) A Handbook of Gravity-Flow Water Systems, London: IT Publications.

Lloyd, B and Helmer, R (1991) Surveillance of Drinking Water Quality in Rural Areas, Harlow, UK: Longman Scientific and Technical.

Pickford, J: The Worth of Water; Technical Briefs on Health, Water and Sanitation. London: IT Publications.

UNHCR (1992) Water Manual for Refugee Situations, Geneva: UNHCR Programme and Technical Support Section.

World Health Organisation (1984): Guidelines for Drinking Water Quality : Vol. 2: Health Criteria and Other Supporting Information, Geneva: WHO.

World Health Organisation (1985) Guidelines for Drinking Water Quality Control for Small Community Supplies, Vol. 3, Geneva: WHO.

World Bank and UNDP have a very large range of technical, social and economic material written for the Water Decade. World Bank Washington DC USA.

Boreholes and Wells

Driscoll, F. G (1986) Groundwater and Wells. 2nd edn. St Paul, Minnesota: Johnson Filtration Systems Inc.

Rowles, R (1990) Drilling for Water: A Practical Manual, Cranfield, UK: Cranfield Institute of Technology Press, Bedford MK43 0AL UK.
Tel: +44 234 752727

Watt, S and Wood, W (1979) Hand Dug Wells; Their Construction, London: IT Publications.

Treatment

Smethurst, G (1988) Basic Water Treatment, London: Thomas Telford Ltd, Telford House 1 Heron Quay London E14 9XF.

Graham, N (1988) Slow Sand Filtration - Recent Developments in Water Treatment, Chichester, UK: Ellis Harwood Market Cross House Cooper Street Chichester West Sussex PO19 1EB UK.

Heber, G (1985) Simple Methods for Treatment of Drinking Water, Eschborn, Germany: GTZ (Deutsche Geschellschaft fur Technische Zusammensarbeit) PO Box 5180 6236 Eschborn Federal Republic of Germany Tel: + 6196 79-0.

IRC: Slow Sand Filtration for Community Water Supply - Planning, Design, Construction, Operation and Maintenance. Technical Paper No.24, The Hague, The Netherlands: IRC.

Smet, J and Visscher, J (eds) (1990) Pre-treatment Methods for Community Water Supply. An Overview of Techniques and Present Experience, The Hague, The Netherlands: IRC.

Schulz, C and Okun, D (1984) Surface Water Treatment for Communities in Developing Countries, London: IT Publications.

Wegelin, M Rural Water Supply Treatment. Section 4.5b in Information and Training for Low Cost Water Supply and Sanitation Series. Washington DC: UNDP/World Bank.

Sanitation

Esrey, S, et al: Health Benefits from Improvements in Water Supply and Sanitation WASH Technical Report No.66. Arlington, VA: Water and Sanitation for Health Project (WASH) 1611 Kent Street Room 1001 Arlington Virginia 22209-2111 USA Tel: +1 703 243 8200.

Franceys, R, Pickford, J and Reed, W (1992) A Guide to the Development of On-Site Sanitation, Geneva: WHO. Copies from WEDC (see below)

Morgan, P (1990) Rural Water Supplies and Sanitation - A Text from Zimbabwe's Blair Research Institute, Harare, Zimbabwe: Blair Research Laboratory, Ministry of Health.

OXFAM (1993) Core Information on Water and Sanitation in Emergency Situations - OXFAM Checklist, Oxford UK: OXFAM.

Cairncross, S (1988) Small Scale Sanitation, Ross Institute Bulletin No.8, London: Ross Institute of Tropical Hygiene London School of Hygiene and Tropical Medicine Keppel Street Gower Street London WC1E 7HT UK.

UNHCR (1994) Technical Approach: Environmental Sanitation, Geneva: UNHCR Programme and Technical Section.

Wagner, E and Lanoix, J (1958) Excreta Disposal for Rural Areas and Small Communities, WHO Monograph Series No. 39. Geneva: WHO.

WEDC (1993) Emergency Sanitation for Refugees. Technical Brief No.38 in Waterlines Vol. 12, No.2 October, London: IT Publications.

Hygiene Promotion

Boot, M and Cairncross, S (193) Actions Speak, The Study of Hygiene Behaviour in Water Supply and Sanitation Projects The Hague, The Netherlands: IRC and London: london School of Hygiene and Tropical Medicine.

Boot, M: Just Stir Gently: The Way to Mix Hygiene Education with Water Supply and Sanitation. Technical Paper No.29. The Hague, The Netherlands: IRC.

IRC (1988) Hygiene Education in Water Supply and Sanitation. Technical Paper No.27. The Hague: IRC.

Annex 2

Useful Contacts and Addresses

Eureka UK Limited
Rotation House 20 Mayday Road Thornton Heath Surrey CR7 7HL UK.
Tel: +44 181 665 0439
Company that manufactures small portable drilling rigs.

International Reference Centre
International Water and Sanitation Centre PO Box 93190 2059 AD The Hague The Netherlands. Tel: +31 70 814911
Produces technical and social papers related to water and sanitation. Preparing to run specific water and sanitation in emergency courses for MSF - Holland.

REDR (Register of Engineers for Disaster Relief)
The Director c/o Institute of Civil Engineers 1 Great George Street London SW1
Tel: +44 171 233 3116
Maintains a register of professional engineers available to work in emergencies for specialist and non-specialist NGOs. Offers expertise in needs assessment and runs training weekends for appropriate water and sanitation technologies in emergencies.

Water, Engineering and Development Centre (WEDC)
Loughborough University of Technology Leicestershire LE11 3TU UK
Tel: +44 1509 222390 or 222391
Runs a number of short courses for rural water supplies and sanitation. Has run courses for MSF specifically related to water and sanitation in emergencies.

Waterlines

Intermediate Technology Publications 103-105 Southampton Row London WC1B 4HH UK. Tel: +44 171 436 9761

Published quarterly, Waterlines is a journal concerned with appropriate technology developments for water and sanitation. IT Publications at the above address have an extensive booklist related to appropriate technologies.

Dialogue on Diarrhoea

AHRTAG - Farringdon Point 29-35 Farringdon Road London EC1M 3JB UK. Tel: +44 171 242 0606

Published quarterly, Dialogue is a newsletter aimed at a broad range of primary health care workers in developing countries. It is a forum for the exchange of information about the prevention and treatment of diarrhoeal diseases as well as providing educational advice on related health education.

Annex 3

Technical Guidelines

The UNHCR Handbook for Emergencies recommends a number of guidelines for refugee situations. It should be stressed that these are guidelines and not standards. They should be aimed for as a minimum.

Water

Quantity

Personal Consumption	15-20 litres/person/day
Health Centres	40-60 litres/patient/day
Feeding Centres	20-30 litres/patient/day

Quality

0-10	Faecal Coliforms/100ml	Reasonable
10-100	Faecal Coliforms/100ml	Polluted = Must Chlorinate
100-1000	Faecal Coliforms/100ml	Very Polluted
1000+	Faecal Coliforms/100ml	Grossly polluted

Access

* Distance to water point	100m maximum
Ratio of taps to users	1 tap/200-250 people

* This is a desirable distance. It has been shown that there is a reverse relationship between the distance people have to walk to collect water and the amount they use,

i.e. the further away it is, the less they use. Many constraints will dictate just how far people have to walk. The rule should be to bring the water as close as is feasible, affordable and practical. It should be remembered that, unless good drainage can be provided, bringing water close to people may cause standing water and potential breeding points for mosquitoes.

Sanitation

For design purposes sludge accumulation rates per year inside pit latrines can be taken as:

Waste retained in water where degradable anal cleaning materials are used	0.04m^3
Wastes retained in water where non-degradable anal cleansing materials are used	0.06m^3
Waste retained in dry conditions where degradeable anal cleansing materials are used	0.06m^3
Wastes retained in dry conditions where non-degradeable cleaning materials are used	0.09m^3

(From Franceys, Pickford and Reed, 1992; Wagner and Lanoix, 1958 in Annex 1)

These rates relate to slow accumulation. Experience from emergency conditions has shown that accumulation is very much more rapid. For design in these situations consider multiplying the accumulation rate by 150-200%.

Siting

Distance to latrines	50m maximum (ideally)
Distance from shelters	6m minimum

Distance from water source eg. spring, tubewell	30m minimum

Space

This is included more in reference to environmental health than specifically to water and sanitation

Sheltered accommodation	3.5 m²/person floor space
Total space excluding provision for communal, agricultural and livestock.	30 m²/person

Annex 4

Checklist for Environmental Health Needs Assessment

Water

How is water supplied to the population (standpipe, tanker)?

What is the source of the water (river, well, cistern, rain)?

Is the source safe to drink and likely to remain so?

Can the source provide sufficient water immediately?

Will the source provide sufficient water in all seasons?

Is the source adequate in all seasons?

How close is the supply to the refugees' shelters?

What is the current consumption of water and is it adequate for all purposes?

Is there evidence of a severe water-related disease problem (skin disease, typhoid, diarrhoea)?

Is there any danger of the source being contaminated from latrines, livestock or (in the case of rivers) other camps and settlements upstream?

Is there any danger of contamination to settlements downstream?

Is the water tested regularly? Is it tested at source, during distribution, or at household level?

Is there any system of water treatment?

Is the method of treatment sustainable?

If a pump is used, how is it serviced and what contingency plans are there if it breaks down?

Are washing facilities provided? If so, where, and is there privacy for women?

Where are animals watered?

How is water stored in dwellings? Are there enough containers for water collection and storage? Are containers clean and covered?

Sanitation and vector control

Is there evidence of high incidence of disease which could be related to poor sanitation (diarrhoea, worms)?

What is the normal practice of defecation of the refugee population (note that women's practices may be different from those of men)?

How are excreta disposed of (family or communal system, pit latrines, water-borne system, cartage, random)? Is there a designated defecation area?

Is there sufficient space for defection fields/trench latrines/pit latrines?

Is water available for handwashing close to the defecation area?

How close is the water source to the excreta disposal point?

Is there a problem with the accumulation and disposal of solid waste?

Is there an obvious problem with flies, rodents, cockroaches, mosquitoes, fleas, lice or bedbugs?

How is solid waste and rubbish disposed of (collection system, burning, burial)?

Is the watertable high or low?

What is the soil structure (rocky, sandy)?

How will different seasons affect existing sanitation systems (flooding)?

How is waste water drained off the site? Are there pools of standing water?

Hygiene promotion

What are the accepted beliefs and practices among the refugees? Are there cultural sensitivities, or taboo subjects?

How much do people understand about the relationship between water, sanitation, shelter, vectors, and disease?

Do the refugees have previous experience of communal living?

What are the common hygiene practices among the refugees (washing hands after defecation, storage and covering of cooked food, disposal of children's faeces)?

Is hygiene promotion integrated both with technical work on water and sanitation and also with the health services?

Has any agency accepted responsibility for hygiene promotion activities?

Source: Adapted from Mears and Chowdury, 1994.

Annex 5

Practical Ways to Prevent the Spread of Cholera

There are many practical steps that can be taken to contain cholera and limit its spread.

Cholera is transmitted by the faecal-oral route. People can be infected but not show any signs of sickness. Their faeces will contain the cholera vibrio. Therefore, take firm action to implement the normal measures to control the transmission of faecal-oral diseases:

Safe food

- Monitor the supply and preparation of food.
- Wash your hands before preparing food and especially after using the toilet.
- Cook food thoroughly.
- Eat cooked food immediately. If cooked food has to be stored, boil or re-heat it thoroughly before eating it.
- Fruits and vegetables should be cooked and peeled. Raw, unpeeled fruit should not be eaten.

Safe drinking water

Wherever possible obtain drinking water from a safe, uncontaminated source such as a sealed well, a borehole, rainwater, or a well-maintained piped water supply. If you are not sure that the water is safe:

- Disinfect it with alum, potash or chlorine.
- Bring the water to the boil, then boil it vigorously for one minute before using.

- Store water in a clean, covered container. Use a ladle with a long handle to take water out, so that your hands do not come into contact with the water.

Hygiene and waste disposal

- If possible, wash kitchen dishes with soap, rinse with clean water, and use a clean cloth to wipe dishes dry (or leave dishes to dry in sunlight in a clean place).
- Dispose of all stools and faecally contaminated materials in a latrine, or bury them if latrines are not available.
- Provide safe excreta-disposal facilities, ensure they are used and prevent indiscriminate defecation.

Public health measures

If an epidemic occurs, local authorities should take the following actions:

- Provide and maintain safe and adequate community facilities for excreta disposal.
- Ensure an adequate supply of safe drinking water.
- Prevent the use of contaminated drinking sources.
- Provide information about how people can purify water at home.
- Ensure the immediate and hygienic disposal of dead bodies.
- Discourage large gatherings, such as feasts or funerals.
- Establish emergency treatment centres with sufficient amounts of essential supplies, such as oral rehydration salts and intravenous rehydration solution.
- Train medical personnel, if necessary, so that they can identify patients early and treat them correctly.
- Treat cholera patients in a separate area and disinfect contaminated materials, such as bedding and drinking vessels.

Common sources of infection

- Water contaminated at its source (for example, by faeces leaking into an incompletely sealed well) or during storage (perhaps by contact with faecally contaminated hands).
- Contaminated foods that are eaten raw or undercooked, or stored at a temperature at which bacteria can rapidly multiply.
- Raw vegetables that have been washed with contaminated water.

This extract is a modified version of the reprint which appeared in the spring 1993 issue of Dialogue on Diarrhoea.

Annex 6

A Gender Checklist for Environmental Health Actions

Unless women are consulted and the participation of women of all socio-economic classes is facilitated, the impact of a project will be minimal. This list is intended to provide useful questions to address:

Assessing needs and priorities

1. What baseline data have been collected? Has a picture of environmental health needs been collected from all sectors of the community? Have current patterns of water collection been fully understood?

2. What measures have been taken to ensure women's participation in the project? Do women participate in setting priorities and objectives? Do men and women identify needs and priorities differently? Who makes the final decisions? Are there mechanisms for representing the views of women?

3. Are women specifically mentioned in the objectives? Are targets gender-specific?

4. What are the requirements for sanitary privacy?

5. What will women do with the additional facilities and with any free time released by the project, particularly if it results in a substantial reduction in workload and working hours? Will there be any negative impact?

Accessibility and acceptance of water/sanitation facilities

1. Have women participated in decisions such as:

    - design and location of water points?
    - selection of latrine designs and sites?
    - design of additional provisions for washing, bathing, livestock watering, waste disposal and waste water drainage?
    - timing of operations?
    - timing and content of hygiene promotion activities?
    - timing, location and content of training activities?
    - selection of local people for maintenance/management of the project? (Are women themselves encouraged to play this role?)

2. Are the technologies used suitable for women? Is the engineering design appropriate for women's use? Does the structure of latrines ensure privacy and conform to cultural rules? Can women repair the facilities? Can women afford to maintain them?

3. Are women's attitudes and beliefs taken into account in devising hygiene promotion? Are hygiene activities geared towards `mothers' only? Are fathers and other women taking care of children also included?

Project personnel

1. What is the proportion of women staff in the programme?

2. Is there special recruitment of women as programme managers, water and sanitation engineers, extension workers and programme promoters?

3. Are women represented in decision-making positions?

4. Are the staff on the programme sensitive to implementing programmes with a gender perspective?

Programme training

1. Do programme training activities give equal opportunities to women?

2. What is the proportion of women in training activities? What special efforts are being made to involve more women?

3. Do educational and promotional materials show women as sanitation engineers, as programme workers? Are men shown using the facilities?

Community involvement

1. Have women's organisations been identified, notified and involved in the programme?

2. Do plans of work exist for the involvement of women's organisations?

3. What kind of support is being given directly to women's organisations?

Programme effects, monitoring and evaluation

1. How will the programme affect women's workload, hygiene, health or other benefits? To what extent do women attribute changes in these areas to the project?

2. How will the programme affect women's access to water and use of water? How will it affect women's work in cleaning the house, clothes, children, food preparation and cooking?

3. What changes are expected or have occurred in women's use of time (e.g. number of hours worked) and what were the hours saved for?

4. How will the programme affect women's income? Do changes cost women more or less money than before? Do women use time saved to make more money?

Adapted from Checklist for Gender Planning (J Cleeves Morse `Gender and Health'; comments arising from NGO proposals and reports, paper at JFS/NGO workshop on gender and development, University of Wales, Swansea July 1993 ; The Tribune Development Quarterly, International Women's Tribune, Newsletter 43 1989).

Annex 7

Chlorine as a Water Disinfectant

Why do we need to disinfect water?

Dirty and polluted water can contain many organisms that are harmful to humans if they drink it. The disease-causing organisms (pathogens) include bacteria, bacterial spores, viruses, cysts, protozoa and helminths. These can cause diseases like cholera, bacillary dysentery, typhoid, infectious hepatitis and diarrhoea. Disinfection of water aims to kill these pathogens without leaving any harmful chemical substances in the water.

Water treatments such as sedimentation and filtration can significantly reduce the number of pathogens in water. However, there is still likely to be a need to kill the remaining and subsequent pathogens. It is at this point that chlorine is used as a chemical disinfectant.

Why use chlorine?

Chemical disinfectants for water should have the following attributes:

- destroy all pathogens present in the water within an acceptable length of time
- be able to perform within the range of temperatures and physical conditions encountered
- disinfect without leaving any harmful effects for humans
- permit simple and quick measurement of strength and concentration in water
- leave sufficient active residual concentration as a safeguard against contamination that might occur after the water has been collected, e.g. in containers
- be readily and reliably available at a reasonable cost

Chlorine is the chemical most widely used as it fulfils the above criteria and is widely available in one form or another (see section below)

How does chlorine work?

The precise way in which chlorine kills pathogens is not known. It is believed that the compounds formed when chlorine is added to water interfere with the chemical processes which ensure the pathogens' survival.

When a suitable chlorine compound is added to water, only a part of it becomes effective in killing pathogens. This part is called `Free Active' or `Active' chlorine (AC). AC is very good at invading the cells of pathogens. It is, therefore, a very efficient killer of pathogens. As a result, only small amounts of chlorine are required to disinfect polluted water.

What affects chlorine's efficiency?

After it has been added the active chlorine needs a certain amount of time to kill the pathogens in the water. This is called the `contact time'. This amount of time must be allowed after adding chlorine before people drink the water. How much contact time is required for the active chlorine to be fully effective depends upon many factors. However, the most important are pH (level of acidity/alkalinity) and water temperature.

Most raw water sources have a pH value within the range 6.5 - 8. As pH levels rise the disinfecting properties of chlorine start to become weaker and at pH 9 there is very little disinfecting power. WHO guidelines recommend that drinking water should therefore have a pH in the range of 6.5 - 8.5. pH can have a significant influence on the performance of chlorine in water which we are likely to be working with for drinking water supplies.

The temperature of the water to be disinfected can have a significant effect on chlorine efficiency. The time needed for disinfection becomes longer as the temperature of the water gets lower. There is a noticeable difference in the killing rate of bacteria between 2 and 20EC.

If the water to be disinfected contains a lot of suspended solids and/or organic matter (i.e. is highly turbid), it will have a high chlorine demand. It is, therefore, desirable to clean the water as much as possible before the chlorination process begins. This will significantly reduce the amount of chlorine needed and improve its efficiency as a disinfectant.

If iron and manganese are present in the water to be disinfected a substantial amount of chlorine may combine with them to form compounds which are insoluble in water. It is, therefore, beneficial to remove the iron and manganese before chlorination. This may not always be possible, although simple aeration systems may be appropriate. It is important that the person responsible for disinfection is aware of the influence that the presence of these metals can have on chlorine demand.

How long does it take to kill the pathogens?

The disinfecting effect of chlorine is not instantaneous. The amount of pathogens killed depends upon the `contact time' between the dosing and the drinking. For our purposes, a minimum contact time of 30 minutes is essential. However, when considering this, account must be taken of the pH, temperature and turbidity of the water. For example, a turbid water with a pH of 7.5 - 8 and a temperature of 10°C will require a longer contact time than a clear water with a pH of 6.5 - 7 and a temperature of 20°C.

MINIMUM CONTACT TIME MUST ALWAYS BE 30 MINUTES.

Types of chlorine

Chlorine gas and chlorine dioxide are widely used in water treatment. However, their handling and transport are considered too hazardous for the sorts of projects OXFAM or its partners are likely to be involved in.

CHLORINE IS DANGEROUS. THE SAFETY RULES CONCERNING ITS HANDLING MUST ALWAYS BE FOLLOWED.

Calcium Hypochlorite - Ca (OCl)²

Calcium hypochlorite, also widely known as bleaching powder or chlorinated lime, comes as a powder containing approximately 33% available chlorine. It is stored in corrosion-resistant containers. Once the container is opened, the powder quickly loses its strength. This can be very significant, e.g. about 5% in 40 days if the container is opened for as little as 10 minutes per day, or approximately 20% if left open for the whole period.

The powder is not added directly to the water to be disinfected. The usual method is to make a solution of 1% available chlorine and to add this to the water.

Solutions of chlorine are more prone to loss of strength than bleaching powder. Sunlight and high temperatures can speed the amount of active chlorine lost. To minimise such losses, the solution should be stored in a dark dry place and at the lowest possible temperature. The solution should be stored in dark corrosion-resistant containers (glass, plastic, wood, ceramic) which must be securely closed.

More stable bleaches are available on the market. They are more expensive to buy but, because they last longer in store, can prove to be more economical in the long run. High Test Hypochlorite (HTH) is one such stabilised form of calcium hypochlorite. It contains between 60% and 70% available chlorine and with suitable storage will maintain its initial strength with little loss. It is available in tablet or granular form. Other prepared solutions include ICI Tropical bleach - 34% available chlorine and Stabochlor - 25%.

Sodium Hypochlorite (NaOCL)

Sodium hypochlorite is generally available as a solution commonly known as bleach. Typical available chlorine contents range from 1 to 5% but can be as high as 18%. Before using these solutions, the available chlorine content should be checked. The solutions become less stable as the chlorine content rises. As with all chlorine disinfecting compounds, extreme care should be used when handling these solutions.

Buying solutions of sodium hypochlorite is not economic for large-scale use, as the transport costs associated with it are high, because of the volume and weight to be transported. It is far better to buy powdered forms of chlorine and prepare solutions for addition to the water on site.

Slow dissolving Trichloroisocyanuric Acid

This form of chlorine is used extensively to disinfect swimming pools. The chlorine, which comes in various sized tablets, is supplied by OXFAM as part of its emergency water supply packs. The compound dissolves very slowly in water and so is suitable for disinfecting drinking water which is stored in large capacity tanks as used in an emergency. It is recommended that this form of chlorine should not be used in drinking water supplies for more than 3 months in one year. As such, this compound is ideal for use during the first three months of disinfection or whilst another source of chlorine is being found locally. It should be noted that the health risks (which are not certain or proved at the time of writing) associated with prolonged use of the tablets are much less than the risks ensuing from drinking non-disinfected water.

This form of chlorine is relatively stable and, if stored in non-humid conditions at temperatures below 25°C, can retain its full strength for 2 years. OXFAM supplies these tablets with a small plastic basket which floats inside the reservoir or tank. The basket should be placed near the inflow of the tank so that the incoming water flows over the tablets. This is the best way of ensuring good contact between the water and the chlorine. When using the 45m^3 OXFAM storage tank, initially use 3 tablets (4 for the 70m^3, 5 for the 95m^3). The residual chlorine will need to be checked daily (see section below) and the number of tablets adjusted accordingly. The tablets should last between 7 and 14 days.

Use of chlorine

How to make chlorine solutions

As we have already said, the most stable solution is 1% available chlorine, and it is recommended that this should be the strength of solution to be prepared. The following tables give an approximate guide to producing 1% solutions from various chlorine compounds. It should be stressed that the strength of the solution will be dependent upon the chlorine content of the chemical used to make the solution.

Table 1 - Quantities of Chemical Required to Make 1 Litre of 1% Chlorine Solution

Source of Chlorine	Available Chlorine %	Quantity Required (g)
Bleaching powder	34	30 - 40
HTH	70	14
Tropical bleach	34	25
Stabilised bleach (stabochlor)	25	40

Bleach (some forms eg. Milton)		1% solution

These quantities of chemicals should be added to 1 litre of water in the following way. In the case of bleaching powder, the amount of chemical needed to make a 1% solution is placed in a suitable vessel and sufficient water is added to make a smooth cream. It is best to use a wooden stirrer to break up the lumps. When all the lumps have been broken, the cream should be diluted to the required amount using more water and thorough mixing. The sediment should be allowed to settle out, and then the clarified liquid can be taken off to be used as the disinfecting agent in the water to be treated. For granular forms, such as HTH, adding the required quantity to 1 litre of water and agitating will be sufficient to ensure good mixing.

The 1% solution is used as the means of disinfecting larger quantities of water.

How much chlorine to use?

When using chlorine to disinfect drinking water the aim is to kill off all the pathogens and then to leave a small amount of active chlorine in the water. This remaining chlorine is called the `residual chlorine'. The residual chlorine is desirable as it can disinfect further contamination of the water once it has been collected e.g. dirty water containers. It is desirable to have a residual chlorine level of 0.3 - 0.5 milligrams per litre (mmg/l). This can be measured quite simply (see below).

The chlorine demand of water will vary greatly from one location to another. It is important therefore that the person responsible for the chlorination process is able to calculate the actual chlorine demand of the water to be treated.

This is a simple process of trial and error. Specific quantities of a chlorine solution can be added to litre samples of the water to be treated, e.g. sufficient to give 3, 4 or 5 mg/l. The residual chlorine can then be tested after a minimum of 30 minutes contact time. The chlorine demand can then be determined by deducting the residual from the amount of chlorine added.

Chlorine demand = known dose = residual chlorine

When the chlorine demand has been calculated, the desired residual level can be added arithmetically to give the required chlorine dose per litre of water, e.g. chlorine demand = 3.5 mg/l, desired residual = 0.5 mg/l, chlorine dose = 4 mg/l. This figure is then used to calculate the amount of solution to be added to the volume of water to be treated.

For reference ***When in water 1 mg/l = 1 part per million (ppm)***

Table 2

Chlorine dose required	Volume of 1% solution to be added to		
	10 litres	100 litres	1000 litres
1 mg/l	1 ml	10 ml	100 ml
5 mg/l	5 ml	53 ml	533 ml
10 mg/l	10 ml	100 ml	1 litre

ml = millilitres

Using these figures to give a 5 mg/l dose of chlorine to a reservoir of 45,000 litres will require 22.5 litres of 1% solution.

Measuring the residual chlorine

It is very important that the residual chlorine is able to be measured as this can tell the person responsible how effective the chlorination process has been. A very simple test involves the use of a kit designed for measuring the chlorine levels in swimming pools. It is called a `pool test kit'.

A sample of the water to be tested is placed in the kit and a DPD No. 1 tablet is dropped into it. The chlorine in the water reacts with the DPD tablet to give a level of coloration in the water.

This colour is compared directly against the colour chart on the kit. The strength of colour then tells the operator the level of residual chlorine. The same kit can also measure the pH of the water sample in a similar comparative manner.

Simple chlorination rules

- pre-treatment is important to get water as clean as possible before chlorination
- do not chlorinate before filtration
- check pH and temperature to help assess contact time
- ensure that minimum contact time is always permitted
- always test for residual chlorine levels
- follow the storage guide for the particular chemical being used

Safety rules

All forms of chlorine used as water disinfectants can be dangerous if not stored and handled in the correct manner.

The following simple rules must always be followed and any particular advice and precautions supplied with a specific product should likewise be closely followed.

- Only authorised personnel should be allowed into the chlorine store.
- Chlorine is caustic i.e. can cause burning and must not come into contact with skin, eyes or clothing. Use of protective clothing including gloves, goggles and overalls or apron is advisable.
- Avoid breathing chlorine dust as it is an irritant to the nose and lungs.
- Chlorine should be stored under dry, cool and dark conditions, preferably raised above the ground. Keep all containers closed and covered when not in use.
- Follow the instructions supplied by the manufacturer of the particular chlorine compound being used.

This was prepared as an information note by the Oxfam Public Health Team.

Relief and Rehabilitation Network

The objective of the Relief and Rehabilitation Network (RRN) is to facilitate the exchange of professional information and experience between the personnel of NGOs and other agencies involved in the provision of relief and rehabilitation assistance. Members of the Network are either nominated by their agency or may apply on an individual basis. Each year, RRN members receive four mailings in either English or French. A Newsletter and Network Papers are mailed to members every March and September and Good Practice Reviews on topics in the relief and rehabilitation field every June and December. In addition, RRN members are able to obtain advice on technical and operational problems they are facing from the RRN staff in London. A modest charge is made for membership with rates varying in the case of agency-nominated members depending on the type of agency.

The RRN is operated by the Overseas Development Institute (ODI) in conjunction with the European Association of Non-Governmental Organisations for Food Aid and Emergency Relief (EuronAid). ODI is an independent centre for development research and a forum for policy discussion on issues affecting economic relations between the North and South and social and economic policies within developing countries. EuronAid provides logistics and financing services to NGOs using EC food aid in their relief and development programmes. It has 25 member agencies and four with observer status. Its offices are located in the Hague.

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