WASH EXPO - 2010

8th – 9th July 2010 New Delhi, India

HAND OUT

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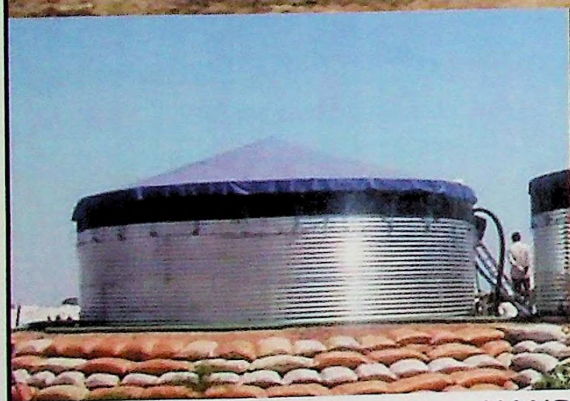

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WELCOME!

The 20th century has seen a rise in the number of disasters that has a heavy impact on the development of nations. Due to rapid population growth, increasing urbanization, and environmental changes, it seems that disasters are increasingly diverse and complicated and our societies are even more vulnerable to disasters. One of the biggest challenges today remains how to address the needs of the various sectors which are affected during disasters.

Looking at the water, sanitation and hygiene issues requires lot of technical expertise and technological advancements. With that in mind, **NDMA, UNICEF, RedR India** and **Sphere India** invite you to the WASH EXPO on 8th- 9th July 2010.

UNDERSTANDING THE CONTEXT FOR WATSAN PROBLEMS IN MASS DISPLACEMENT EMERGENCIES

Of all of the primary human needs, water has the greatest importance for survival. A safe water supply and some form of sanitation are basic human needs that are necessary to protect the community from diseases caused by human excreta. Unfortunately, water is also a carrier of pathogenic organisms, causing many outbreaks of water-borne diseases, particularly diarrhoea. Diarrhoea can have devastating effects both on the individual and on the group. It lowers resistance to other diseases, reduces the ability of the body to readily absorb valuable nutrition, and causes low morale and apathy. At its worst it is fatal.

Emergency shelters and camps are potentially dangerous to human health and life largely because of poor water quality and poor sanitation conditions. Relatively few camps have been planned and prepared in advance of the arrival of a mass population movement. With inadequate provisions for sanitation, water, drainage, space and shelter and despite the delivery of supposedly adequate food quantities, many camps have outrageously high death rates. Proper water and sanitation programs play a major role in disrupting the deadly cycle of disease transmission and thus prevent sickness and death.

Cultural factors affect personal hygiene practices and how decisions regarding water and sanitation are made. Politics and local influential personalities largely determine most decisions on what interventions are allowed. For example, host country officials may be reluctant to permit latrines to be constructed in a camp when their own country lacks resources to provide them to their own people.

One can exist longer without food than without water. Safe water is essential for life and health. The provision of water demands immediate attention from the start of a refugee emergency. In emergencies, water is often not available in adequate quantity or quality, thus creating a major health hazard.

Understanding Water Sources

An adequate amount of water is essential for good personal hygiene to be practiced. In general, the supply of adequate quantities of water to people in crowded conditions has a greater overall impact than supplies of small quantities of microbial pure water.
Nevertheless, whenever possible, sources of clean water should be sought or disinfection systems established. Hand, utensil, and clothes washing depends upon sufficient water that is safe and accessible. There are three different types of *water sources* which may serve to meet the overall requirement. There are some issues associated with each of these sources that should be considered:

1) Rain Water- may be a useful supplement for individual needs. As a main source of water, it is generally not suitable because of its unpredictable availability. For this to be a successful option there must be sufficient rainfall throughout the year and there must be suitable shelter and household storage facilities.

2) Surface Water- If the only available source is surface water, great care must be taken to protect it. Do not allow people or animals to enter the water- especially upstream of the intake point, if it is a river.

Contamination of surface water by rain runoff from latrines or open defecation areas is a severe problem. Surface water sources include seasonal catchments, rivers and ponds. All of these have great potential for contamination and disruption.

Although in the initial phase of an emergency the refugees will usually use surface water, like rivers and lakes if available, it is preferable *not* to draw water from such sources since they are likely to be contaminated. In emergencies, however, the only immediate solution may be to use these sources. In this case, an accurate water quality monitoring system and appropriate treatment measures (i.e., sand filtration or chlorination) must be quickly developed and put into place.

3) Ground Water – includes infiltration galleries, boreholes, wells and springs. ***Springs*** with sufficient flows are the ideal source for groundwater, water supply schemes. The quality of water is usually good, but should be tested.

Water Treatment

The three main principles of *water treatment* in emergency situations are:

1. **Coagulation and Sedimentation** – If the raw water contains high silt loads, sedimentation is necessary. The water will flow through a large tank where velocities are kept very low. This allows the solid matter to settle out, leaving relatively clean water to exit the tank. If the particles are of a small size, the sedimentation can be assisted by adding a *coagulant*. The particles will *flocculate* (attach to each other) and settle faster. The microbiological quality, however, does not improve significantly through these processes so a further treatment of the water is still required.

2. **Filtration** – An effective method of treatment for emergency situations is the slow sand filter. The water moves down through a filtered of 600 to 900 mm of deep sand, physically filtering out solids and, more importantly, a thin and very active layer of algae, plankton, bacteria and other forms of life develops on the surface of the sand bed. It is here that micro-organisms break down organic matter and kill pathogens. Provided the rate of filtration is slow enough, the quality of the treated water is very good.

The construction of sedimentation and filter tanks requires considerable time which is often not available in emergency situations. However, THE AGENCY provides a sand filtration unit that is set up easily and can be flown into nearly any location.

3. **Disinfection** – Pathogenic organisms can be destroyed by disinfecting. This can be done by adding disinfectant, by ozone, by UV light or boiling. Chlorine or chlorine compounds (bleaching

powder) are most commonly used. Chlorine is an oxidizing agent and, if added to the water, will oxidize the impurities. This makes it a very effective bactericide.

It is essential that the dose of chlorine is exactly determined, if an insufficient dose is used, it will not kill all pathogens. If the "residual" chlorine level is too high, people may reject the water because of the unpleasant odour and taste. An adequate dose satisfies the chlorine demands and leaves a minimum residue which provides protection against contamination during the distribution.

The residual chlorine doses should be checked regularly after a contact tine of 30 minutes to ensure that the doses applied are sufficient. **The optimum residual chlorine measurement is 0.5 ppm**. If the level is higher than 1 ppm, people will probably reject the water due to unpleasant taste. The level of chlorine can be easily checked in the field with a DPD chlorine comparator kit.

Understanding the Hygiene Loop

Water, sanitation and personal hygiene (the sanitary practices undertaken to maintain a clean body and clean environment in and around shelters) are all interrelated and of major concern in the refugee camp. Improper disposal of faecal material can lead to contamination of water. Contamination of water supplies leads to higher disease and malnutrition rates. Improper hygiene, poor food storage or preparation techniques, or lack of personal cleanliness can cause minor skin diseases and also severe diarrhoea and other diseases.

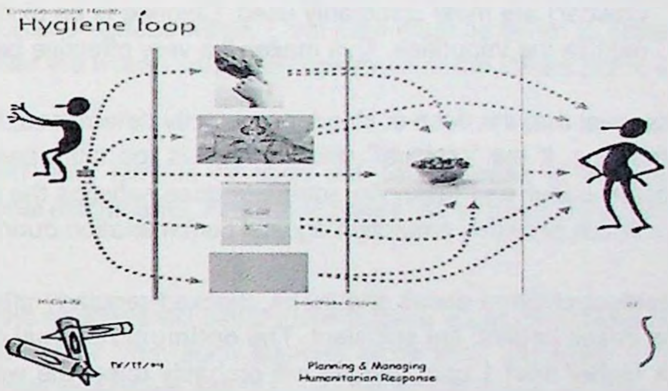
In the management of refugee camps, the interrelationship of water, sanitation and hygiene is known as the *hygiene loop*. This implies that the basic elements cannot be treated independently. Rather, they must be treated as a system in order to control disease.

Since failure of any of these systems or activities falls under the direct responsibility of the refugee camp manager, it is important that the administrator be aware of how to determine if problems exist in the loop and how to correct them. Safe and adequate water supplies cannot be taken for granted. The camp environmental system and sanitary practices must be evaluated constantly to detect and prevent the possibilities of a deadly communicable disease outbreak from occurring. This can affect not only the refugees but the surrounding host community as well.

An infectious disease is one that can be transmitted from one person to another or, sometimes, to and from animals. All infectious diseases are caused by living organisms, such as bacteria, viruses, or parasitic worms. By passing the organisms from one person's body to the other (faecal/oral route) the diseases are transmitted. In the transmission of diseases from the sick, or from carriers of the diseases, to the healthy, a chain of conditions is necessary:

- An agent that can cause disease must be present
- The agent can cause an infection in its host
- The agent can escape from the host

- The agent can be transmitted from the host to a potential new host
- There is a possibility of entry into the new host
- The new host must be susceptible to the agent



If any of the above conditions is absent, the spread of the disease is impossible.

Hygiene Loop illustrates the many ways bacteria and other disease causing organisms can be transmitted to cause communicable disease. The lines are complex and confusing as these organisms can be transmitted in many different ways. Therefore, it becomes more evident that the concept of the hygiene loop is the only practical approach that integrates all the water and sanitation activities needed in order to obtain the desired effect. Understanding the relationships illustrated in the hygiene loop is critical to establishing an effective water and sanitation program. A program that just stops transmission in one route will probably not have the desired outcome.

Bacteriological analysis of water should be carried out through fecal and total coliform bacteria counts. As a preventative measure, new water supplies should be tested ***before*** use, and supplies that are already in use should gave scheduled periodic testing. As a curative measure, testing of the water supplies being used should be performed whenever there is an indication of water-borne illness/disease.

Normal practice dictates detection of "indicator bacteria". These bacteria are always excreted in large numbers by humans and other warm-blooded animals – regardless of whether they are ill or healthy. Their presence in a water sample indicates a fecal contanimation of the water. The most commonly used indicator is Escherichia Coli (E Coli).

The usual testing done by local water laboratories and experience of local sanitarians will probably be directly related to the typical water problems faced by the host country community.

The most widely used tests implicate and enumerate faecal coliforms and are performed in water testing labs. Virtually every country is equipped with at least one such lab. Usually, several labs are able to carry out tests for the presence of coliforms rapidly and routinely. If there is no available lab, a portable Delaqua water testing kit might be considered. They are readily available from various resources and good results can be obtained in the field.

The presence of coliform bacteria in a water distribution system indicates that the treatment or disinfection has failed.

A rough guide to faecal coliform concentrations and their associated water quality level follows:

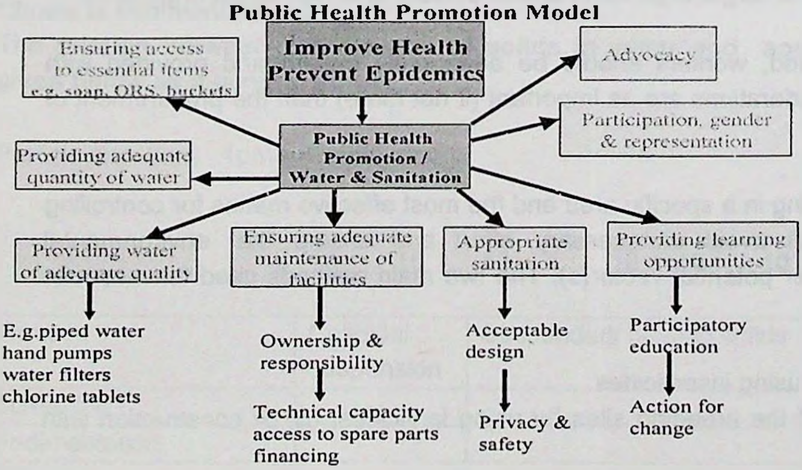
0-10 faecal coliforms/ 100 ml water	⇨ reasonable quality
10-100 faecal coliforms/ 100 ml water	⇨ polluted
100-1,000 faecal coliforms/ 100 ml water	⇨ very polluted
> 1,000 faecal coliforms/ 100 ml water	⇨ grossly polluted

Detailed standards for water quality are presented in WHO's guidelines for *Drinking Water Quality*, the UNHCR *Handbook of Emergencies* (Chapter 16) and the Sphere Project standards (Chapter 2).

Avoiding Faecal Contamination

From experience, it is evident that the faecal disposal problem is one of the greatest sanitary hazards in a camp environment. This can be most effectively dealt with during initial camp design. Water and sanitation facilities in a refugee camp usually require a substantial investment of money, both for the construction of the facilities, and their on-going maintenance. In many cases, on-going maintenance costs can be much more than the initial cost to construct the systems. A major way to reduce maintenance costs is to focus on the water and sanitation systems during camp planning. In fact, good planning will not only reduce maintenance costs but will improve the use of these facilities. For example, if latrines are constructed that are too far away from the users homes or shelters, there will be increased use of the surface areas in the camp for defecation. Or, if water supplies are too distant, efforts to encourage refugees to improve personal hygiene by washing will be difficult.

Public Health Promotion Model



Water is heavy. Use is dependent upon closeness of the supply and availability of proper receptacles for transporting it that can be used by the group whose task it is to carry it. Or, if water supply taps are provided in large numbers throughout the camp, but there is no provision of drainage from these tap outlets, massive unsanitary conditions will result at these taps. Construction of latrines that require pumping by a vehicle but not providing road access to the latrines will result in wasted resources and health hazards.

If latrines are not carefully sited, pollution from them can enter the water supply. This seems obvious but may not become apparent until a flash flood or heavy rains. A site for latrines should be selected with many criteria in mind.

Initially, excreta should be contained within specific areas until a more appropriate sanitation system can be implemented. Personal or family latrines that are ***well maintained*** are the best solution.

Sphere Sanitation standard 1: access to, and numbers of toilets (latrines). ***Poorly maintained and unclean latrines are a health hazard.*** If communal trench latrines are to be used, responsibilities regarding cleaning and maintenance should be assigned carefully.

Dealing with Solid Waste (Garbage)
Garbage that is mismanaged can promote a variety of environmental hazards. Planning and organizing refuse collection services is a complex business. Major types of refuse treatment and disposal are:

1. Sanitary landfill
2. Incineration
3. Composting

Poor refuse disposal will encourage fly breeding and may thus promote the transmission of faecal-oral infections. It can also promote diseases associated with rats.

Burying (sanitary land filling) is better than burning (incineration). Incinerators, however, might be advisable for clinics/health centres where medical/hazardous wastes are to be disposed of in the safest possible manner. Communal systems are better than individual pits.

Proper management of garbage, excreta (see above as for fly control) and domestic wastewater disposal through environmental measures such as filling and drainage are a more effective means of vector control than chemicals (i.e. use of pesticides). It is more cost-effective and may avoid undesirable effects such as resistance of target organisms and/or poisoning of non-target organisms.

Before spraying activities are launched, workers should be adequately trained and provided with protective clothing. These safety considerations are as important (if not more) than the procurement of chemicals and sprayers.

Awareness of the vector species existing in a specific area and the most effective means for controlling those vectors is essential. This will avoid unnecessary effort and ensure that environmental modifications do not favour some other potential vector(s). The two main methods used for mosquito control are:

1. Killing adult mosquitoes by using insecticides
2. Treatment or elimination of the breeding sites by using larvicides, oil, or construction with proper drainage.

Control measures should be concentrated within 1-2 km from settlement(s).

Reading 1.1 Water & Sanitation in Emergencies

Please review the UNHCR Handbook for Emergencies, pages 211-246 for information on Site Selection, Planning and Shelter, also the Table on page 373 is a good overview of some of the quantitative aspects and planning figures used for refugee camp planning

WATER TREATMENT IN EMERGENCIES – I

SPHERE standards of quality & quantity:

It is obligation of relief agency to provide reliable water supply in emergencies complying with the set standards.

Quantity

15 litres/ person/ day for drinking, cooking, washing and bathing.
10 litres/person/day (If washing and bathing can be managed from other sources)

Quality

Turbidity (cloudiness index) - less than 5 NTU
Faecal coliforms (for un- disinfected supplies) - less than 10 FC/ 100 ml

Residual chlorine (if disinfected) – 0.2 to 0.5 mg/l

What is treatment?

If underground sources (springs, dug wells, tube well) are used practically no treatment would be necessary. They are preferable. Surface water sources (lakes, streams, rivers) are generally polluted. Water from these sources would require proper treatment to make it fit for human consumption.

Water treatment is an exercise of producing water of required quality standards from the available water.

Choice of treatment processes:

The relation between particle size of solids in water and applicable treatment processes is given below as a general guide.

Particle size (μm) 1μm = 1/1000 mm

10 10 10 1 10 10^2 10^3 10^4 10^5 Larger

Process	Colloidal suspension	Suspended/ floating solids
Screening		
Sedimentation		
Filtration		
Chemical coagulation		

Waters with high colloidal turbidity levels are more amenable to treatment using chemical coagulation followed by settling (physio – chemical process).

Waters containing suspended matter with adequate nutrients are amenable to treatment comprising of multistage filtration (physio – microbiological process)

Treatment in emergency situation:

Following considerations apply to emergency situation in contrast to regular treatment works

- The response has to be quick
- Looking to short term use, some chemical contamination can be tolerated (There are limitations of treatment in emergencies)
- Optimisation of capital and running cost is rated secondary compared to urgency.

Treatment process for post emergency response:

For surface waters multistage filtration based on physics- micro biological processes is suitable for long-term use in post emergency situation.

The treatment comprises of following unit processes.

1. Up flow gravel pre filters (Roughing filters – RF)

It is a pre-treatment as name implies.

Water containing large degree of solids (high turbidity) are passed through pre filters to bring down turbidity within limit to load on slow sand filters. The pre filter also reduces microbial contamination to some extent.

2. Slow sand filters (SSF)

The name slow sand filter is due to very low rate of filtration implied.

SSF can be deal effectively with the water containing low turbidity and high microbiological contamination. As such, raw water having low turbidity or effluent from RF can be treated by SSF. The SSF has great ability to remove microbiological contamination.

3. Terminal disinfection

Disinfection by using chlorine is resorted, if required.

The treatment system is simple, easy to maintain. It has proven effective to deal with harmful pathogens and produce safe quality of water.

Roughing filter features:

Roughing filter is nothing but a tank filled with gravel / broken stones media in which water passes from bottom to top.

If water is fairly clean, single stage RF is used. Three different sized broken stones/ gravel in layers are used with largest size layer at bottom. The media size depends on results of pilot study with raw water. However, the details might be like this –

Layer/ depth	Media size (mm)
Bottom layer/ 600 mm	15/20 to 25/30
Middle layer/ 300 mm	10 to 15/20
Top layer/ 300 mm	5 to 10

The multi stage (normally 3 staged) RF is required for more turbid waters. The water is passed through successive tanks filled with one media in each tank i.e. coarser media in first tank, medium in the second.

The maximum surface loading for RF is 0.60 $m^3/m^2/hr$ beyond which efficiency drops. With lower surface loading rates (upto 0.3 $m^3/m^2/hr$), there is no significant difference in removal efficiency.

Most of the suspended solids are removed in coarser media layer having maximum voids. The further stages are useful for refinement of quality.

Single stage (3 layers) RF has removal efficiency varying from 75 % to 85 % at 0.6 $m^3/m^2/hr$ to 0.3 $m^3/m^2/hr$ e.g. RF with 0.3 $m^3/m^2/hr$ loading is able to bring down turbidity of water from 100 NTU to 15 NTU.

The three stages RF can offer 87 % to 92 % removal efficiency at 0.60 to 0.30 $m^3/m^2/hr$. e.g. 3 stage filter can bring down turbidity of water from 50 NTU to 5 NTU (90 % removal), amenable to chlorination and then supply.

The RF is found effective even for removal of smaller sized (0.75 μm) particles. The faecal coliform removal efficiency is found to be 80 – 90 %.

Slow sand filter features:
Slow sand filter is physio-biological filter in which water is passed from top to bottom through filter sand of specified grading.

A typical SSF consists of 75 to 90 cm layer of filter sand supported on 20 to 30 cm gravel layer. The water depth is maintained between 1 to 1.5 m. The loading rates are kept at 0.1 to 0.2 $m^3/m^2/hr$. The version of SSF in The Agency tank T 70 is shown below.

The specifications for filter sand are:
Max size = 3 mm, minimum size = 0.10 mm
D10 effective size (sieve size through which 10 % sand passes)
= 0.20 to 0.35 mm
Uniformity coeft (U.C.) < 2

Sand suitable for good construction work will be suitable as filter sand.

The sand is washed properly to remove fines, silt and organic matter before loading.

Slow sand filtration process:
After the filter is commissioned, certain "good" micro organisms develop a film on top of sand and in the filter fabric. The film called "filter skin" or "schmutzdecke" is biologically active.

The micro organisms in the film break down and digest organic matter. They also produce chemical and biological substances, which act as poisons to pathogens and kill them. At the same time, suspended solids are retained in fabric and filter medium by simple straining.

The SSF ensure virtually complete pathogen removal (99.9 to 99.99 %)

Multistage filtration using The Agency tanks:
The Agency provides tank kit for various capacity circular tanks consisting of sheets, liners and roof. The tanks can be erected at site within a matter of a few hours. These tanks can be provided with inlet, outlet, drain piping using the holes made in the sheets. The details of available tanks are as below.

The Agency code	Nominal storage capacity (litres)	Height (m)	Dia (m)	surface are (m^2)
T 11	11,000	2.30	2.60	5.31
T 45	45,000	1.50	6.40	32.15
T 70	70,000	2.30	6.40	32.15
T 95	95,000	3.00	6.40	32.15

Roughing filters are built in T11 tanks (A = 5.31 m^2)
Output at 0.6 $m^3/m^2/hr$ rate
= 0.6 x 5.31 = 3.20 m^3/ hr per tank.

SSF are built in T 70 tanks (A = 32.15 m^2)
Output at 0.2 $m^3/m^2/hr$ rate
= 32.15 x 0.20 = 6.40 $m^3/m^2/hr$
Thus two RF tanks are required per SSF tank. If multistage RF are provided, there will be two parallel streams of RF stages per SSF tanks.

Plant sighting and layout:
The location of treatment plant gets decided by compromise between conflicting parameters.

- Elevation above distribution area
- Proximity to source
- Proximity to distribution area

The levels of clean water tank are decided by working backward from distribution area. Gravity flow to units eg. raw water tanks, RF, SSF, clean water tank has to be ensured by providing sufficient level difference between various tanks.

e.g. Base level to Raw water tank is set between 0.70 m to 1.10 m above base level of RF / SSF.
- Each RF stage tank is set 0.30 m higher than next RF stage tank.
- Difference between RF and SSF tank bases is set 0.60 m

This may be achieved by correcting ground profile / constructing earthen banks.

RF operation and cleaning:
It is preferable to run RF as continuous process and not as batch process.

The proper cleaning interval for the RF can be decided based on its actual experience. Before such experience gathers, following is suggested as guide.

Raw water turbidity range (NTU)	Initial cleaning interval (days)
< 25	20
25 – 100	10
100 – 500	5
500 – 800	2
> 800	Daily

For cleaning operation, the inlet valve is closed and all the washout valves are opened simultaneously to achieve max scouring,. Cleaning velocity between 60 – 90 m / hr is ideal. If necessary, pump is used to add clean water at top during emptying for ensuring adequate scouring.

The head loss in RF should be between 0.2 to 0.30 m.

The RF should be cleaned manually when head loss exceeds greatly Inspite of regular cleaning (interval 1 – 5 years)
SSF commissioning & operation:
The filter is commissioned by filling filter from bottom (through scour valve)and adjusting outlet valve to achieve steady output rate required (6.40 m^3/ hr in T 70 tank)

The biological process in filter explained earlier, takes several days to establish. During this period filter outlet is not connected to clean water tank. Quality of filtered water is checked intermittently. When desired quality (FC < 10/ 1000 ml preferably) is obtained, the water can be taken to supply tank.

If after 10 – 15 days, no improvement in quality is noted, one can consider chlorination. Once filtered water quality is ensured, chlorination can be stopped. (Chlorination only after and not earlier to SSF is permitted).

For maintaining biological process in filter, the filter must be run on continues basis. (At least 10 % flow to be maintained) Water depth of at least 0.10 m on fabric top should be ensured all the while.

Cleaning of SSF:
As filtration continues the pores in fabric and sand get clogged. The head loss shown on indicator tube goes on increasing (usual initial head loss is around 0.30 m). In order to get required flow the outlet valve is opened. After some period the filter is so blocked that it does not give rated output, though valve is fully opened. The head loss at this stage may be around 0.80 m. This is a sign that filter has become due for cleaning.

Filter runs between two cleanings range from 3 to 12 weeks depending on quality of water. Enhanced filter runs are obtained due to use of geo textile fabric on top.

Procedure for cleaning:

- Drain the tank (upto 0.20 m below sand level)
- Remove the fabric strips carefully and wash with water jet
- Remove carefully top layer of sand (about 10 mm) blocked with debris and micro organisms. This is to be done only if essential for satisfactory operation. The sand removed is washed properly and preserved for regarding.
- Replace filter fabric
- Refill filter from bottom (through outlet and under drains) with clean water
- When water level is above fabric, open inlet and close outlet.
- Allow water to waste through outlet for a few hours (watch clarity of output)
- Open the outlet valve gradually to achieve rated output in 24 hr
- It takes about 2 – 4 days to re-establish biological process in the filter. During this period or till satisfactory quality is obtained, continue chlorination.

Re-grading of SSF:

The minimum sand depth of 0.50 m in filter is essential. After several years of operation due to scraping of top sand layer, is necessary to replenish the sand and decommission the filter as explained previously.

Monitoring of plant performance:

Monitoring of plant performance can be done by following means. Proper record shall be maintained thereof.

<u>Quantity</u> – By measuring output by water meter on outlet of filter

Quality parameters

FC count of filtered water	by membrane filtration
Turbidity at various stages (Raw water inlet, RF outlet, SSF inlet, SSF outlet)	By visual tube method
pH value	By colour comparator
Residual chlorine (if disinfected)	by colour comparator.

Example:

Prepare a layout of treatment system and pumping schedule for a camp from following data.

1) No. of persons 10,000
2) Water supply rate 15 l/h/day
3) Pump discharge
(source to treatment plant) 18000 lph
= 18 m^3/hr

4) Difference between base of Raw water tank (T95) and first RF tank (T11) 0.70 m

5) Anticipated turbidity at raw water tank outlet 300 NTU

Solution:

Daily quantity to be supplied = 10000 x 15 = 1,50,000 lit
= 150 cum

For continuous operation of filters
The plant rating = 150/ 24 = 6.25 m3/m^2/hr

Roughening filters:

If single stage filter is used, expected efficiency = say, 80 %
Therefore expected effluent turbidity = 300 x 0.20 = 60 NTU

If three stage filter is used, expected efficiency = say, 90 %
Expected effluent turbidity = 300 x 0.10 = 30 NTU

We go for 3 stages RF, in order to keep turbidity on SSF within limits.

The output of T11 tank (A = 5.31 m2) at 0.60 m3/m^2/hr = 3.20 m3 /hr

Therefore for 6.25 m3/m^2/hr output, we require to employ two parallel streams of 3 stages RF (T11)

Slow Sand Filter:

Using T 70 tank (A = 32.15 m^2),

Output expected = 6.40 m3/ hr

Therefore we require employing one SSF tank after RF to deal with 6.25 m^3/hr flow.

Clean water tank:

Keeping 12 hours storage requirement, Capacity = 150/ 2 = 75 cum

Therefore, we employ T 70 tank

Raw water pumping schedule:

Water level in SSF tank (T 70) would fall at same rate as raw water tank (T 95), as dia meters of both tanks are same (6.40 m)
To ensure continuous operation of plant, we have allowance
= 0.70 m (base level difference) + 0.70 m (water depth difference in Tank T95 & T11)
= 1.40 m

Ensuring 0.20 m water depth in SSF all the while, the level in raw water tank can deplete by 1.20 m at 0.2 m / hr.
Therefore we have 6 hrs time margin for pumping in batches.
Therefore pumping schedule can be worked out as under

Total hrs required in 24 hrs (daily)
= daily requirement/ pumping rate
= 150/18 = 8 hrs – 20 min
The schedule

Start time	Hrs	Qty
12.00 (night)	2 h – 5 m	37.5 m^3
6.00 (morning)	2 h – 5 m	37.5 m^3
12.00 (noon)	2h – 5 m	37.5 m^3
6.00 (evening)	2 h – 5 m	37.5 m^3
	Total	150 m^3

We have about 4 hrs detention time in raw water tank for settling. We arrive at layout of plant

WATER TREATMENT IN EMERGENCIES – II

Physical, chemical treatment processes are more suitable in early stages of emergency. They are speedy to install and effective in performance.

Basic of treatment processes

A. Coagulation

Plain sedimentation (without addition of coagulants) has limitations. For waters having high turbidity levels containing fine particles, it is necessary to add chemicals called coagulants to facilitate process of settling.

$Al2\ (SO_4)_3\ n\ H2O$ – Aluminium sulphate (Alum) is commonly used coagulant. Turbidity particles carry –ve charge which makes them repel each other. The addition of Alum removes the –ve charge on the particles and as a result the particles come together. Thus destabilization of turbidity particles is achieved by coagulation.

Reaction: Alum acts with alkalinity in water.

$$Al_2(SO_4)_3 + 3\ Ca\ (HCO_3)_2 = \underset{\downarrow}{Al\ (OH)_3} + 6\ CaSO_4 + 6\ Co_2$$

The hydroxide floc settles down.
If water has low alkalinity, lime $Ca\ (OH)_2$ or Soda Ash ($Na_2\ CO_3$) are added.

The floc particles are spongy. They are capable of adsorbing dissolved and colloidal particles.

Alum as coagulant is effective in pH range 6.5 to 7.50. The optimum dose of alum and optimum pH for particular water can be fixed by conducting jar test.

$FeSO_{4\ .7H2O}$ (Copperas), $FeCl_3$, $Fe_2\ (SO_4)_3$ are some other coagulants.

They are not suitable for emergency situation due to handling and storage problems. Alum is generally used as it is easily available everywhere, can be air freighted and easy to handle and apply.

Coagulant aids improve the efficiency of floc formation. They are useful for low turbidity water. Polyelectrolytes, oxidants are examples of coagulant aids.

B. Flocculation

Once the turbidity particles are destabilised due to removal of charges, in coagulation, it is necessary to increase contact opportunities for the micro flocs formed. In flocculation process an orderly, gentle motion is provided to water, so that microflocs collide with each other and form larger floc or lump for easy settlement. Flocculation is a physical process. One has to ensure that motion is not excessive to result in breaking the floc.

C. Sedimentation

The floc formed entraps turbidity, bacteria, colour particles. In sedimentation process, opportunity is provided for settlement of floc formed. Specially designed sedimentation tanks with proper inlet, outlet arrangement can do this job efficiently. In emergency situations, the tanks available are to be used.

D. Disinfection

Chlorine is used for disinfection in emergency situations.

- Chlorine is effective disinfectant.
- It is easily available at reasonable price
- It can be applied easily in measured quantum.
- It retains its residual after application, which is useful to take care of further contamination in system or at household level.
- The residual can also be measured to make sure affectivity of application.

Chlorine reacts with suspended solids and organic matters. It is therefore necessary to bring down turbidity of water upto 5NTU to reduce its chlorine demand.

Chemistry of Chlorination

$Cl_2 + H_2O = HOCl$ (Hypochloric acid) + HCl
HOCl $H^+ + OCl$ Hypochlorous ion)

Both HOCl & OCl are disinfectants and are called " free chlorine"

HOCl is more effective (about 50 times) compared to OCl as disinfectant. When pH is lower, HOCl predominate and disinfection is more effective. If water contains Ammonia, chlorine forms Monochloramines (NH_2Cl) and Diachloramines ($NHCl_2$) which are also disinfectants of low degree. They are called "combined chlorine".

Dose of Chlorine

Chlorine is consumed by turbidity and organic matter in the water. (Called "Chlorine demand of water"). It is also consumed during conveyance upto delivery point. It is therefore necessary to add enough chlorine to leave required residual at delivery point.

The chlorine dose has to be provided such that minimum of 0.2 – 0.3 mg/l residual is obtained at delivery point. The dose for particular water will have to be fixed by trials and testing of residual level at various points in the systems.

Contact time

The affectivity of chlorination depends on contact time, as well. Minimum contact time of 30 minutes is recommended.

Batch process of treatment

Typical operation schedule may be somewhat like this.

1. Filling the tanks with pumping/ gravity
2. Coagulation and settling (2-6 hr)
3. Emptying clear water in final tanks and chlorination.

From one set of tanks in series, 3 batches of water can be produced daily.

The desludging of tanks is done from tank bottom washouts. Manual cleaning is required occasionally. Proper sludge disposal has to be ensured (eg. landfill).

Application of processes on plant scale

a. **Coagulation**

The coagulant dosing is possible by following means.

(a) Suction side dose: It is installed on suction side of raw water pump.

Alum solution is sucked at regulated rate from the coagulant vessel. The rate is fixed with respect to dose required, concentration of solution and pumping rate. There is rapid mixing of solution in water

Application:

This method is useful both for batch process and for continuous process using upflow clarifiers. Prolonged use of these methods will corrode pump impellers.

(b) Gravity feeding at outlet of raw water storage tank.

When water is supplied to up flow clarifier in continuous process from storage tank.

c) Injecting dose in inlet stream to sedimentation tank (application: Batch process)

Dosing vessel is positioned suitably and feed line injects coagulant dose into coming stream.

b. **Flocculation**

Spiral (coiled) pipe flocculator can be used for causing velocity gradient, i.e. (Differential velocities in various particles in water)

In case of batch process, one spiral hose is used and in case of upflow clarifier two spirals are used. They are wrapped around the outer side of clarifier tank. The coagulated water is pumped through the spiral pipe before entry in S.T./ clarifier. Normally detention time of 2 to 6 minutes is provided. One can vary either through put rate or length of the pipe.

c. **Sedimentation**

In a batch process simple tanks are used.
In continues process up flow clarifiers developed by The Agency can be used. The system is built in T 11 tanks and can produce 7-9 m^3/hr (surface loading between 30 to 40 m^3/m^2/day). It can deal with high turbidity water and can produce high efficiency as much as 98 %. It requires less maintenance and cleaning. It is more reliable than pressure filters and can be installed in couple of days.

The process comprises of
(i) Dosing of coagulant by suction side doser/ from outlet of raw water tank.
(ii) Passing through spiral pipe flocculator
(iii) Sedimentation in upflow clarifier.
(iv) Filtration through fabric filter installed on top of clarifier tank.
(v) Chlorination

Features of up flow clarifier

Process:
The water enters through inlet. Its velocity reduces and floc formed starts dropping down.

Through the slots water enters at the bottom of the funnel. As it rises up, velocity goes on reducing. At certain height above bottom up thrust on upward travelling floc becomes equal to gravity force on it. The floc stops moving upwards and floc blanket is formed at that point.

The blanket goes on building. More and more flocs get trapped. The water coming through the blanket is clear. The water gets final finishing when passing through fabric filter at top of tank. The final effluent flows out of outlet.

The sludge is drained out periodically and disposed properly. For manual cleaning required occasionally, funnel can be removed and washed with water jet.

The start flow may be kept low say 6.5 m^3/hr or so. The dose decided by jar test should be applied. After about an hour, flow is increased gradually. The stabilised blanket level should be just below the funnel top. For variations in quality (eg. rains) adjustments of flow and coagulant dose would be necessary. Too high flow or incorrect doses may result in break through of blanket. One has to watch for floc carry over and blanket condition.

It is desirable to run clarifier on continuous basis to maintain in the sludge blanket.

Or else, the blanket formed will collapse and will have to be reformed.

d. Disinfection
Chlorine is used in various forms.
The available chlorine % gas are:
Bleaching powder – 34 %.
Calcium hypochlorite granules (HTH) – 70 %

Application Methods

a) For batch process prepare 1 % solution using required quantity and add to tank.
b) By using constant flow dosing device on upflow clarifier outlet or outlet of water storage tank and applying 1 % solution.
c) By use of chemical dosing pump.

Chlorine tablets are used in floating pot chlorinators, where slow release of chlorine is required over longer period. The amount of tablets and openings of pot can be varied by trials to achieve required residual.

Illustrative example

Calculate the Alum solution dose per hour for 30 m3/hr water flow assuming 40 mg/l alum dose.

Water quantity per hour = 30 m3
= 30,000 litres
Alum to be added = 30,000 x 40/106 kg
= 1.2 kg/hr
Keeping solution concentration 10 %,
Solution dose = 1.2 x 10 = 12 lit/ hr
With 5 % solution, dose = 1.2 x 20 = 24 l/h
With 2 % solution, dose = 1.2 x 50 = 60 l/h

We have to adopt concentration of solution to suit available feeding equipment.

WATER QUALITY

Core Tests							
Test	**Why the failure is of concern**	**Origin of the feature**	**When is testing require?**	**Suggested guidelines level (maximum)**			**Ideal equipment range and accuracy**
				Survival	**Longer term**		
Turbidity	acceptability to the consumer and determines treatment requirements (reduces effectiveness disinfection)	suspended matter e.g. clays, silts, organic matter, microscopic organisms	core test (when water is not totally clear)	20 NTU	10 NTU	5 NTU 1 NTU for disinfection (aesthetic on which value is based are noted in brackets)	1,5,10,20,50,100, 200 NTU
Odour	acceptability to the consumer and an indicate the presence of other pollutants	hydrogen sulphide from septic conditions, organic matter, algae, fungi, industrial wastes	core test	no restriction	acceptable to the consumers	15 TCU (aesthetic)	
Colour	acceptability to the consumer and can indicate the presence of other pollutants	organic matter, metals, industrial wastes	core test	no restriction	acceptable to the consumers	15 TCU (aesthetic)	
Conductivity	acceptability to the consumer	dissolved solids	core test	no restriction	1400 µS/cm	1400 µS/cm (from 100	500-1700 +/- 100 µS/cm

	(taste), corrosion and encrustation					mg/l TDS (aesthetic)	
pH	effects treatment requirements, corrosion and acceptability to the consumer (taste)	coloured peaty substances, acids or alkalis, acid rain	cores test	no restriction	6 to 8 for coagulation with aluminium sulphate < 8 for disinfection	preferably < 8.0 for effective disinfection with chlorine (treatment)	4-10 +/- 0.5
E.coli	indication of the possible presence of pathogens	faecal con-tamination	core test	always aim to disinfect supplies if this is not possible then; < 1000 thermo tolerant coliform (E.coli)/ 100 ml	always aim to disinfect supplies if this is not possible then; < 10 thermo tolerant coliform (E.coli)/ 100 ml	0 thermo tolerant coliform/ 100 ml (health)	< 10, 10, 100, 1000, > 1000

Test	**Why the failure is of concern**	**Origin of the feature**	**When is testing require?**	**Suggested guidelines level (maximum)**			**Ideal equipment range and accuracy**
				Survival	**Longer term**		
Chloride	acceptable to the consumer (taste) corrosion, high levels can indicate contamination by urine	salt deposits, industrial pollution, sewage discharges, landfill leachate	complaints of salty taste or high conductivity	600 mg/l	250 mg/l	250 mg/l (aesthetic)	100-800 +/- 50 mg/l

		and water intrusion					
Fluoride	deposits, acceptability to the consumer (taste and colour)	rocks and minerals, acid mine drainage, landfill leachates, sewage, industrial effluents	reports of metallic or bitter tastes, red/orange staining or deposits, test if using iron as a coagulant for assisted sedi-mentation	no restriction	1.0 mg/l (healt h long term)	0.3 mg/l	0.1 – 1.5 +/- 0.2 mf/l
Manganes e	deposits, acceptability to the consumer (taste and colour)	rocks, and minerals, anaerobic ground water	metallic or bitter tastes, black staining or deposits	no restriction	0.5 mg/l (healt h long term)	0.5 mg/l (health) 0.1 mg/l (aesthetic)	0.1-0.8 +/- 0.1 mg/l
Nitrate	health (blue baby syndrome) can also indicate faecal contaminatio n	breakdown or vegetation, fertilizer, sewage	agriculture is practices in the catchment area, reports of blue baby syndrome, high levels of algae; can be use for monitoring purpose	50 mg/l as NO_3, (dangerou s for babies under 6 months above this level)	50 mg/l as NO_3,	50 mg/l as NO_3, o r 11 as N (health)	30-100 +/- 20 mg/l as NO_3

Test	Why the failure is of concern	Origin of the feature	When is testing require?	Suggested guidelines level (maximum)			Ideal equipment range and accuracy
				Survival	Longer term		
Nitrate	health (blue baby syndrome) can also indicate faecal contamination	breakdown or vegetation, fertilizer, sewage (indicates recent pollution)	agriculture is practices in the catchment area, reports of blue baby syndrome, high levels of algae; can be use for monitoring purpose	3 mg/l as NO_3,	3 mg/l as NO_3,	3 mg/l as NO_3, 0.9 as N (health)	1 to 5 +/- 1 mg/l as NO_3
Sulphate	health (diarrhoea), acceptability to the consumer (taste), corrosion	rocks such as gypsum, acid mine water, industrial wastes	new users of the source usually experience diarrhoea, bitter tastes	400 mg/l (can cause diarrhoea which in turn could lead to epidemic)	400 mg/l	400 mg/l (aesthetic)	100-800 +/- 100 mg/l
Taste	acceptability to the consumer; can indicate other pollutants	organic matter, industrial pollution, rocks, anaerobic conditions salt, deposits, sea water intrusion	complaints from locals	must be drinkable	acceptable to the consumer	should be acceptable to the consumer (aesthetic)	

Test	Why the failure is of concern	Origin of the feature	When is testing require?	Suggested guidelines level (maximum)		Ideal equipment range and accuracy
				Survival	Longer term	
Arsenic	suspected carcinogen on accumulation	refuse tips, week killers, insecticides, industrial pollution. Some naturally occurring (usually < 0.1 mg/l but can be upto 12 mg/O)	indication that industry may be discharging the parameter, or where the parameter is known as a problem regionally (especially for ground water)	WHO guidelines value is recommended for long-term consumption. However, as suitable alternative figures are not available for short-term consumption this figure should still be used as t he guidance	0.01 mg/l (health)	0.005 – 3 mg/l (note: difficult to find suitable equipment)
Permanganate value	indicates organic pollution which could be faecal in origin, could affect the treatment processes, or could come from industrial pollution	Can be used when organic pollution is expected (either natural or industrial) Rough conversions can b e made from PV to 'probable BOD'. These conversions have been formulated for sewage effluent: 'Probable BOD' = PV x 1.5				Standard equipment measurers 0-10; 10-20; 20-30; and > 30 PV

Chlorine demand (of the raw water)	high demand an indication of pollution (organic matter, oxidiable compounds, micro-organisms)	Can be used as another test for overall pollution level 0-2 mg/l = quite clean water (calmcross and Feachem, 1988 p 92); Surface water can have a chlorine demand upto 6-8 mg/l (Twort, 1984, p332) Note: It is difficult to be sure of the original concentration of the chlorine used as it loses strength with time. however chlorine demand can be useful tool to monitor changes in raw water quality over time.	See treatability tests table , p173

Treatment tests

Treatment monitoring tests							
Test	**Why the failure is of concern**	**Origin of the feature**	**When is testing require?**	**Suggested guidelines level (maximum)**			**Ideal equipment range and accuracy**
				Survival	**Longer term**		
					minimum recommend ed	WHO guidelin es, 1993 (criteria on which value is b ased are noted in brackets)	
Chlorine (residual)	acceptabili ty to the consumer (when high) and treatment requireme nt	water treatmen t with chlorine or industria l effluents	always test when disinfecting	0.2 mg/l minimum on disinfection 3.0 – 0.5 mg/l max. (WHO, 1996)	0.2 – 1.0 mg/l	0.2 mg/l (aesthiti c)	0-2.0 +/-0.2 mg/l & (2.0 to 8.0 mg/l advantageo us)

Aluminium	acceptability to the consumer (taste) and treatment requirements	water treatment with alluminium salts, industrial pollution, erosion, leaching of minerals and soils	test if treatment process involves assisted sedimentation with alluminium sulphate	if > 0.3 mg/l present after treatment then there is fault in the coagulation or sedimentation stages. Higher values are not dangerous to humans in the short form	0.2 mg/l	0.2 mg/l (aesthetic)	0-0.5 +/- 0.1 mg/l
Temperature	acceptability to the consumer (taste) and treatment requirements	heating from sun or thermal pollution from industrial process es	physical assessment by touch, test if abnormally high				-10 to 110 C

Alkalinity	may be needed to improve treatment efficiency or to modify pH to prevent corrosion or for acceptability to the consumer	rock formations such as limestone	if there is a requirement to modify the pH or to improve the process efficiency of the assisted sedimentation process	]			5-100 mg/l as $CaCO_3$ +/- 5 mg/l

Treatability tests			
	Shy undertake the test?	**What does the test tell you?**	**When is testing required?**
Sedimentation	to reduce the turbidity to improve the acceptability of the water and the efficiency of the disinfection process	whether sedimentation is an appropriate method to remove turbidity	when there is turbidity >20 NTU (survival level); > 10 or < 5 NTU (minimum recommended and WHO values respectively for longer term level)
Assisted sedimentation (jar test)	to reduce the turbidity to improve the acceptability of the water and the efficiency of the disinfection process	a rough guide to the quantity of coagulant which will be required and most appropriate dosage	when there is a high turbidity and the sedimentation test results ae not acceptable (> 1 hour to sediment to acceptable turbidity)
pH adjustment	to modify the pH of the water for more effective chlorination, assisted sedimentation or to reduce corrosion	a rough guide to the quantity of chemical required to adjust the pH and the most appropriate dosage	if pH is high or low and chlorination or assisted sedimentation treatment process would be adversely affected

Chlorination (chlorine demand of the treated water)	to determine the chlorine volumes required for disinfection	a rough guide to the volume of chlorine which will be required for disinfection, the most appropriate dosage, and an indication of the chlorine demand (pollution level) of the water	always when disinfection

WATER QUALITY TESTING

Why test Water?

Water is tested for the following reasons:

- For choosing water sources. Tests are done to see if the water can be drunk without treatment, or to determine what treatment methods are needed. See section 7.3.2.
- For monitoring water quality once supplies are established; monitoring the quality of untreated water and monitoring the performance of the treatment system.
- For monitoring water quality at the point of consumption, to see whether it has become contaminated during collection and storage.

Routine water quality testing

Monitoring quality of water supplied

Once the water source has been chosen and the treatment system established, they should be monitored regularly to check the safe water is being supplied. If the treatment system succeeds consistently in producing water of less than 5 NTU turbidity and with a minimum residual free chlorine level of 0.2 mg/ 1 after a half hour contact time, then it can be assumed to be biologically safe. There is no need to do regular biological testing where a centrally managed water treatment system including chlorination is operated, unless system monitoring shows that there are problems with the treatment process.

At central water treatment works, residual free chlorine should be checked every day, and also turbidity where treatment involves clarifying the water. During the early days of operating the system this monitoring will need to be more frequent as the system is fine turned. If the raw water quality is very variable tests may need to be done after each rainfall or even on each tank full of water before distribution, but this is expensive and time consuming to sustain in the long term. Generally, once the system operations are well established and the operators are familiar with the normal variations in raw water quality, then less frequent checks should be necessary. Simple forms or exercise books should be used to record information,, including the operators responsible for the particular shift, to help identify causes of problems found and allow long term trends to be identified.

Where water is not treated and water quality depends on good protection of the source, biological testing is more important and should be established as a routine. The frequency of testing depends on the number of people using the source. Typically, a spring supplying a settlement of 5,000 people should be tested for faecal contamination every month.

Testing stored water

Once water is collected and stored in people's shelters, there are many possibilities of contamination, particularly if the water is stored for a long time, in open and metal containers. Testing biological quality is useful to gather information on water storage and use, and to inform hygiene promotion work or argue for distribution of more or better waste containers. Measuring the residual free chlorine level in water after collection may be done where recontamination is a concern.

Microbiological testing and sanitary surveys

Principle of microbiological testing

The principle of the most common microbiological water test is to isolate and count the number of Escherichia coli bacteria in the water sample. E. coli or faecal coliforms are present in mammal excreta and their presence indicates faecal contamination, though not necessary from human sources. There are two principle methods doing the test: one is the most probable number (MPN) technique and the other is by membrane filtration. The MPN technique requires laboratory conditions to be performed, though it uses cheap and simple equipment whereas membrane filtration can be done with portable equipment in the field, though reliable equipment is expensive to purchase and supply with consumable items. Samples are taken, and tested within 6 hours, then incubated for 14 to 18 hours before the numbers of faecal coliforms can be estimated. Results are expressed as numbers of faecal coliforms per 10 ml.

The Agency uses a portable water testing kit which includes tests for the presence of faecal coliforms, indicators of faecal contamination. See appendix V for more details. Other tests, for instance to identify cholera in water, require more specific techniques and are generally outside the scope of normal procedures.

Application and limitations

Biological water quality tests are a very useful means to get quantifiable data on the quality of water at a certain time. The results can be expressed simply and clearly to explain the situation to other people and allow comparisons to be made over time and between different places. But it is important to remember that tests on a single sample of water show only its quality at the moment of collecting the sample and say nothing about the source of contamination or its duration. Biological testing should be carried out in conjunction with a sanitary survey and the results are interpreted together, to avoid drawing incorrect conclusions and possibly closing down sources unnecessarily, or ignoring serious risks of contamination which have not yet affected the source.

Sanitary surveys

A sanitary survey is a methodical assessment and description of a water source which identified possible sources of contamination and suggests remedial action. The survey is done using a prepared form which helps the surveyor check all the important features of the water source and record the information for interpretation, reporting and comparison. Whilst biological testing needs specialised equipment and skills, a sanitary survey can be carried out by anyone with some basic training ad no special equipment. A sanitary survey should be carried out once every month on water supplies such as springs and wells which provide untreated water and on pipes water systems to check for leaks from pipe and valves and to check the free chlorine residual at the taps. See appendix VI for a sample sanitary survey form.

Responsibility for water testing

Whilst responsibility for selecting water sources is usually with the implementing agency, routine testing may be done by the agency responsible for health, by a health ministry or by the water ministry. Where there are several different agencies responsible for water supply it can be useful for water testing to be done centrally (apart from the daily monitoring of treatment operations) and the results.

Extract from John Adams ;Managing water supply and Sanitation in Emergencies'

SANITARY INVESTIGATION (SURVEILLANCE)

The sanitary investigation looks at the environment in the local vicinity (within ½ km) of the source and hence predicts the risk of faecal pollution to the source,. Use section A if the source does not have existing engineered facilities (spring box, borehole, etc) and sections A & B if the source does have existing engineered facilities.

- Any yes answers in the high risk section that the source is of high risk.
- Any yes answers in the medium risk section (but none in the high risk section) implies the source is of low risk.
- Any yes answers in the low risk section (but none in the high or medium risk selection) implies the source is of low risk.
- If there are no yes answers in the high, medium or low risk categories then there is only a very low risk of pollution (negligible)

All surface water sources will fall into the high risk category. However, the questions should still be answered to identify which of the risk factors are present and which can be improved. If two similar water sources are being compared it is unlikely that there will be a difference in the risk level indicated by the table. Independent judgement will be required to determine if one is slightly higher risk than another and if this should be taken into account during selection. An example of similar sources would be abstraction points up-and downstream of a bathing and animal-watering point in a river.

Repeat the questions allowing for improvements that can reasonably be made to protect the source. The risk indicated will then give the 'Improved sanitary risk'.

Sanitary Investigation

Question **(Answer the question which are applicable to the source under consideration)**	**Yes**	**No**	**Not applicable**
A. Use for a source with or without existing engineered facilities **High risk of faecal or other pollution** ▪ animals drink near to or from the source ▪ water is being collected directly from the source in individual containers ▪ human defecation occurs in or near the source ▪ the source is used for bathing or laundry ▪ the source is used upstream by other communities ▪ surface run-off from the camp is likely to enter the source upstream of the abstraction point			
Medium risk of faecal or other pollution ▪ industries or agriculture operate near to the source ▪ refuse can be found around or in the source ▪ there is standing water within 2 m of the source (i.e. drainage is inadequate)			

▪ there are latrine <10 m from source or on higher ground than the source and <30 m away ▪ the source has a wide boundary (such as a lake, never or stream) and hence is difficult to protect			
B. Use for source with existing engineered facilities **Medium risk of faecal or other pollution** ▪ protection structures are inadequate in design (borehole capping; drainage curtains or channels well lining; spring box) ▪ if the source is a borehole it is <100 m from uncapped wells or other sources of pollution such as sewers, septic tanks or refuse dumps ▪ if the source is a borehole it is less than 800 m from a graveyard ▪ if the source is a spring the cut-off drain above the spring is inadequate			

Question **(Answer the question which are applicable to the source under consideration)**	**Yes**	**No**	**Not applicable**
When the source is from an existing pipes supply: ▪ the supply is intermittent ▪ there is less than 0-4 mg/l of residual chlorine entering the distribution system or 0.2 mg/l of free residual chlorine at the collection point ▪ the treatment systems are unreliable with possible interruptions ▪ there are leaks from the pipe work or valves ▪ the pipes are closer than 10 m to latrines, sewers or drains			
Low (but still possible) risk of faecal or other pollution ▪ there is inadequate fencing around the source (if it is not enclosed in a building) ▪ there is damage or cracks to the abstraction or protection structures (borehole capping; drainage curtains or channels; well fining; spring box) ▪ if the source is a spring box the overflow pipe or air vents are damaged or blocked ▪ the pump sumps are dirty ▪ the pumps are not in good working order ▪ the lifting or pumping devices are not secure and well fixed ▪ storage tanks are uncovered or cracked.			

(Lloyd and Helmer, 1991; MSF Holland, updated; Smith, 1995; Siru, 1992)
Extracts from WEDC 'Emergency Water Supply'

SANITATION OVERVIEW:

ONSITE SANITATION OPTIONS

Simple Pit latrines

The simple pit latrine consists of a hole in the ground (which may be wholly or partially lined) covered by a squatting slab or seat where the user defecates. The defecation hole may be provided with a cover or plug to prevent the entrance of flies or egress of odour while the pit is not being used.
The cover slab is commonly surrounded by some form of superstructure that provides shelter and privacy for the user. The superstructure design is irrelevant to the operation of the latrine but crucial to the acceptability of the latrine to the user. Superstructures range from a simple shelter of sacks or sticks to a building of bricks or blocks costing more than the rest of the latrine. The choice of superstructure will reflect the income and customs of the user.

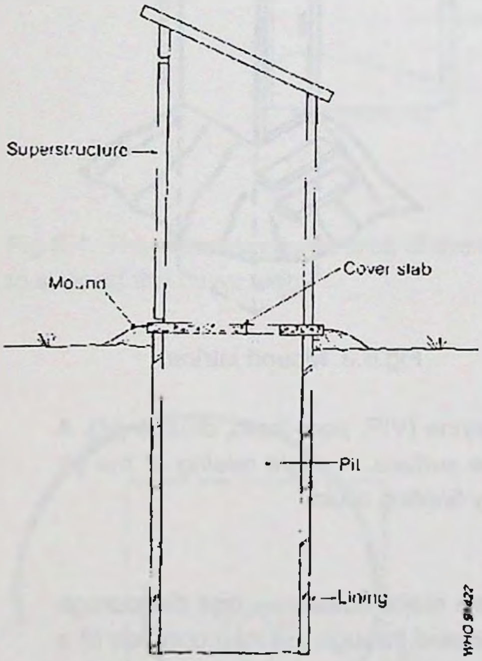


Fig. 6.1. Simple pit latrine

The cover slab should be raised at least 150 mm above the surrounding ground to divert

The simple pit latrine is the cheapest form of sanitation possible. Once constructed it requires very little attention other than keeping the latrine area clean and ensuring that the hole cover is in place when the latrine is not in use. Unfortunately the superstructure frequently becomes infested with flies and mosquitoes and full of pungent odours because users do not replace the squat hole cover after use.

Raised pit latrines

Another way of dealing with the problem of difficult ground conditions close to the surface is to construct raised pit latrines. The pit is excavated as deep as possible, working at the end of the dry season in areas of high groundwater. The lining is extended above ground level until the desired pit volume is achieved.

If the pit extends more than 1.5 m below the ground there will probably be sufficient leaching area below ground for a pit latrine having a full depth of 3.5 m. In such cases, the lining above ground should be sealed by plastering both sides (Fig. 6.17). The minimum below-ground depth depends on the amount of water used in the pit and the permeability of the soil. Where insufficient infiltration area can be obtained below ground level, the raised portion of the pit can be surrounded by a mound of soil. The section of the lining above ground (excluding the top 0.5 m) can be used for infiltration provided the mound is made of permeable soil, well compacted with a stable side slope, and is thick enough to prevent filtrate seeping out of the sides (Fig. 6.18). Earth mounds are not recommended on clay soils as the filtrate is likely to seep out at the base of the mound rather than infiltrate the ground.

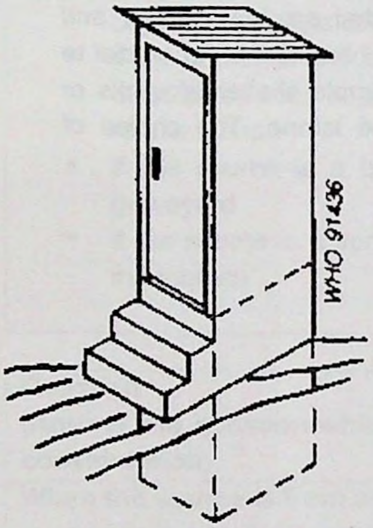


Fig.6.2. Raised pit latrine

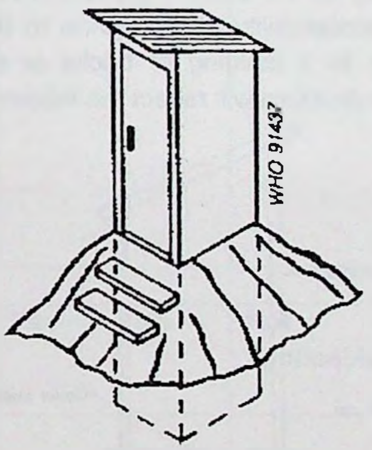
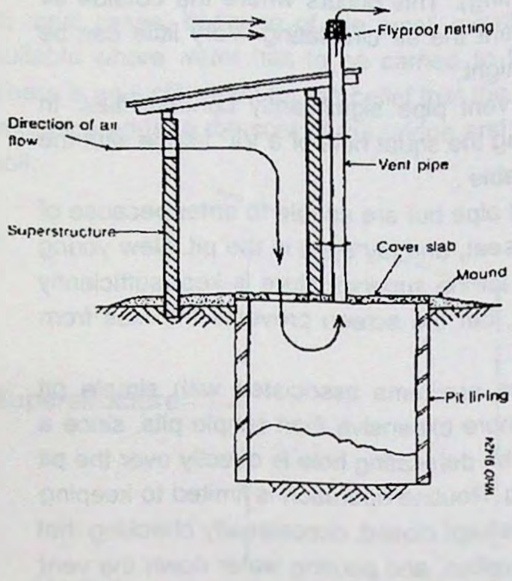


Fig.6.3. Mound latrine

Raised pits can be used in combination with any other type of pit latrine (VIP, pour-flush, double-pit). A common application is where the groundwater level is close to the surface. A slight raising of the pit may prevent splashing of the user or blockage of the pit inlet pipe by floating scum.

Ventilated (Improved) Pit latrines

These are also known as ventilated improved pit (VIP) latrines. The major nuisances that discourage the use of simple pit latrines - smell and flies - are reduced or eliminated through the incorporation of a vertical vent pipe with a fly screen at the top (Morgan, 1977). Wind passing over the top of the vent pipe causes a flow of air from the pit through the vent pipe to the atmosphere and a downdraught from the superstructure through the squat hole or seat into the pit. This continuous flow of air removes smells resulting from the decomposing excrete in the pit and vents the gases to the atmosphere at the top of the vent pipe rather than through the superstructure. The flow of air is increased if the doorway of the superstructure faces the prevailing wind (Mare, 1984). If a door is fitted it should be kept shut at all times (except when entering or leaving) to keep the inside of the latrine reasonably dark, but there should be a gap, normally above the door, for air to enter. The area of this gap should be at least three



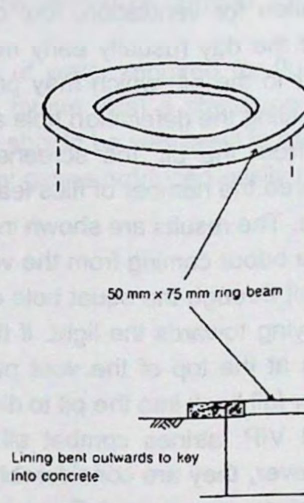


Fig.6.4. The cross-sectional area of the vent pipe. Fig.6.5. Ring beam on top of a thin pit lining to support the coyer slab

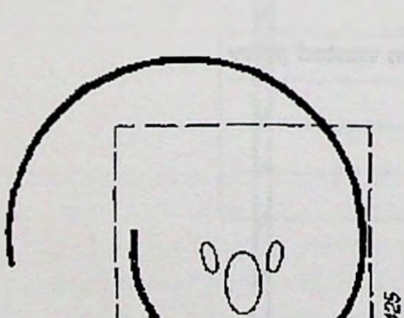


Fig.6.6. Spiral construction for the superstructure

The superstructure can be constructed in the form of a spiral (Fig). This excludes most of the light whether a door is fitted or not. The defecation hole must be left open to allow the free passage of air. The vent pipe should extend at least 50 cm above the latrine superstructure except where the latter has a conical roof, in which case the pipe should extend as high as the apex. Air turbulence caused by surrounding buildings or other obstructions may cause reverse air flow, leading to foul odours and flies in the superstructure. If mean wind speeds are about 2 m/s, as is fairly common in rural areas, air speeds in the vent pipe are about 1 m/s (Ryan & Mara, 1983). Air flow may also occur at lower wind speeds because of solar radiation heating the air in the vent pipe, causing the air to rise. The vent pipe should then be placed on the equator side of the superstructure. It may be painted black to increase solar absorption, if the material of the pipe is not itself black.

In latrines relying on solar radiation for ventilation, foul odours are sometimes experienced in the superstructure at certain times of the day (usually early morning). This occurs where the outside air temperature is colder than the air in the pit, which may prevent the air circulating. Very little can be done to prevent this, other than sealing the defecation hole at night.

In addition to removing odours from the pit, the screened vent pipe significantly controls flies. In Zimbabwe, Morgan (1977) compared the number of flies leaving the squat hole of a VIP latrine with the number leaving a simple pit latrine. The results are shown in Table .

Flies are attracted to the pit by the odour coming from the vent pipe but are unable to enter because of the screen. A few flies enter the pit through the squat hole or seat, and lay eggs in the pit. New young flies attempt to leave the pit by flying towards the light. If the latrine superstructure is kept sufficiently dark, the major source of light is at the top of the vent pipe, but the screen prevents the flies from escaping there and they eventually fall back into the pit to die.

Well-constructed and maintained VIP latrines combat all the problems associated with simple pit latrines, except mosquitoes. However, they are considerably more expensive than simple pits, since a ventilation pipe and full superstructure are required. Because the defecating hole is directly over the pit they accept any form of anal cleaning material without blocking. Routine operation is limited to keeping the superstructure clean, ensuring that the door (where fitted) is kept closed, occasionally checking that the fly-proof netting on top of the vent pipe is not blocked or broken, and pouring water down the vent pipe once a year to remove spiders' webs.

Table Comparison of the numbers of files leaving the squat holes of a simple pit latrine and a VIP latrine

Period of trapping	No. trapped in unvented privy	No. trapped in vented privy
8 October-5 November	1723	5
5 November-3 December	5742	20
3-24 December	6488	121

Pour-flush latrines

The problems of flies, mosquitoes and smell in simple pit latrines may be overcome simply and cheaply by the installation of a pan with a water seal in the defecating hole (Fig.) gives details of the design and fabrication of water seals. The pan is cleared by pouring (or, better, throwing) a few litres of water into the pan after defecation. The amount of water used varies between one and four litres depending mainly on the pan and trap geometry. Pans requiring a small amount of water for flushing have the added advantage of reducing the risk of groundwater pollution. The flushing water does not have to be clean. If access to clean water is limited, laundry, bathing or any other similar water may be used.

Pour-flush latrines are most appropriate for people who use water for anal cleaning, and squat to defecate, but they have also proved popular in countries where other cleaning materials are common. However, there is a likelihood of blockage where solid materials such as hard paper or corncobs are put in the pan. The placing of solid cleaning materials in a container for separate disposal is not generally recommended unless careful attention can be given to them. Handling of the waste and sterilizing of the container. Blockage may also be caused by material used by menstruating women. This should be disposed of separately, e.g., by burying or burning. Efforts to clear blockages often result in damage to the water seal.

In most cases, because of the small quantity of water required for flushing, pour-flush latrines are suitable where water has to be carried to the latrine from a standpipe, well, or other water source. There is no justification for the belief that the pit should be ventilated to prevent the build up of gases. A vent pipe adds to the cost of the latrine and any gases produced easily percolate into the surrounding soil.

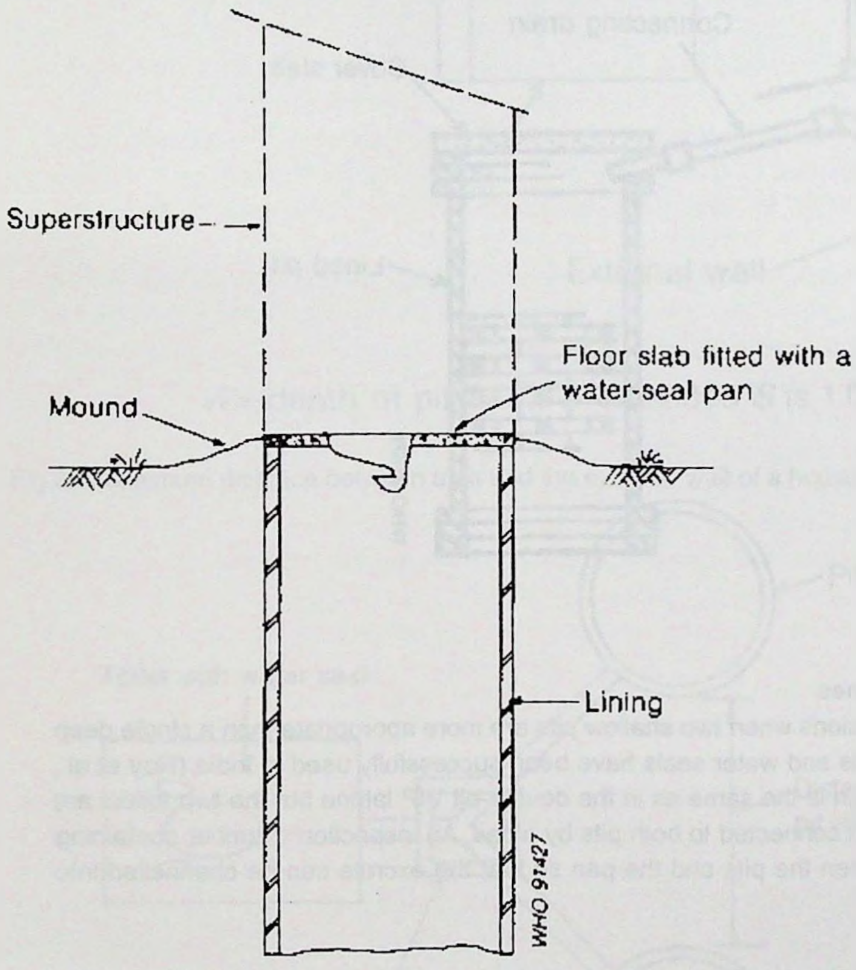


Fig.6.7. Pour-flush latrine

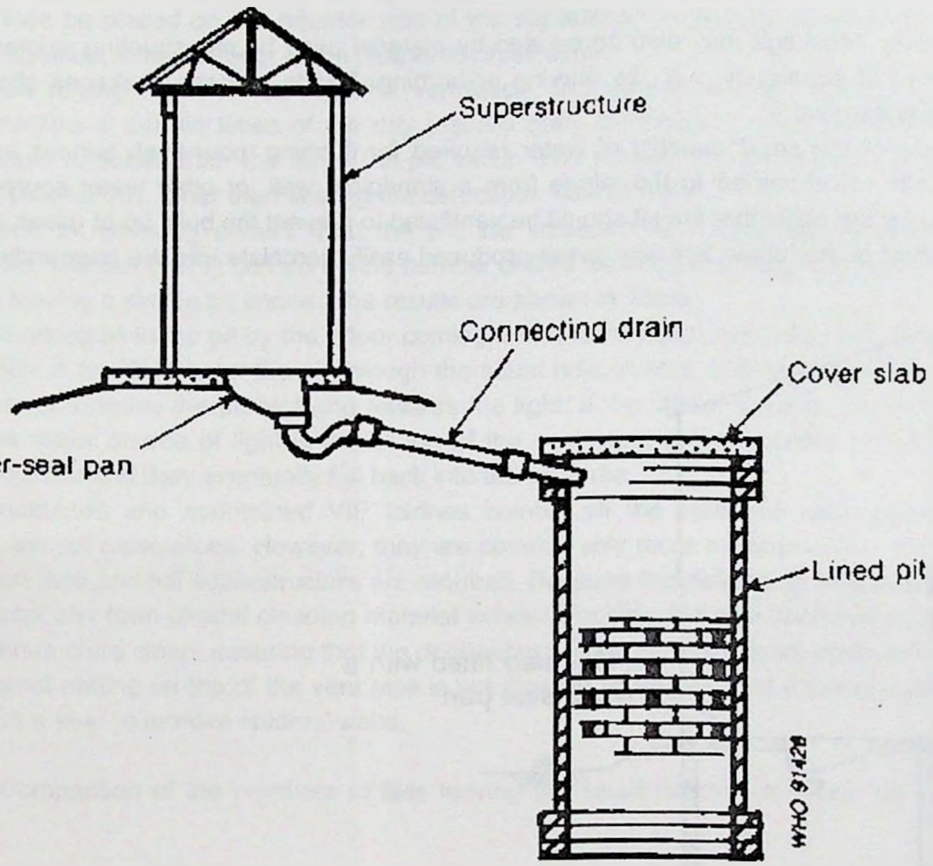


Fig.6.8. Offset pour-flush latrine

Double-pit offset pour-flush latrines

As with VIP latrines there are occasions when two shallow pits are more appropriate than a single deep pit. Double pits with pour-flush pans and water seals have been successfully used in India (Roy et al., 1984) and elsewhere. The pit design is the same as in the double-pit VIP latrine but the two toilets are replaced by a single water seal pan connected to both pits by pipes. An inspection chamber containing a Y junction is normally built between the pits and the pan so that the excrete can be channelled into either pit (Fig).

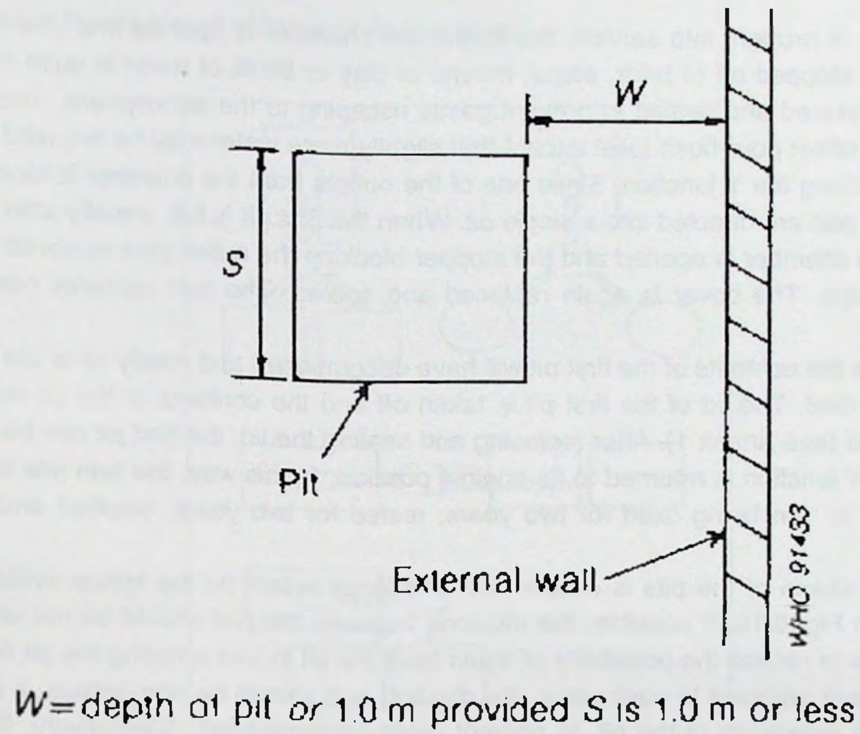


Fig.6.9. Minimum distance between a pit and the external wall of a house

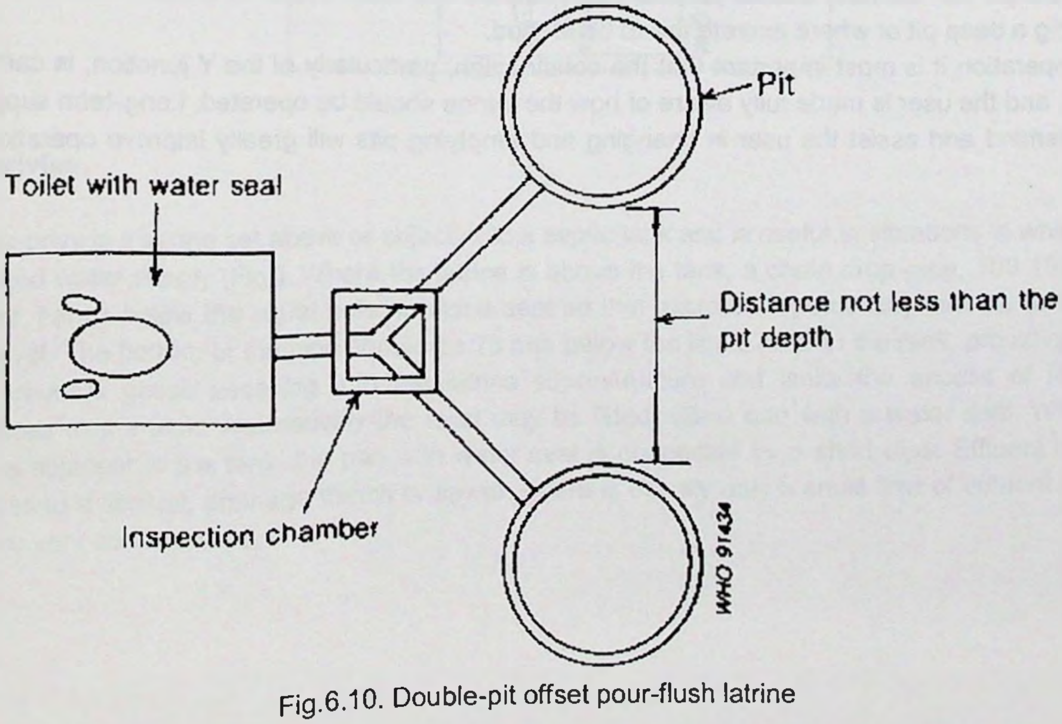


Fig.6.10. Double-pit offset pour-flush latrine

Before a new latrine is brought into service, the inspection chamber is opened and one of the pipes leading to the pits is stopped off (a brick, stone, mound of clay or block of wood is quite satisfactory). The cover is then replaced and sealed to prevent gases escaping to the atmosphere. The latrine can now be used like an offset pour-flush toilet except that slightly more water may be required for flushing to prevent solids blocking the Y junction. Since one of the outlets from the chamber is blocked, all the contents of the toilet pan are directed into a single pit. When the first pit is full, usually after a couple of years, the inspection chamber is opened and the stopper blocking the outlet pipe removed and placed in the other outlet pipe. The cover is again replaced and sealed. The pan contents now enter the second pit.

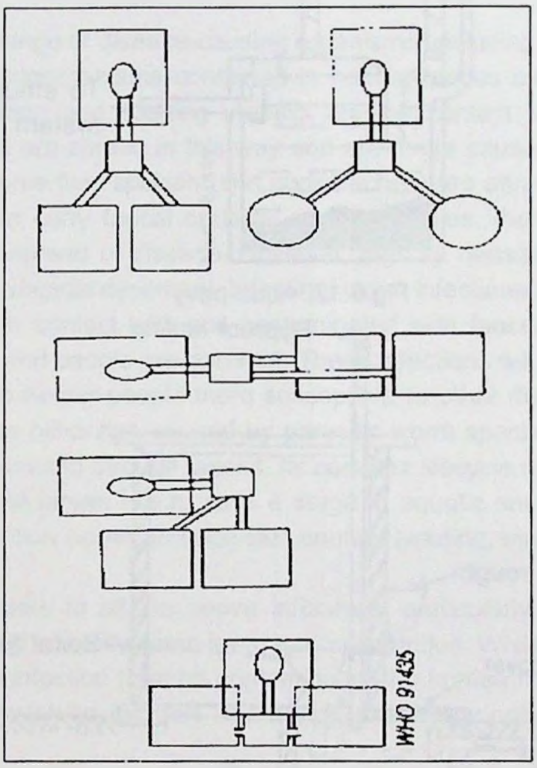
In a further two years the contents of the first pit will have decomposed and nearly all of the pathogenic organisms will have died. The lid of the first pit is taken off and the contents of the pit removed and disposed of or reused (see Annex 1). After replacing and sealing the lid, the first pit can be used again if the stopper in the Y junction is returned to its original position. In this way, the twin pits can be used indefinitely, each pit in turn being used for two years, rested for two years, emptied and then used again.

The positioning and shape of the pits is determined to a large extent by the space available. Some options are shown in Fig. 6.16. If possible, the distance between the pits should be not less than the depth of a pit. This is to reduce the possibility of liquid from the pit in use entering the pit not in use. If the pits have to be built adjacent to each other, the dividing wall should be non-porous. It can also be extended beyond the side-walls of the pit, to prevent cross-contamination. Alternatively, the pit lining can be constructed without holes for a distance of 300 mm either side of the dividing walls.

As with double-pit VIP latrines, double-pit pour-flush latrines are most useful in areas where it is not possible to dig a deep pit or where excrete are to be reused.

For proper operation it is most important that the construction, particularly of the Y junction, is carried out properly, and the user is made fully aware of how the latrine should be operated. Long-term support facilities to remind and assist the user in changing and emptying pits will greatly improve operational success.

Some layout options for double-pit offset pour-floch latrines



Aqua-privies

An aqua-privy is a latrine set above or adjacent to a septic tank and is useful in situations in which there is a limited water supply (Fig.). Where the latrine is above the tank, a chute drop-pipe, 100 150 mm in diameter, hangs below the squat hole or latrine seat so that excrete drops directly into the tank below water level. The bottom of the pipe should be 75 mm below the liquid level in the tank, providing a seal which prevents gases escaping into the latrine superstructure and limits the access of flies and mosquitoes to the tank. Alternatively the toilet may be fitted with a pan with a water seal. Where the latrine is adjacent to the tank, the pan with water seal is connected by a short pipe. Effluent from the tank goes to a soakpit, drainage trench or sewer. There is usually only a small flow of effluent and it is therefore very concentrated.

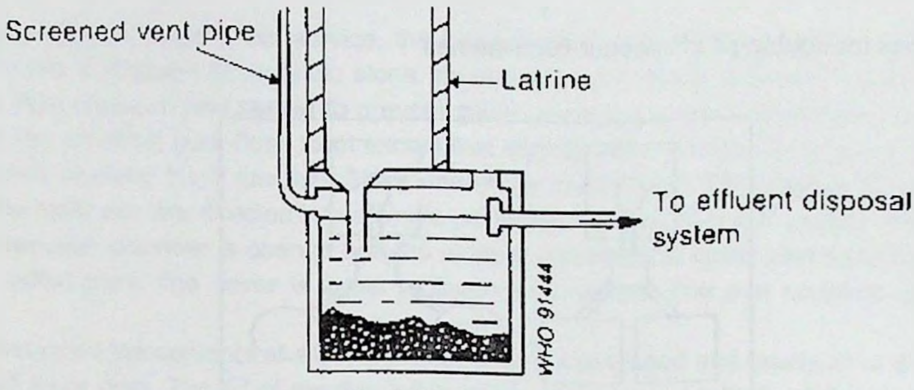


Fig.6.12. Aqua-privy

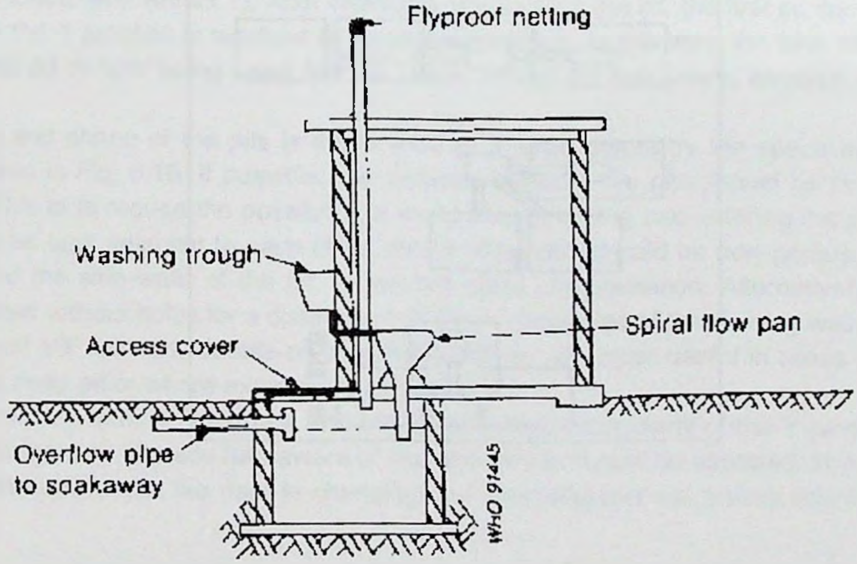


Fig6.13. Aqua-privy with pan flushed by waste from a washing trough

In order to keep a seal at the bottom of the drop-pipe it is essential that the water level in the tank is maintained. If the tank is completely watertight, a bucketful of water every day, used to clean the latrine, is sufficient to compensate for any losses due to evaporation. However, it has been found in practice that many tanks leak. In some places sullage is discharged into the tank (Fig), but even this has not proved sufficient to ensure that the water level is above the bottom of the drop pipe at all times. In Calcutta, aqua-privies used by people who use water for anal cleaning have a water seal incorporated in the drop-pipe below the pan (Pacey, 1978).

The design capacity of aqua-privy tanks may be calculated by the same procedure as for septic tanks. Regular removal of sludge and scum is essential, so a removable cover for desludging is required. A vent pipe is usually provided.

HUMAN WASTE & HEALTH

Faeces

Human faeces may contain a range of disease-causing organisms, including viruses, bacteria and eggs or larvae of parasites. The microorganisms contained in human faeces may enter the body through contaminated food, water, eating and cooking utensils and by contact with contaminated objects. Diarrhoea, cholera and typhoid are spread in this way and are major causes of sickness and death in disasters and emergencies. Some flies species (and cockroaches) are attracted to or breed in faeces, but while they theoretically can carry faecal material on their bodies, there is no evidence that this contributes significantly to the spread of disease. However, high fly densities will increase the risk of transmission of trachoma and *Shigella* dysentery. Intestinal worm infections (hookworm, whipworm and others) are transmitted through contact with soil contaminated with faeces and may spread rapidly where open defecation occurs and people are barefoot. These infections will contribute to anaemia and malnutrition, and therefore also render people more susceptible to other diseases. The intestinal form of schistomiasis (also known as bilharzia), caused by parasitic worm species living in the veins of the intestinal tract and liver, is transmitted through faeces. Its complex lifecycle requires the faeces to reach water bodies where the parasite larvae hatch, pass a stage in aquatic snails and then become free-swimming infective larvae. Infection occurs through skin contact (wading, swimming) with contaminated water.

Children are especially vulnerable to all the above infections, particularly when they are under the stress of disaster dislocation, high-density camp living and malnutrition. While specific measures can be taken to prevent the spread of infection through contamination by human faeces (e.g. chlorinating the water supply, providing hand-washing facilities and soap), the first priority is to isolate and contain faeces.

Urine

Urine is relatively harmless, except in areas where the urinary form of schistosomiasis occurs. This parasitic infection, caused by *Schistosoma haematobium*, is similar to the one described in the section above, except this parasite species resides in the veins around the bladder and its eggs are excreted with urine. In these areas, urinating in water courses should be prevented; otherwise, indiscriminate urination is not a health hazard.

Sullage

Wastewater from kitchens, bathrooms and laundries is called sullage. It can contain disease-causing organisms, particularly from soiled clothing, but its main health hazard occurs when it collects in poorly drained places and causes pools of organically polluted water that may serve as breeding places for *Culex* mosquitoes. This genus of mosquitoes transmits some viruses as well as the parasitic disease lymphatic filariasis. Mosquitoes that transmit malaria do not breed in polluted water.

Solid waste

Rats, dogs, cats and other animals, which may be carriers (reservoirs) of disease-causing organisms are attracted to discarded food, cloth, medical dressings and other components of solid waste. Small rainwater collections in solid waste may serve as the breeding places for *Aedes* mosquitoes, vectors of the dengue virus. Deep, compacted burial and, in particular, incineration of medical waste are essential to eliminate the associated health risks. Inorganic waste, such as fuel ash, can be hazardous to health.

Items such as empty pesticide containers should be crushed and buried to ensure that they are not accidentally recycled.

The importance of hygiene behaviour

The links between sanitation, water supply, and health are directly affected by hygiene behaviour. It is important to bear this in mind when considering technical options, so that facilities provided in emergencies are acceptable to the users and can be used and maintained hygienically. See Chapter 15 for more information on hygiene promotion.

Strategy for excreta disposal in emergencies

Excreta-disposal techniques referred to in this section are described more fully in section 8.3.

Situations demanding an emergency excreta-disposal response

Disaster-affected urban areas

Major health risks due to inadequate excreta disposal after disasters arise in urban areas following damage to existing systems, or when parts of a city receive large numbers of displaced or homeless people, so putting increased pressure on facilities that may already be under strain. A rapid assessment of damage and needs is required to decide what emergency actions to take.

The immediate response may include establishing or reinforcing sewage tankering services, to bypass blocked sewers or to carry out intensive septic tank or latrine emptying in urban areas. Every effort should be made to allow people to use their existing toilets, through temporary repairs to broken sewers and sewage treatment works. In extreme situations, it may be necessary, as a temporary measure, to discharge sewage directly into a river or the sea, or to hold it in a safe, isolated place. If this is done, the public must be informed, and any places used for this purpose should be fenced off.

When sections of the population can no longer use their toilets, public facilities may need to be provided, by allowing access to schools, community centres, etc., or by setting up temporary public toilets. If available, chemical toilets may be placed on street corners and emptied by municipal workers. Simple drop-hole latrines can be placed over open inspection covers, allowing excreta to drop straight into a sewer, if the sewer is still in operation and sufficiently flushed with sewage. If not, then water tankers can be used to flush them one or more times per day. Storm drains can also be used for this purpose, but only after careful consideration of the environmental risks.

Where bucket latrines are normally used, the collection of night soil may be disrupted by the emergency. Continued use of buckets should be encouraged and alternative arrangements made for collection and disposal (e.g. a common neighbourhood deep-trench latrine) until collection has returned to normal. The protection and health of the workers involved in bucket collection should be a major concern. The use of bucket latrines should be replaced by hygienic alternatives as soon as possible.

In general, defecation in rivers and streams should be discouraged unless absolutely necessary, and then only if an area downstream of other human use can be designated for the purpose. Similarly, defecation in the sea should also be discouraged, especially when the population density is high or when bays, lagoons, or estuaries are used for fishing. If the sea is to be used, the tides, currents and prevailing winds should be studied so that excrement does not wash back on shore, and a specific area set aside for defecation.

A neighbourhood health committee should be organized as soon as possible (or if it already exists, identified and mobilized) to liaise with the public-health authorities in making more permanent arrangements for human excreta removal and for supervising general waste disposal.
Previous training exercises should have revealed material needs, and the items concerned should be in stock, or obtainable on loan from another government department or the private sector.
Post emergency activities should focus on ensuring a return to, or improvement on, levels of service prior to the disaster.

Disaster-affected rural areas
Disasters affecting sparsely-settled rural areas are less often of great concern, because of the lower concentration of people and lesser risk of faecal contamination through inadequate sanitation. In such situations, a focus on the protection of water sources is usually the priority. However, protection of water sources often requires efforts to improve excreta disposal, at least in certain areas, and an emergency may provide the opportunity to raise awareness of sanitation generally, and start a longer-term process of improvement.

Displacement emergencies
In displacement emergencies, large numbers of people find themselves in crowded conditions, in transit, or in camps, with inadequate sanitary facilities. Initial sanitary arrangements can be very simple. As a minimum, defecation should not be allowed where it can contaminate the water supply or food chain. Defecation should be discouraged along river banks; in the beds of rivers or wadis (possible future water sources); within 30 metres of wells or boreholes; within 10 metres of taps; on or above the surfaces prepared for rainwater catchments; within 30 metres uphill of a spring or 10 metres downhill; or within 10 metres of any water-storage tank or treatment plant.

Open defecation should also be discouraged along public highways, in the vicinity of hospitals, feeding centres, reception centres, food storage areas, food preparation areas, and in fields containing crops for human consumption. When it is impossible to establish defecation fields, open defecation should be limited to specific, well-defined areas, which should be closed as soon as alternative sites for defecation are available.
Along displacement routes, between transit points, there may be a lot of open defecation by the side of the road. Faeces should be picked up, daily if possible, and buried nearby. If open defecation is inevitable and people also stop overnight by the side of the road, people should be encourages to use one side of the road for defecation and the other side for cooking and resting.

It is usually necessary to set up a more structured system, such as defecation field, or defecation trenches, that ensure better separation and containment of excreta. These may be followed by longer-term, but intermediate, measures, such as public trench latrines when the transit centre or emergency settlement is likely to remain in place for more than a few weeks. However, as emergency settlements are often likely to remain for at least a year, then construction of family toilets, usually simple pit latrines, should begin without delay.

Communal facilities should be regularly cleaned by staff who are rewarded for their work, and who are adequately trained and equipped. Clean latrines help to encourage proper use of the facilities; dirty latrines inevitably lead to carelessness and unsanitary defecation practices in and around them.

Routine inspection by supervisors is necessary to ensure that cleaning standards are maintained and that repairs are carried out. Staff may need to meet with the users to encourage clean use of the toilets.

As far as appropriate, user families should be involved in latrine construction programmes. They should be involved in the choice of technology and materials, sighting and orientation of latrines, pit digging, slab installation, and superstructure building. The implementing agency should work closely with user families to encourage latrine construction, provide advice on sighting and construction, and ensure that pits and finished latrines meet standards for stability, capacity and hygiene. The agency may provide tools and materials, as well as advice and information.

Gradual improvement

Although people may be able to reduce their water use drastically for a short period following a disaster, they can do nothing about their production of excreta. Whenever environmental health staff travel to a disaster-affected location they find people who have already established a pattern of excreta disposal, using whatever means are available. The general strategy should be to gain a rapid understanding of existing practice and take temporary steps to improve it, if necessary, and then make further improvements, responding to areas of greatest need as defined by disease incidence and lack of access to facilities.

Subsequent steps in an emergency excreta-disposal response involve more detailed assessment of damage to existing facilities, in the case of urban-based disasters, or of likely population movements and the development of needs and resources in the case of displacement emergencies. This more detailed assessment should prompt a series of actions and reassessments that ensure a constant improvement in sanitary arrangements. The various options available need careful consideration and discussion with the population concerned, to produce a strategy that takes account of short- and long-term public-health risk, cost, time and user preferences. A technical option that may be used in a programme is for gradually improving excreta disposal.

Technology choice

A guide to technology choice for excreta disposal in emergencies that takes into account the difficulties posed by different types of ground condition. Where the opportunity exists for selecting and planning an emergency settlement site, environmental health staff should be closely involved in ensuring that sites are chosen and laid out in a way that provides suitable conditions for sanitation.

Any successful measure for managing human excreta includes the principles of separation, containment and destruction. A simple pit latrine, for example, separates excreta from humans; it contains it within the pit, beneath the slab; and the excreta is destroyed by a process of decomposition and die-off of pathogens. Whatever form of toilet is designed and built in an emergency, it must fulfill these three functions to minimize health risks.

Excreta disposal measures must be designed and built to avoid contamination of water sources that will be used for drinking-water.

Consultation with the disaster-affected people is an essential aspect of technology choice. Whereas they are consumers with regards to water supply, they are producers with regards to excreta disposal and other aspects of sanitation. Sanitary arrangements and sensitivities vary a great deal between cultures, and different groups in the camp, such as men, women, or the elderly, may have special needs and wishes. A health committee is very important as a means of communicating with the disaster-affected people, for whom the living arrangements may be strange and disorienting. Sensitive and culturally-specific issues, such as arrangements for disposing of menstrual discharge, or for anal cleansing after defecation, can best be discussed with the health committee.

Assessment

Urban situations with existing facilities

A proper health assessment of the impact of damaged sanitation systems requires a sanitary survey. In particular, an assessment of the status of the sewage system is required as soon as possible after immediate disaster relief has been provided. Information should be gathered on the number of breaks or obstructions in sewer lines; the lengths and sizes of pipes that need to be replaced; and a list of the repair equipment required, such as pumps, bulldozers, excavating machinery, trucks, tools, construction materials, etc. An early estimate is also needed of the equipment, materials and labour necessary to restore sewage-treatment plants and pumping stations to working order.

In pre urban areas where on-plot sanitation is likely to be the norm, assessments should identify the number of households without functioning toilets, the current arrangements made for excreta disposal by those households (including the use of neighbours' toilets), and requirements for immediate and post emergency action.

Displacement emergencies

In displacement emergencies, the assessment process is likely to be quite different, as the people concerned are likely to find themselves in situations they are not familiar with, with considerable loss of social cohesion. Key information includes the number of people currently affected and likely future population movements; existing excreta-disposal arrangements; pre disaster excreta-disposal practices; ground conditions; availability of construction materials and tools; the workload and labour availability of the affected population; the water-supply and drainage situation; the general health of the displaced population; and the incidence and/or risk of excreta-related diseases.

Standards

UNHCR recommend one toilet per family as the best option, one per 20 people as the second best option, and one per 100 people, or a defecation field, as the third best; recommendations are given for the design and construction of facilities, to ensure they are appropriate and correctly used (United Nations High Commissioner for Refugees, 1999). The Sphere Project recommendations are similar to those of UNHCR, but provide more detailed advice on the quality of toilet facilities and their acceptability to users (Sphere Project, 2004).

Techniques for excreta disposal in emergencies

The techniques in this section are described broadly in order of increasing permanency and complexity. In some emergency situations, several of these options are used at different stages of the response as the situation develops. The first three techniques– defecation field, shallow trench latrines, and deep trench latrines–have mostly been used in displacement emergencies, but may be useful in any situation where temporary toilets are needed rapidly. The other techniques are widely used in stable situation ns, but can be adapted to any long-term emergency settlement. Whatever the technical option chosen, consideration should be given to hand-washing facilities and night lighting. The needs of small children should be given special attention.

Excreta control and small children

Children's faeces are generally more infectious than those of adults, and many children are unable to control their defecation, so preventing indiscriminate defecation by small children should be a high priority. In short-term relief centres, it may be possible to provide parents with disposable napkins. Usually, however, this is not possible, and parents should be encouraged to clean up and dispose of children's faeces rapidly and hygienically. Shovels, small spades, or home-made digging tools made from wood should be available to parents to enable them to bury children's excrement.

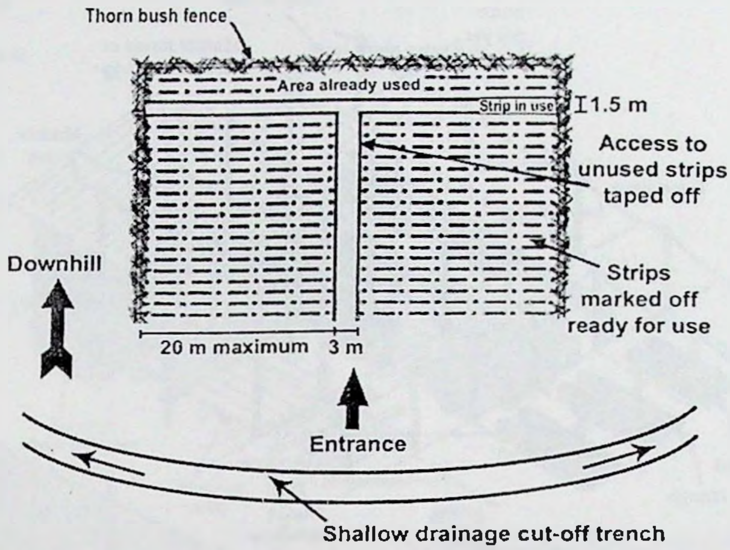
In Ethiopian relief camps in the mid-1980s, special defecation trenches for children were used successfully by the Save the Children Fund. Mothers sat on one side of the trench with their feet propped on the other side, and placed the children between their feet. When the children had defecated, they left via a hand-washing facility. Each time a mother left, a latrine guard shovelled earth over the faeces (Appleton & Save the Children Fund Ethiopia Team, 1987).

Defecation fields

A defecation field is illustrated in Figure below. The area set aside should be of sufficient size to accommodate 0.25 m^2 per person per day excluding access paths. Separate areas for men and women are usually desirable. The field should be in a convenient place, but no nearer than 30 metres to other camp facilities. Ideally, it would be on land that slopes away from the camp and any surface water sources. The soil should be soft enough to dig easily in order to cover excreta. Health education is required to obtain the cooperation and understanding of the user population. A defecation field requires an attendant, for providing information to users and for cleaning and maintenance.

Users should be directed to strips of land in the defecation field roughly 1.5 metres wide. They should use one strip until it is filled, usually entering by one access path and leaving by another. When a strip is filled, excreta are then covered by the attendant with at least 10 centimetres of soil and another strip is opened some metres away. The field is used systematically in this way, beginning with the strips furthest from camp. An improvement on this basic system is to dig shallow trenches (15 centimetres deep) in the strips, so that the excreta can be completely buried.

The active part of the field should be illuminated at night and demarcated with poles and pegs. Users should be guided to active strips by ropes or coloured tapes, as shown in Figure 8.3. A further improvement is the erection of walls of plastic sheeting, to divide the defecation field into smaller, more private areas, where this is culturally desirable.



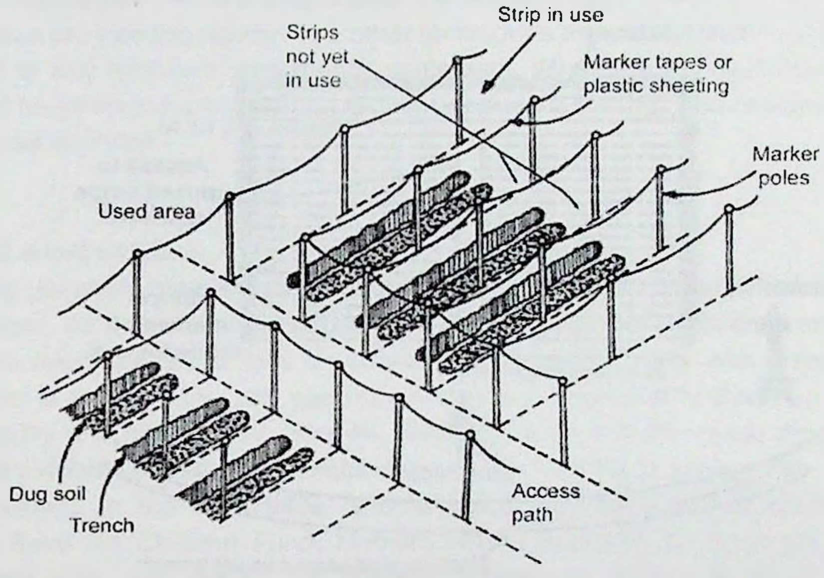
Source: Reed (1994).

Shallow trench latrines

Shallow trench latrines (see Figure 4) allow faeces to be buried and far better contained than in a defecation field. Approximately 3–5 metres length of shallow trench is needed for every 100 people, and it is preferable to have a number of shorter, shallow trenches. Trenches should never be used for more than a week before they are completely filled, compacted and replaced by new trenches. Shallow trench latrines should be sited in the same way as defecation fields.

Consultation with the camp health committee will reveal whether it is better to arrange for each family in a tent or shelter to dig and use its own shallow trench. A stock of shovels should be kept for use by residents.

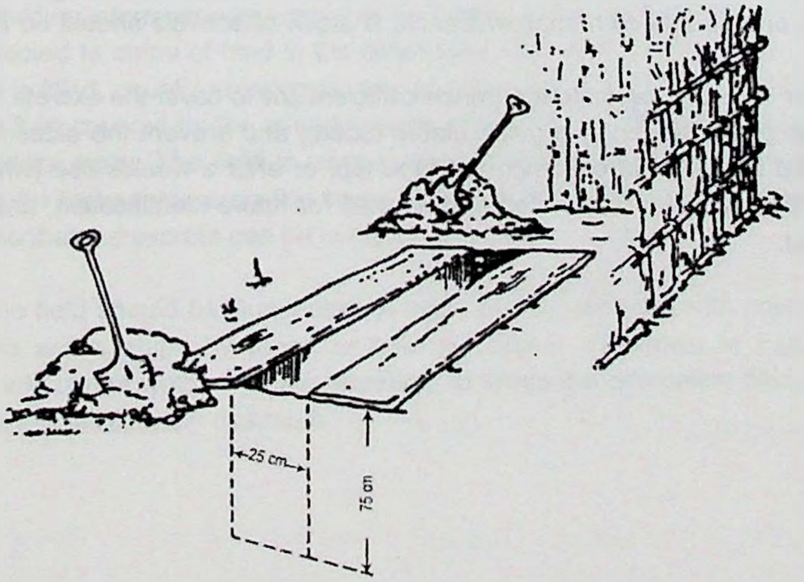
After each visit, the user should shovel into the trench sufficient soil to cover the excreta. Boards can be placed along the edges of the trench to provide stable footing and prevent the sides from caving in. When the trench is filled to within 30 centimetres of the top, or after a week's use (whichever comes first), it should be completely filled, compacted and marked for future identification, and a new trench should be dug and used.



[1]Source: Reed (1994).

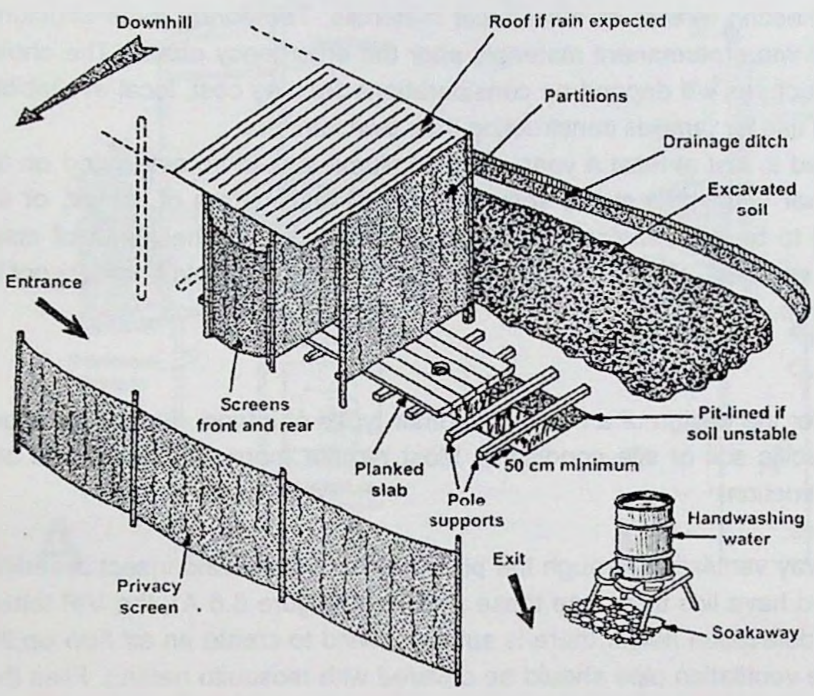
Deep trench latrines

A further improvement is the deep trench latrine, which is deeper, longer and wider than the shallow trench latrine. It can last 1–3 months and is constructed as shown in the figure below. It can be constructed from a variety of materials, including wooden planks and plastic squatting plates for the floor and plastic sheeting, and wooden planks or



[1]Source: Rajagopalan & Shiffman (1974).

Deep trench latrine[1]



[1]Source: Reed (1994).

metal sheets for the superstructure. In the former Yugoslav Republic of Macedonia, during 1999, most Kosovar refugee camps had 10-metre-long deep trench latrines, each provided with 10 plastic squatting plates and superstructures with wooden frames and either metal or plastic sheeting.

In the example shown, each deep trench can accommodate up to six cubicles, screened for privacy as shown. Each cubicle measures 90 centimetres wide by 80 centimetres high. At peak usage, it is reasonable to use an estimate of 50 people per day per cubicle, or 240 each day for each deep trench. Soil is piled up and used to cover excrement, as in a shallow trench system. The simple arrangement of using boards across the trench as foot rests can easily be improved on as time and materials allow. Eventually, however, a wooden cover with either squatting plates or seats can be constructed. There may be carpenters among the residents, and volunteers should be mobilized to help; such improvements, and the use of ashes and soil to cover excreta, can help to control flies.

A number of agencies now use plastic latrine slabs that can be placed in line over a deep trench to form a row of toilets that are rapid to construct and easy to keep clean.

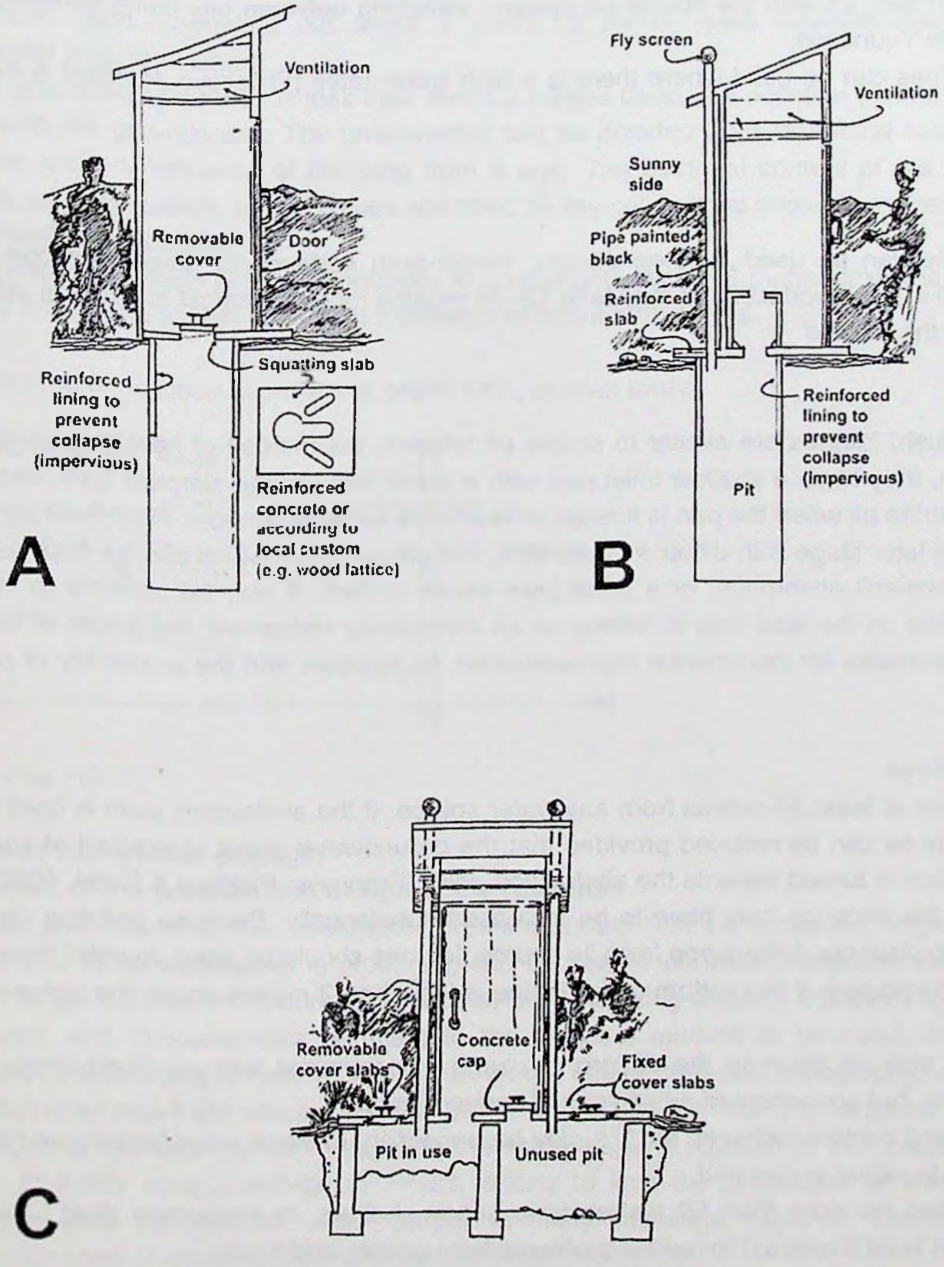
Simple pit latrines

Individual simple pit latrines, either hand-dug or drilled, may be an option in lower-density, longer-term emergency settlements. Family latrines are normally preferred as they are more hygienic than public facilities, and there are long-term benefits in terms of maintenance.

A family can dig its own latrine if given advice and provided with tools. Initial, simple screening to provide privacy can be improved to give protection from the weather as needed. It is important for the control of flies, mosquitoes and odours that tight-fitting lids for the squatting holes are provided and are always closed by users after each visit to the latrine.

The latrine slab can be made of sawn timber, logs (with or without an earth covering), concrete, plastic, or a combination of two or more of these. The latrine superstructure may be made of a wooden framework covered with plastic sheeting, grass, or other local materials. Temporary superstructures may be replaced by the users with more permanent materials after the emergency phase. The choice of materials for slabs and superstructures will depend on considerations such as cost, local availability, environmental impact, and ease of use for families constructing their own latrines.
Normally the pit should be designed to last at least a year, and its volume should be calculated on the basis of about 0.07 m^3 per user per year. In unstable soils, the top 50 centimetres of the pit, or the whole depth of the pit, may need to be lined to prevent collapse. Pit linings may be made of many different materials, including brick, concrete, old oil drums or bamboo. Pit linings should normally not be watertight below 50 centimetres deep.

Other types of latrine
The simple pit latrine is the basis for the design of a number of other types of latrine, described below. Some may be appropriate for specific soil or site conditions. Most require more time, materials and specialist knowledge for their construction.
Ventilated improved pit (VIP) latrines
The VIP latrine incorporates one-way ventilation through the pit to reduce odours and insect breeding. While non ventilated latrines should have lids to reduce these problems (Figure 8.6 A), the VIP latrine does not require a cover over the defecation hole if there is sufficient wind to create an air flow up the pipe (Figure 8.6 B). The end of the ventilation pipe should be covered with mosquito netting. Flies that breed in the pit and then fly up the pipe towards the daylight cannot then leave the latrine and flies on the outside



[1]Source: United Nations High Commissioner for Refugees (1999).

that are attracted by the smell coming from the top of the pipe are unable to enter the latrine. Pit design is as for the simple pit latrine.

Double-pit latrines

Double-pit latrines (Figure 8.6 C) are useful where there is limited room for digging new pits. The filled side can be emptied via an access hatch while the other side is being used. If the filling of one side takes sufficient time (at the very least, 6 months, better 2 years), emptying can be delayed until anaerobic decomposition has killed the pathogens. Double-pit latrines may be ventilated or non ventilated. A variation on this technique is the twin-pit latrine used with water-seal toilets. Two separate pits are used, joined to a water-seal toilet with a pipe with a Y-junction in an access chamber. Each separate pit is used in turn, as with the double-pit system, switching between pits being achieved by blocking one half of the Y-junction.

Raised or mound latrines can be used where there is a high water-table (Franceys, Pickford & Reed, 1992).

Composting latrines

The composting latrine can be used in lower-density, longer-term settlements, where the compost produced can be used in food production. It may take 12–24 months for the compost to become safe to handle, depending on the climate.

Water-seal latrines

Water-seal (or pour-flush) latrines are similar to simple pit latrines, but instead of having a squatting hole in the cover slab, they have a shallow toilet pan with a water seal. In the simplest type, excreta falls directly into the latrine pit when the pan is flushed with a small quantity of water. Pour-flush latrines can be connected at a later stage with either a septic tank, the effluent from which can be disposed of by means of subsurface-soil absorption, or a small-bore sewer system. It may be possible to install such latrines, depending on the lead time in setting up an emergency settlement; the length of its life (and hence the time available for incremental improvements); its location; and the availability of pour-flush pans.

Site selection for latrines

Latrines should be sited at least 30 metres from any water source. If the abstraction point is upstream of the latrine, the distance can be reduced provided that the groundwater is not abstracted at such a rate that its flow direction is turned towards the abstraction point (Franceys, Pickford & Reed, 1992). In heavily-fissured rock this distance may have to be increased substantially. Because pollution (faecal and chemical) tends to disperse down slope from its source, latrines should be sited *downhill* from any groundwater source, particularly if the bottom of the latrine is less than 2 metres above the water-table (see Figure 8.7).

Consideration should also be given to the pattern of usage of communal latrines. Such usage will probably not be uniform, but concentrated along lines of common travel
(e.g. to and from feeding centres, schools, etc.). It may be necessary to close some latrines and open others at some stage, to adjust to demand.

Latrines should be sited no more than 50 metres from users' shelters, to encourage their use, but sufficiently far away (at least 6 metres) to reduce problems from odours and pests.

Management of excreta disposal facilities

One of the main reasons that sanitation facilities fail in emergencies is insufficient management. There are several reasons for this, including insufficient consultation with users at the design stage, leading to facilities that are not used as intended; insufficient resources provided for maintaining and cleaning public facilities; and inadequate supervision of self-build sanitation programmes, leading to incorrect sighting and construction of latrines. Excreta disposal programmes in emergencies demand substantial resources and management support, from the assessment stage to decommissioning facilities or handing them over.

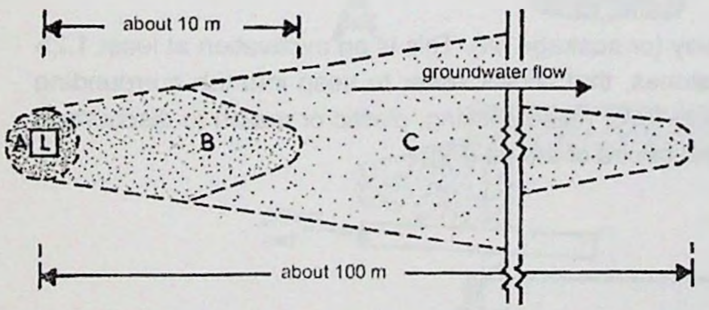
Key:

A. Pollution cone, spreading out about 1 metre all round, goes vertically downwards until the groundwater level is reached.

B. If the groundwater surface is less than about 3 metres deep, the pollution then spreads cone-wise, flowing with the groundwater. The groundwater can be diverted from its natural course if the area is within the circle of influence of pumping from a well. The bacterial content of the pollution spreads sideways and downwards, and becomes absorbed by the soil until, at about 10 metres from the source, it has virtually disappeared.

C. The cone of chemical pollution continues to spread until about 25 metres from the source, and then gradually reduces to almost nothing at a distance of about 100 metres.

L. Source of pollution at pit latrine, septic tank, or soak away.



Source: Pike (1987).

Disposal of wastewater (sullage)

Assessment of the problem and design of the response

The scale and nature of the wastewater problem should first be assessed. Important information includes: how much wastewater is produced, and by how much does production vary during the day and over longer periods; the nature of the wastewater, including whether it is likely to be contaminated with faeces, and characteristics pertinent to the disposal method to be used; the source of the wastewater; the location of risks or nuisances it may cause; and soil, topography, climate and other factors that may determine which disposal options are possible. In many emergency situations, it may be judged that the quantity and nature of the wastewater produced do not present a health risk sufficient to justify control activity. In others, efforts to limit the production of wastewater may be sufficient to keep the problem under control. In many situations, however, specific measures are needed to dispose of wastewater, and these are described below.

The response chosen should take the above factors into account, and be carried out in a way that complements concurrent activities in water supply and excreta disposal.

Wastewater disposal techniques

The main options for disposing of wastewater are to discharge it into water courses, with or without treatment, to infiltrate it into the soil, or to use it for irrigation (in which case most of the water is disposed of by infiltration, evaporation and evapotranspiration).

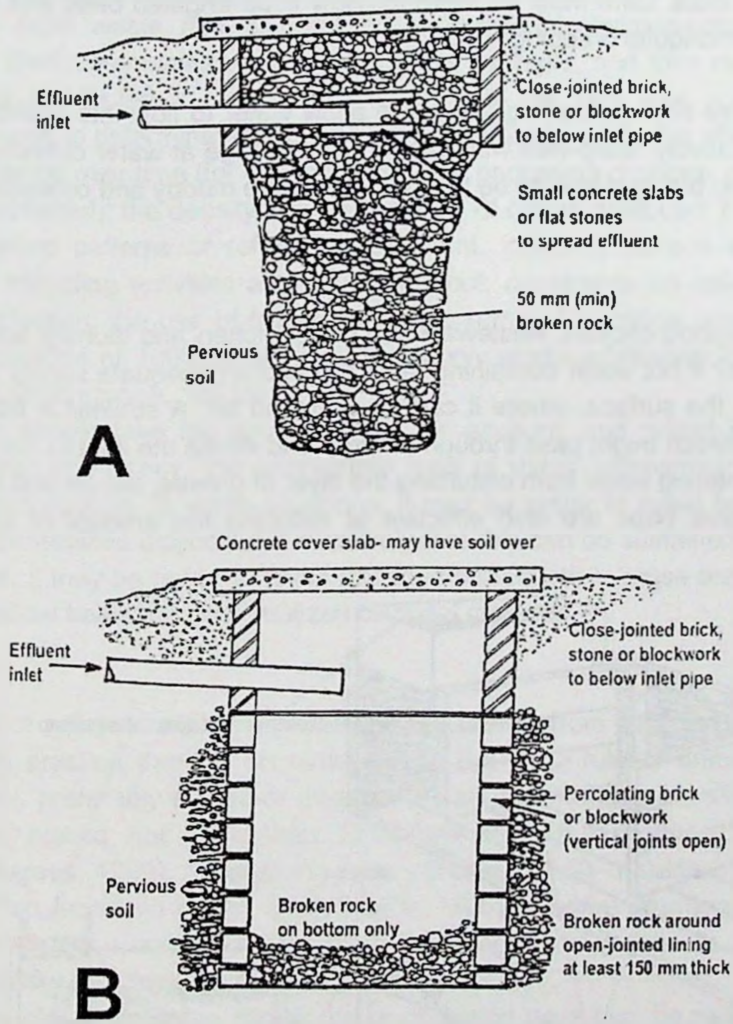
Disposal into water courses

If nearby water courses suitable for accepting the type and quantity of wastewater produced are available, the best disposal method may be to direct the wastewater to them through pipes or open channels. It may be possible to make a connection to an existing drainage network and thereby to treatment and discharge installations. It is important for staff to investigate the drainage system as far as the final discharge point, to avoid creating or contributing to environmental pollution and contamination of water supplies. But where relatively small quantities of slightly contaminated wastewater are produced (for instance, the water spilled at a water collection point), discharge into a water course may have no significant environmental impact.

Infiltration techniques

Infiltration into the soil should be facilitated where large quantities of spilled or used water will accumulate, e.g. under water-distribution tanks and taps, outside bath houses and laundries, and near communal kitchen areas.

The simplest technique is to construct a soak away (or soakage pit). This is an excavation at least 1.25 metres deep and 1.25 metres wide, filled with stones, that allows water to seep into the surrounding ground. It is sealed from above by an impermeable layer (oiled sacking, plastic or metal) to discourage insect breeding. Wastewater is fed by pipe into the centre of the pit (Fig).



Source: Assar (1971).

In emergencies, soak aways may consist simply of pits filled with small stones or gravel into which wastewater is directed. As long as the level of the water in the pit does not rise above the top of the ground, insect breeding is minimal.

Soak aways can only dispose of a limited amount of water because they provide a relatively small area of soil surface for infiltration. Infiltration trenches, which are commonly used for disposing of the effluent from septic tanks, overcome this problem through a series of parallel trenches in which perforated pipes are laid in a bed of gravel.

Evaporation and evapo-transpiration techniques

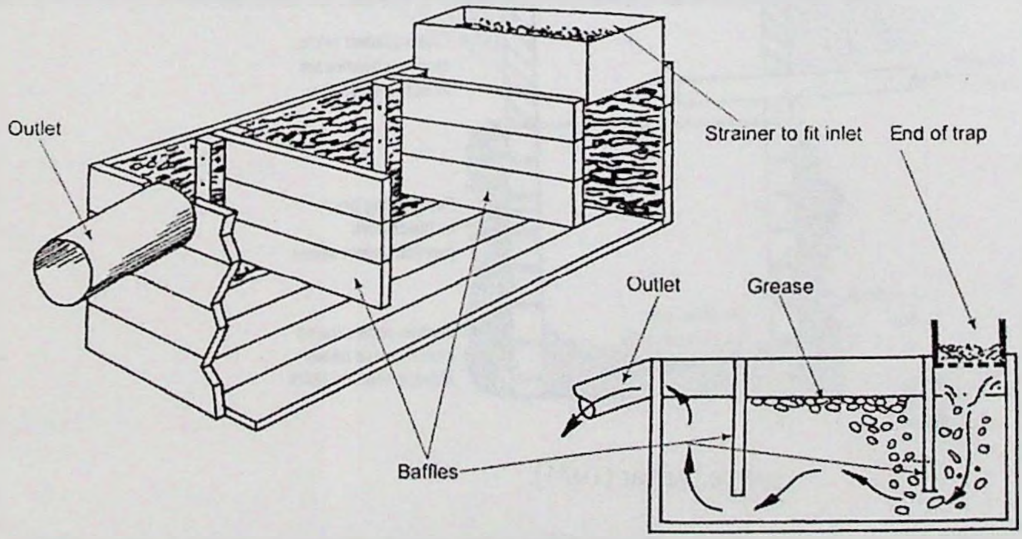
Where infiltration methods do not work effectively because of low soil permeability, wastewater may be disposed of by using it for irrigation. Even when infiltration methods are possible, it may be appropriate to use wastewater for vegetable gardening if irrigation water is scarce. Such a system might be considered for longer-term use, for instance, adjacent to a nutrition rehabilitation centre, health centre or school.

Water is applied to garden plots by simple flood irrigation, or by allowing it to collect in basins from where water is carried to plots. Care must be taken to allow flood-irrigated beds and storage basins to dry out regularly to avoid mosquito breeding.

A simpler system that does not involve irrigation, is to allow water to flow into shallow pans, where it simply evaporates. Alternatively, soap-free wastewater from spillage at water collection points may be used for watering livestock, but care should be taken not to create muddy and contaminated areas near water points.

Grease traps

Whatever the disposal method chosen, wastewater from the kitchen and laundry area should first be put through a grease trap? If hot water containing fat is run into an adequate supply of cold water, the fat solidifies and rises to the surface, where it can be skimmed off. A strainer is fitted to the inlet to catch any large particles which might pass through the trap and choke the inlet to the soakage pit. The first baffle prevents the entering water from disturbing the layer of grease, the second keeps the effluent from carrying it off. Grease traps are also effective at reducing the amount of sand and soap in wastewater.



Source: Skeet (1977).

Management of refuse

In many parts of the world, a disaster can cause transportation problems that disrupt waste-management systems that are inadequate even during normal times. Extra quantities of waste, or new forms of waste, such as rubble from destroyed buildings, or flood debris, may be generated by the disaster. Immediate problems that commonly follow disasters such as floods and hurricanes are blockage of roads and water courses and mixing of hazardous and nonhazardous wastes. The first priority is often the clearance of post-disaster debris to reduce health risks, open routes and lessen the psychological impact of the disaster.

Assessment of the problem and design of the response

As with wastewater, solid waste may not present a particular environmental health problem in emergencies. Where rural communities are displaced, for example, and they receive a dry ration of grain, pulses and oil distributed in bulk, there is likely to be very little solid waste produced. Assessments should seek to determine: the quantity of refuse produced by the affected population, and how that is likely to change over time (for example, as ration packaging changes, or as market activities develop or are re-established); the density and composition of refuse produced; the composition of the refuse produced; existing patterns of refuse management, including storage and destruction; any collection, reuse and recycling activities already carried out; constraints on collection and transport, such as personnel reduction, the use of trucks for rubble removal in critical areas, and damaged or blocked routes. A population of 1000 people may commonly produce between 2–4 m^3 of solid waste per day (World Health Organization, 1991b).

The response chosen should take the above factors into account, and reflect knowledge about the possible duration of the emergency, the appropriate level of users' involvement, and the economic sustainability of different options. In some situations, it may be better to avoid launching a system of refuse collection and centralized disposal if it is unlikely that this can be sustained for more than a few months. In such cases, it may be better to focus attention on reduction, reuse and recycling of refuse, or stimulate local initiatives based on decentralized disposal methods.

Refuse storage

The number and size of refuse containers needed varies greatly from situation to situation, and can only be determined in practice through an assessment. But as a rule of thumb, one container of capacity 100–200 litres, preferably plastic or metal and with a tight-fitting lid, should be provided for every 10–20 families, placed not more than 15 metres from the shelter (United Nations High Commissioner for Refugees, 1999). Alternatively, one container of 50–100 litres may be provided for every 25–50 people (Pan American Health Organization, 1996). In some situations, large street-corner storage containers may be used, provided they have tight-fitting lids. In most cases, these recommendations will allow two days' worth of refuse to be stored.

In markets and commercial areas, large containers or collection bays may be needed. To control flies and rats, a market authority or committee should be established to manage cleaning of the market area and manage the refuse collection site. Certain wastes, such as waste from animal slaughtering, may need special containers to deal with the large quantities of liquids produced.

Arrangements for refuse storage, collection and transport should be made in consultation with the affected population and should aim to minimize nuisance and health risks.

Refuse collection and transport

Before starting the collection service, it is necessary to determine: the quantity of solid waste to be collected; how much waste will be generated; the frequency of the service; the quantity and size of collector trucks; the number of workers required; the final disposal method; and the disposal site.

For every 1000 residents, 2.5 workers should be appointed. Their tasks include cleaning streets and open spaces; collecting waste containers; cleaning facilities, markets, and the like; and transferring waste to the treatment or final disposal site. The number of workers will decrease as refugee services are organized (World Health Organization, United Nations Environment Programme, 1991).

Daily refuse collection is best, especially from kitchens, but collection not less than once a week is essential to minimize insect breeding (flies produce a new generation approximately every eight days in warm conditions).

One 5-ton truck will probably be sufficient for 10 000 people, but this depends on the quantity and density of refuse collected, the ease of collection, and the time required to transport refuse to the disposal site. Although any kind of truck may be used for emergency responses, compactor trucks are always preferable if these can be afforded. Otherwise, the truck should be chosen on the basis of the volume and density of waste to be collected. Handcarts can also be used in large, densely-populated settlements.

Collection routes and frequency will be determined according to waste generation. This information should be communicated to the population as soon as possible.

Treatment and disposal

This section deals with disposal of household refuse and market waste. Disposal of medical waste should be managed completely separately (see section 8.5.6).

Burial

In low-density settlements where relatively small quantities of refuse are produced, small refuse pits may be dug by each family.

Alternatively, a communal trench 1.5 metres wide and 2 metres deep can be excavated by hand for the refuse. Each day, refuse should be covered with 20–30 centimetres of earth. When the level in the trench is 40 centimetres below ground level, the trench should be filled with earth and compacted, and a new trench dug. A 1-metre long trench for every 200 camp residents will be filled in about a week (Pan American Health Organization, 1996).

If time and available labour permit, refuse should be separated into material that is biodegradable (vegetable matter), which should be dumped in one trench, and other material (bottles, can, plastic, etc.), which should be dumped in another. The trench for biodegradable refuse can be dug out after 6 months and used as compost.

Bottles and cans may be cleaned and recycled, but care should be taken to segregate all containers used for dangerous chemicals, such as pesticides. Containers that have contained pesticides should be crushed so that they cannot be reused. They should be buried far from any water source.

Sanitary landfill

In most cases, the use of sanitary landfills will be the best option for final disposal. When existing landfills are inoperative or inaccessible, the construction of new landfills will be necessary. The landfill site should be:

- — located away from the settlement;
- — accessible;
  - — on vacant/uncultivated land;
- — located in natural depressions with slight slopes;
- — downwind from the settlement;
- — sited and organized to avoid surface water and groundwater pollution;
- — in an area that is not exposed to landslides or earthquakes.

The site must be carefully selected, as it may be used as a permanent place for final disposal.

Earthmoving equipment may be needed to modify the site and to manage the landfill operation. It has been estimated that an area of 0.4–0.5 hectares (4000–5000m^2) can serve 10000 inhabitants (World Health Organization, United Nations Environment Programme, 1991).

Incineration

Incineration is a third possibility, but it is not usually suitable for the volume of domestic refuse produced by the general population, because it requires large incinerators and large amounts of fuel, and air pollution is almost inevitable. Incinerators should be located away from the settlement, on the opposite side from the direction of the prevailing wind. They should be built on an impervious base of concrete or hardened earth. Ash and any unburned refuse should be buried and covered with 40 centimetres of soil. In many countries, waste is partially burned at landfill sites. This has the advantage of reducing the volume of waste to be buried, but the smoke created is a nuisance and a hazard to health.

Waste recycling

It may be appropriate to encourage and facilitate recycling of refuse after collection and transport. Refuse can be sorted as an income-generating activity, producing paper, glass, metals and plastics for recycling, where these materials are present in significant quantities in the refuse. Measures should be taken to ensure that people sorting refuse for recycling are protected from health hazards, such as exposure to harmful chemicals, or cuts from sharps.

Composting is a practical way to treat the organic waste remaining after sorting. Simple methods produce good-quality compost for use in gardens. It may be possible to co-compost refuse and sludge from emptying latrines and septic tanks. In this case, special attention is required to ensure compost heaps attain and maintain adequate temperatures to kill pathogens. If there is any doubt about this, the compost should be stored for at least a year before use.

Disposal of rubble

Disasters often produce rubble from damaged buildings and other structures that far exceeds the capacity of solid waste management systems. This waste is not hazardous, but it hampers the emergency response by blocking roads and hiding the full extent of the damage, and blocks drainage channels, which leads to flooding and wastewater overflow.

It is necessary to take into account that all initial efforts are aimed at the rescue of buried people who may remain alive for up to seven days. Although quick and effective demolition methods are necessary, they should be carefully applied to prevent collapses that may produce even more damage.

After floods, accumulation of sludge both inside the house and outdoors may become a major problem. It is recommended that waste is removed manually from inside dwellings, mechanically from public roads, and then disposed of with other rubble. Ash produced by volcanic eruptions can be cleared by groups of workers, often from the affected community. New ash falls may need to be cleared every day or so.

Initial assessments of the affected areas and estimated tonnes of material to be cleared are crucial elements for demolition activities and waste management. These assessments should be rapid and general, as detailed research may usually be time-consuming, and a prompt response is required.

In highly developed urban areas, an average of 1.5 tonnes of building waste may be generated per square metre constructed (United Nations Environment Programme, International Environmental Technology Centre, 1992). In residential areas, this amount ranges from 0.5 to 1.0 ton per square metre constructed, depending on the materials used in each locality. Decisions on the demolition of damaged buildings are often difficult to make since costs, policies, structural risk and other factors must be first analysed.

The various components of rubble should be separated to facilitate recycling. Metals, mainly iron and steel, can be smelted for reuse. Concrete can be crushed for road-building, land reclamation, etc. Wood can be used as fuel. In many cases, the local population will spontaneously recover useful materials. This activity may need monitoring to reduce the risks of accidents and avoid legal problems. Final disposal may be in landfill sites.

Medical wastes

Special care must be taken with refuse from a field hospital or health centre. The main categories of waste of concern are: infectious waste; pathological waste; sharps; pharmaceutical waste; genotoxic waste; chemical waste; waste with high heavy metal content; pressurized containers; and radioactive waste (World Health Organization 1999c). Each type of waste requires specific measures for handling, storage, collection and destruction. In the case of simple health centers, particularly in rural areas, well-managed on-site burial may be appropriate. In larger centres producing a significant quantity of sharps and infected waste, incineration may also be required. When health facilities operate diagnostic laboratory services, radiological diagnosis and treatment facilities, pharmacies, etc., waste management is a specialized activity requiring trained and well-equipped staff, and the subject is beyond the scope of this book.

Waste management during triage and classification of victims

Triage and classification of victims generate potentially infectious waste. Since this is a rapid-response activity, it is highly recommended that all wastes generated during this stage, without exception, are stored in containers, preferably in red bags, that are properly labelled as "biocontaminated waste". Direct contact with such wastes must be avoided.

Waste management during routine medical activities

Management will be similar for permanent (existing hospitals and health centres) and provisional (field hospitals) health facilities. Wastes should be segregated at the point of generation according to their type:

— biocontaminated wastes (including sharp materials);

— chemical wastes (drugs, chemical solutions, etc.);

— common wastes (paper, cardboard, glass, or the like; chemical product containers should be treated as chemical wastes).

For each hospital room, washable and easily disinfected PVC containers with a capacity of 40–50 litres should be used. Waste should be disposed of in coloured bags according to the following codification:

— red bags for biocontaminated wastes;

— yellow bags for chemical wastes;

— black bags for common wastes.

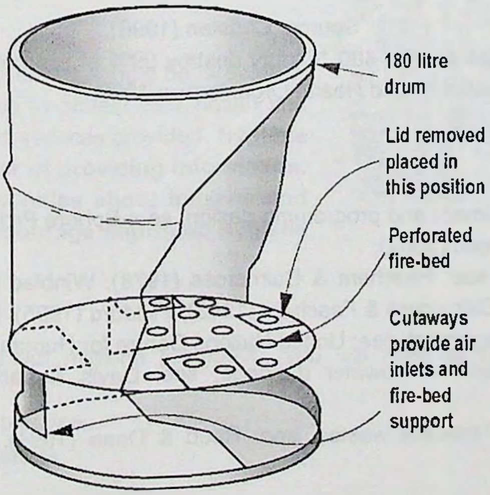
Hermetic plastic containers of 2–5 litre capacity or opaque glass bottles may be used to store sharp objects.

These wastes should then be collected separately every 12–24 hours. Small carts, preferably with lids, should be adapted to this end and the personnel assigned should be protected with aprons, masks, boots and gloves. Treatment should be done according to the type of waste. Sharp materials should be disinfected with a 0.5% total chlorine solution before incineration or burial in a sharps pit. Bio contaminated wastes should be incinerated.

Burned bio contaminated wastes, disinfected sharp materials, and chemical wastes should be disposed of by burial on-site if possible. The burial area should be isolated and protected to avoid illegal recycling. However, this may not be possible in permanent health facilities, due to lack of space. In such cases, protected areas should be used at landfill sites to receive treated wastes. Common wastes may be managed by the municipal waste-collection service, as long as they do not contain hazardous material.

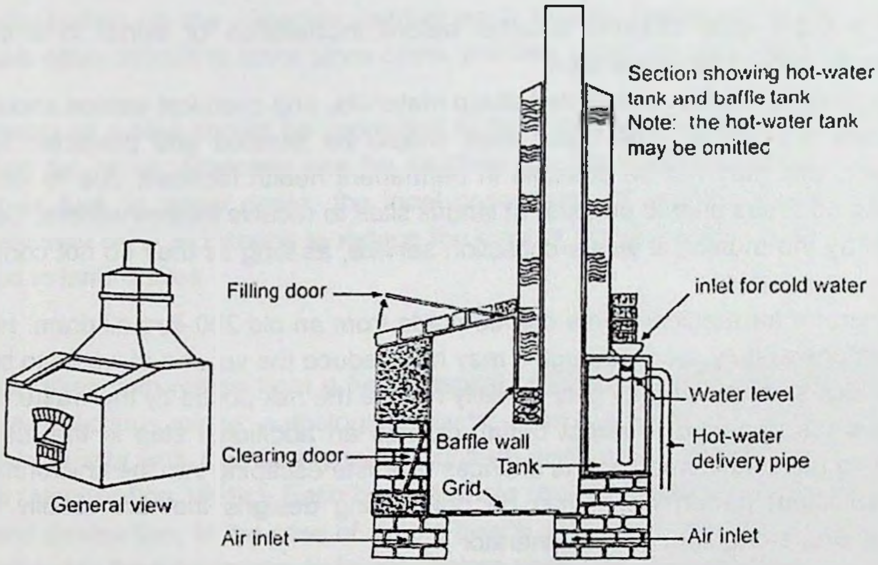
A temporary incinerator for medical waste can be made from an old 200-litre oil drum. However, this is unlikely to perform adequately, and although it may help reduce the volume of waste to be buried, it will produce a lot of black smoke and may only partially reduce the risk posed by the waste. In addition, the use of incinerators, as opposed to direct burial, creates an additional step in the disposal process, exposing workers to risk and increasing the chances of waste escaping into the environment. Brick-built incinerators, of sufficient performance, can be built, using designs that are readily available (e.g. Christen, 1996). A single-chamber brick incinerator

Figure 8.10 Simple basket incinerator made from a discarded oil drum[1]



[1] Source: Skeet (1977).

180 litre drum
Lid removed and placed in this position
Perforated
fire-bed
Cutaways
provide air
inlets and
fire-bed
support



[1]Source: Christen (1996).

(Figure 8.11) that incinerates at 300–400 °C may destroy 99% of microorganisms and greatly reduce the volume and weight of waste (World Health Organization 1999c).

Further information

For further information on:

— sanitation assessment and programme design, see: Sphere Project (2000), Davis & Lambert (2002), Harvey, Baghri & Reed (2002);

— latrine designs, see: Feachem & Cairncross (1978), Winblad & Kilama (1985), Franceys, Pickford & Reed (1992), Cairncross & Feachem (1993), Pickford (1995), Davis & Lambert (2002);

— solid waste management, see: United Nations Centre for Human Settlements (1989);

— surface water and wastewater drainage, see: Davis & Lambert (2002), World Health Organization (1991c);

— management of medical wastes, see: Reed & Dean (1994), World Health Organization (1999c).

HYGIENE PROMOTION IN EMERGENCIES

This fact sheet outlines some of the key activities in dealing with hygiene promotion in post-disaster emergencies.

What is hygiene promotion?

The goal of hygiene promotion is to help people understand and develop good hygiene practices to prevent disease and promote positive attitudes towards good health practices.

Focus of hygiene promotion in emergencies

Your aim in carrying out hygiene promotion in emergencies is to: rower high-risk hygiene behaviour; and sensitize your target population to the appropriate use and maintenance of facilities.

This latter point is important. Your efforts should be directed at encouraging people to take action to protect their health and make best use of the facilities and services provided. **Hygiene promotion is not simply a matter of providing information. It is more a dialogue with communities about hygiene and related health problems, to encourage improved hygiene practices.**

Community meeting In carrying out hygiene promotion, you will need to carry out the following activities:

- Evaluate current hygiene practices.
- Plan what you need to promote.
- Implement your plan.
- Monitor and evaluate your plan.

Evaluate whether current hygiene practices are good and safe

You will need to identify the key hygiene behaviour risks and judge the probable success of any promotional activity. The main risks are likely to be:

- Excreta disposal.
- Use and maintenance of toilets.
- Lack of hand washing with soap or alternative.
- Unhygienic collection and storage of water.
- Unhygienic preparation and storage of food.

Prioritize these by choosing those which pose the greatest health risk. You should look at the resources available to your target population taking into account local behaviours, knowledge and cultural norms. The needs of vulnerable groups should be given particular attention.

Plan which good hygiene practices to promote

The understanding you gain from the above evaluation should be used to plan and prioritize assistance. Give priority to targeting those behaviours which pose the greatest health risks. Target a small number of practices for each user group: sustained and repeated messages covering a small number of practices are likely to have greater impact than a large amount of promotional messages centred on several practices. The key is to identify the most harmful practices in each user group and focus on these. Implement a health promotion programme that meets community needs and is understandable by everyone.

Implement your plan

1 **Target specific audiences.** It is important that you know who your audience are and that you direct messages at groups responsible for carrying out the activity being referred to.

2 **Messages about diarrhoea in children should be directed at those involved in childcare.** It is desirable that all gender groups (women, men, children and those with disabilities), should receive equal attention. There are reasons why this does not always happen. Women, for example, will shoulder domestic responsibilities in most households. As a consequence, most promotion activities are directed at women, on the premise that if they understand, accept and act upon the messages, the benefits will be immediate. Men, on the other hand, might understand and accept the messages but not act upon them if they are not involved in domestic duties.

3 **Identify motives for behavioural change.** People may change their behaviour for reasons not necessarily related to potential health benefits, but for totally unrelated reasons. It is important to identify and understand cultural norms and use this knowledge as a basis for articulating motives for change.

4 **Certain behaviours may be seen to confer status within the community and be adopted for this reason.** For example: Fatima built a utensils drying rack for after noticing her neighbour Zainabu, who is a teacher, had one. A woman may adopt the correct disposal of children's' faeces upon seeing a health worker doing so.

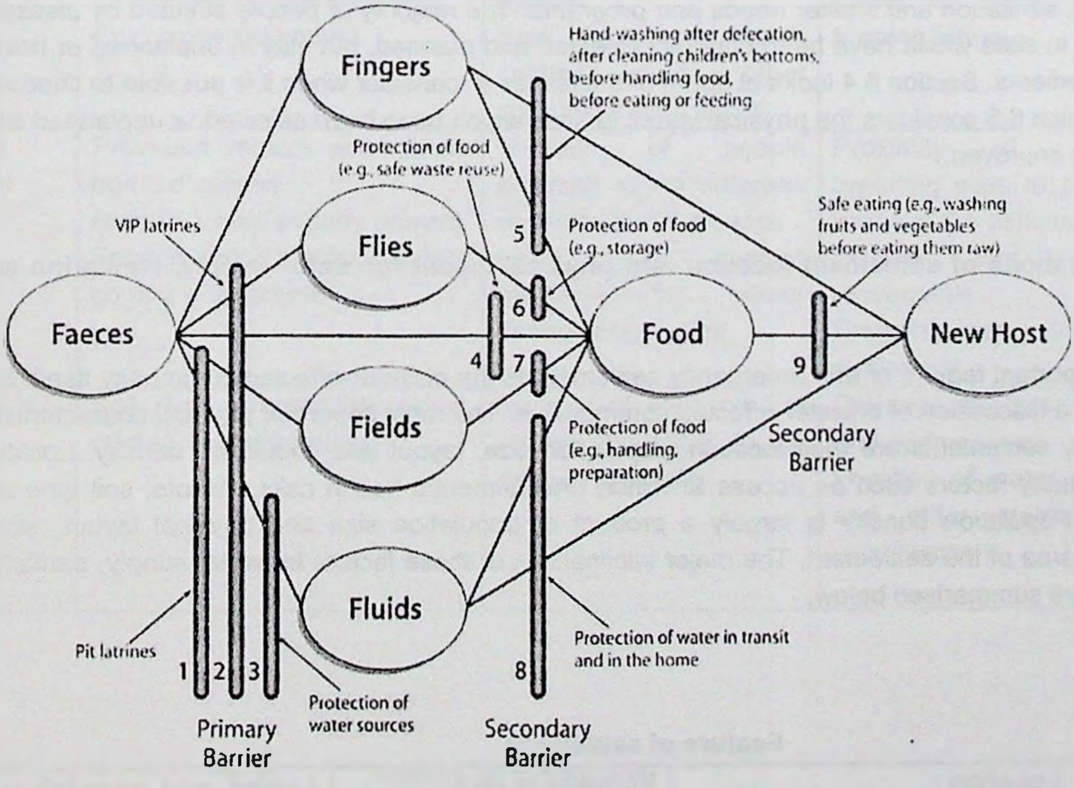
5 **Hygiene messages need to be positive.** Hygiene messages should be presented in a positive light making use of humour wherever possible. Nobody likes being lectured to: people will be much more receptive to positive messages.

6 **Identify appropriate communication channels.** You need to know how your different target audiences prefer to receive information and any cultural aspects to this. Do they listen to the radio, pick up information through informal discussions, use health facilities, rely on religious functions, theatre and

dance and so on? It is usually more effective to use the channel that your audience identifies with and regards as trustworthy. Staff may be recruited from among elders with a lot of life experience, teachers, community leaders, health workers, religious leaders, traditional birth attendants and so on. Although there are no hard and fast rules, a ratio of one facilitator to every five hundred people or one hundred families is recommended.

Monitor and evaluate the programme to see whether it is meeting targets

You will need to review your hygiene promotion programme regularly. Ideally, members of the community should be involved to ensure that issues important to them are covered. The review should evaluate remembers' feelings about the hygiene message and whether they need more information. Reviews should also mean you gain feedback about how to improve your programme. It is good ideas to have members decide the frequency of reviews. All information gathered during monitoring and evaluation should be shared with the wider community and interested stakeholders.



Further information

Harvey P., Baghri, S. and Reed, R.A. (2002) Emergency Sanitation: Assessment and programme design. WEDC, Loughborough University, UK.
Howard, A.G. (2002) Healthy Villages: A guide for communities and community health, WHO, Geneva.

9. EMERGENCY SETTLEMENTS, SITE SELECTION AND PLANNING

Introduction

The number of people affected by disasters has multiplied several folds in recent years. It is estimated that in 1995, 38 million people fled conflicts, as refugees or internally displaced people, and more than 160 million people were affected by natural disasters. A large proportion of people affected by disasters spend at least part of the post-disaster period in temporary settlements, where living conditions and the constraints imposed by the location and nature of the settlement may have a huge impact on their well-being. There is a growing realization of the problems caused by settling disaster-affected people in camps and the need for a new approach to emergency settlements which takes a broad view of the needs of the disaster-affected community, whilst considering issues such as sustainability, environmental impact, social and economic impact and security in the short and long terms. This chapter recognizes this broader perspective, but concentrates on issues raised by site selection and planning which have direct consequences on water supply, sanitation and shelter.
The first sections of the chapter look at features of emergency settlements which have an impact on water supply, sanitation and shelter needs and programs. The majority of people affected by disasters do not settle in sites which have been carefully selected and planned, but stay in unplanned or hastily chosen settlements. Section 6.4 looks at some of the issues to consider when it is possible to choose a site, and section 6.5 considers the physical layout of sites which have been selected or unplanned sites which can be improved.

Major implications of settlement location and physical layout for water supply, sanitation and shelter

The most important feature of any emergency settlement is the disaster-affected community itself. See chapter 1 for a discussion of disaster-affected communities. The most important physical characteristics of emergency settlements are their location, population size, layout and population density. Location determines many factors such as access to water, environmental health risks, climate, soil type and topography. Population density is largely a product of population size and physical layout, which includes the area of the settlement. The major implications of these factors for water supply, sanitation and shelter are summarised below.

Feature of settlement

Programme element	Location	Population size	Layout and population density
Water supply	Quantity of water available Distance to water sources Quality of water available and need for treatment Possible sources of contamination Access for local people to the	Quantity of water needed Scale of response required Large populations are more dependent on central systems	Possible pipe routes Space for water points and drainage Distribution network density

	water supply		
Excreta disposal	Soil type Climate Water table depth Slope Availability of local materials Possible contamination of water supplies Impact on local environment	Impact on local environment Supplies of local materials Possible pollution by off-site excreta disposal	Space available for on-site disposal systems Zones for locating toilets or defecation areas Access for latrine emptying if needed
Solid waste management	Type and quantity of resources brought into the settlement, and type and quantity of waste produced Soil type for possible on-site burial Location of off-site discharge Environmental impact	Amount of refuse to be disposed of Number of waste collection points Likely need for a centralised collection system Size of markets, health centres and other sources of solid waste	Location and number of waste collection points Space available for on-site disposal Access for solid waste collection Effect of smoke from burning refuse
Vector control	Prevalent vectors and vector-borne diseases Breeding sites already present Environmental impact of vector control programme	Number of people exposed to an outbreak of vector-borne disease Level of support available for vector control programme	Proximity of vector breeding sites to certain areas of the settlement Density and vector movements Breeding sites within the settlement
Drainage	Soil type, vegetation cover, rainfall, slope, flooding	Number of shelters and volume of water to be drained from site	Drainage courses, roads and open spaces Location of water points and other sources of wastewater

Feature of settlement

Programme element	**Location**	**Population size**	**Layout and population density**
Hygiene promotion	Hygiene problems to be addressed Security	Social structures in place and which develop Social cohesion and conflict	Hygiene problems to be addressed

Shelter	Climate Available materials	Available local materials within walking distance Cost of delivery of materials from other sources	Exposure to the elements Fire risk Distance between shelters Hygiene problems associated with population density

Broader considerations

There are a number of broad and interrelated considerations to take into account when selecting a site for settling an emergency affected population. These considerations may be used to define what sort of settlement is desired or acceptable, how long it should be possible to remain in place, what sort of local impact it should have etc. From this broad definition, a set of more specific criteria can be used in the site selection process. These broad definitions may be seen as ranges or sliding scales, which are not exhaustive, nor universally applicable.

Security: Security for the affected community and for programme staff is influenced by settlement location in relation to local communities, borders or fighting forces. Settlement size and layout may have an influence on violence within the affected community. People from within the emergency settlement may pose a threat to others outside it and vice versa.
Sustainability: Many disasters produce long term settlements of displaced people, though there may be a reluctance to recognise this on the part of everyone concerned, for many reasons. A long term view is needed to ensure that people affected by the disaster can live healthy and dignified lives over a long period, without creating undue problems for local people. Planning for sustainability requires consideration of other issues such as security, protection, access, environmental concerns, the local context, host authority, donor attitudes and the nature of the displaced population.
Social cohesion: This can be influenced by the location, size and layout of the emergency settlement. Large, isolated and dense settlements without a clear spatial definition of local areas may create tensions and disorientation and make community rebuilding more difficult.
Integration with or separation from local communities: The degree of integration or separation influences social relations, local markets for labour and goods, political developments, security and sustainability. It is important to be aware of the relative numbers of directly affected people and the host communities and their relative wealth.

Site selection
It may be necessary and possible to settle the disaster affected population on a site chosen for that purpose. The site may be a transit centre or camp, a semi-permanent camp or an extension to an existing settlement or camp. The minimum standard should be used to determine the suitability of the site for settling the affected population and for delivering assistance whilst optimising long term local impact.

Sphere Project Minimum Standard

Topographical conditions are suitable to host the number of people involved

Key indicators

- *There is sufficient water for household cooking, hygiene and sanitation.*
- *Drainage of sanitation and surface water: the gradient should be no less than 2% to enable run-off, but to avoid soil erosion should not exceed 6 %.*
- *The site is not less than three metres above the anticipated water table in the rainy season.*
- *The soil type allows for digging and water penetration.*
- *Elevation in relation to latitude is correct: day and night temperatures are suited to the available shelter and clothing.*
- *Vegetation: there are grasses, scrubs and trees for shade and to avoid soil erosion.*
- *Environmental health and hygiene promotion: see Water Supply and Sanitation, and Health Services.*
- *The site is at least 10km from protected or fragile areas.*
- *The site is not close to a volcano.*
- *Access to the site for heavy trucks is less than 5 km from an all weather road. Light four wheel drive trucks are able to reach distribution sites.*
- *The site is near to existing social and economic facilities if possible.*
- *Land rights and permitted use are firmly established prior to occupation.*
- *Water rights, and the right to use other natural resources, wood, stone, sand are arranged immediately before, or at the same time as, the site is selected.*
- *The site is not prone to tidal waves and flooding.*

Site selection process

Site selection in practice is a difficult process, requiring a number of short and long term considerations to be weighed up, in a situation of great uncertainty, with conflicting priorities to be taken into account. Decisions taken on site location during the early days of an emergency situation have long term implications and there may be tremendous pressure to take decisions rapidly. It is helpful for the decision making process to use a systematic approach when comparing possible options. There are bound to be different sectoral priorities involved, and so a joint decision making process should be used, which allows all the significant issues to be considered in an open way as follows:

1. Agree issues to be addressed like security, possible duration, dependency / self sufficiency, programme costs, integration with / segregation from local host population, urgency of decision, likely future population movements
2. Agree list of criteria which have an impact on these issues, such as topography and location, soil type, water sources, land area available, access, vegetation, fuelwood, environmental impact of settlement and service delivery, environmental health hazards, political and security issues, and social, legal and cultural issues
3. Prioritise criteria according to their importance to the key issues to be addressed (point 1), and agree a method of weighting which reflects these priorities
4. Determine the site and population characteristics through site visits & assessments. These assessments should include the following:

Disaster-affected community profile. Use UNHCR's People Oriented Planning (POP) or other technique for identifying important social features as follows:

- urbanites, farmers or pastoralists - the culture of the disaster-affected people, their material and skill resources
- different cultural backgrounds - people in the same camp may originate from both urban and rural situations, different religious or political backgrounds, or completely different countries
- gender, age and vulnerable groups - people of different ages, genders and types of vulnerability have different requirements and play different roles

Local population profile: Demographic and economic characteristics of the local host population. Use POP or other techniques to describe a similar profile of the local population. In addition a basic local and regional economic profile should be used to identify sources of materials, areas of potential conflict of interest between disaster-affected community and local people, existing development initiatives and local services.

Environmental and resource survey: Vulnerability, carrying capacity, local use and natural materials availability.

- Long term availability and management of local natural resources, such as water, fuel and construction timber, and livestock fodder.
- Potential impacts of the disaster-affected population on the environment, such as soil erosion from deforestation and the creation of areas of standing water.
- Short and long term environmental health risks due to local disease prevalence and the presence of disease vectors and their breeding sites.

5. Rank the sites. Once the criteria and weightings have been agreed and the assessments carried out, the sites can be compared by giving each one a score which is the total of scores for each of the criteria. The score for each criterion is obtained by multiplying its weighting by its score a particular site. Some criteria may be so critical to the outcomes required (point 1) that a low score would effectively rule out that site. For instance, a site prone to severe seasonal flooding would simply not meet the requirements for duration if it is anticipated or desired that the site is in place for more than a few weeks.

Staff responsible for water supply, sanitation and shelter should be involved in the site selection process at certain of these selection stages, as follows:

Listing and weighting key criteria: Ensure that topography, soil type, water sources, space available, access, vegetation, environmental impact and environmental health hazards are given sufficient weighting. The technical challenges and cost implications of providing water, sanitation and shelter on unsuitable sites are often not appreciated by people without specialist knowledge in these areas.

Determining site characteristics: Water, sanitation and shelter specialists should be involved in the assessment process to ensure that the characteristics of the site relating to these activities are properly understood and an appropriate score given to each of the criteria which are relevant. The assessment questions listed in Chapter 1 can be used as a means of checking all the main points relevant to water supply and sanitation are addressed in the assessment of the site.

Ranking the sites and choice of site: This is usually a process of negotiation, readjustment of criteria and last minute lobbying or pressure from various sources. Water supply, sanitation and shelter specialists should ensure that criteria which effectively veto certain sites are applied and not ignored, and that objective assessments and analyses are not discounted for political reasons. In practice the most suitable site is rarely selected, and this is often for reasons which are broadly political, and not made explicit in the determination of issues to be addressed at the beginning of the process. The implications of the choice should still be made very clear, and efforts made to ensure that the decision making process is as transparent as possible and responsibility for unsuitable site selection is identified.

In many cases the site selection process is done at a time when the affected population is already settled on a temporary site and the costs of moving to a better site also have to taken into account. The costs of moving people and programmes are often overstated in relation to the long term benefits. There is often a tendency for agencies which have invested in the original site to give a high weighting to the costs of closing down their existing facilities and starting again on new sites. This should be counterbalanced by a realistic weighting given to the advantages of moving. The longer the decision is left the greater the short term costs and the less likely it is that the site will be changed. There is sometimes a very short period of days or weeks during which it is possible to make a decision before unsuitable sites become semi-permanent, with long term consequences for the welfare of the affected population, local people, the local environment and programme costs.

Physical planning of emergency settlements

Where new sites are selected, existing sites extended or reorganised, water supply, sanitation and shelter staff should be involved in the physical planning process to ensure that the settlement created is a healthy environment in which to live and where essential activities can be carried out effectively.

Sphere Project Minimum standard

The layout ensures sufficient space for family household areas and provides people with an identity and an address. It provides for effective, efficient provision of services and internal access.

<u>*Key indicators*</u>

- *The site provides 30 m² space for each person. This includes infrastructure (roads, sanitation, schools, offices, water systems, security/fire breaks, markets, storage facilities, shelter locations), but excludes land for agriculture (crops and livestock).*
- *Clusters of living areas or village groups are established; there is empty land for future expansion, graveyards, wood lots and playgrounds.*
- *There is easy access to services on the site by roads and bridges.*
- *There is appropriate space for markets, offices, workshops, warehousing, distribution of donated commodities, staff housing, solid waste disposal, health facilities, religious services, community and nutrition centres, and water points.*
- *There are firebreaks at every 300 metres, 50 metres wide. Roads are wide enough to serve as firebreaks.*
- *There is a graveyard for each population group and graveyards are appropriately located.*
- *Quarantine camps are established at least 300 metres from any population to minimise the spread of infectious disease such as cholera.*
- *Decisions are based on sound judgements using appropriate maps.*

Site planning process

Water supply, sanitation and shelter staff should be involved in the site planning process to ensure that attention is given to the following points in particular. These apply whether a new site or an extension to an existing site is being laid out, or an existing site is being improved by rearranging living and service areas and providing more space by moving some people to a new site or to the periphery.

Water supply

- The population settled on the site is no more than can be supplied by the water available
- Shelters and latrines are located so as to avoid contaminating water sources
- Space is available for water points in areas which allow drainage of waste water and where contamination is not a significant risk
- Space is available for pipe routes
- The areas of the site to be served can be supplied cost-effectively and without serious technical complications

Excreta disposal

- Land is available sufficiently close to shelters for toilets. Enough land is available to allow latrines to be sited at least 6 metres form shelters and sufficiently far from water points to avoid contamination
- On sites with varied soil type and topography, land available for latrines is suitable
- Land is available for excreta disposal measures such as latrines and off-site disposal which reduces the risk of contaminating the environment surrounding the site
- Access to latrines and septic tanks for emptying is possible

Solid waste management

- Key waste producing points such as markets, abattoirs and health facilities are located so as to facilitate refuse management and reduce the risk of contaminating the site
- Suitable space is available on site or off site for final disposal of solid waste. This is located so as not to cause a nuisance or health hazard to the affected community or local people
- Access to solid waste collection points is possible using the appropriate means (wheelbarrow, handcart, animal cart or truck)

Vector control

- Living areas are located as far as necessary from permanent or seasonal vector breeding sites to reduce peoples' exposure to an acceptable level
- Sufficient living space is allowed to keep vector-borne disease related to overcrowding to an acceptable level

Drainage

- Living areas and service areas and structures are located so as to reduce the risk of their flooding and so as to facilitate disposal of any run-off and wastewater they may produce
- Settled areas of the site are located on land which meets minimum standards concerning slope, vegetation cover etc.

Hygiene promotion

- The layout of the site and the number of people settled on the site enable social cohesion and reduce forces producing conflict within the community and between the affected community and local people
- The layout of the camp allows social and administrative structures a spatial expression, to facilitate contacts with the affected population
- The layout of the settlement is such that hygiene-related problems are kept to a minimum

Shelter

- Living areas are sited so as to reduce exposure to harsh climates
- Shelters are sufficiently far apart from each other and groups of shelters are separated from firebreaks to avoid serious fire hazard

Other Sphere Project minimum standards relating to site selection and planning

Environmental concerns

Minimum standard

Serious efforts are made to minimise damage to the environment that may be caused by the displaced population.

<u>*Key indicators*</u>

- *During site layout all trees are spared, and roads and drainage patterns are marked along natural contours. As much vegetation as possible remains intact.*
- *There are no sites on slopes with a gradient over 6%, depending on soil type, population pressure and vegetation.*
- *Site population does not exceed a range of 20,000 to 50,000 people. 30,000 is the optimal maximum.*
- *There is no animal overpopulation on and around the site.*
- *Measures are taken to reforest the site and the area around it.*

Security

Minimum standard

Site selection and planning ensures the personal liberty and security of women, unaccompanied children, unaccompanied elderly people, people who have been victims of violence, single-headed households, people with HIV-AIDS, and agency personnel.

<u>*Key indicators*</u>

- *The site is at least 50 km from possible external threats to physical security.*
- *Single women, orphans and vulnerable people are able to obtain secure areas.*
- *The displaced population and the local community are at peace with each other.*
- *Reasonable steps are taken to ensure that agency personnel are not at risk.*

Further reading

Davis, J. and Lambert, R. (1995) <u>Engineering in Emergencies: A practical guide for relief workers.</u> RedR / IT Publications, London. Chapter 17.

Calendar, A. (1998) <u>Temporary Human Settlement Planning for Displaced Populations in Emergencies.</u> RRN Good Practice Review 6. ODI, London.

SOP for Site Planning for Transitional Settlements

Support for planned or self-settled camps should be considered very carefully. In the majority of cases, camps are supported when other, more appropriate transitional Settlement (TS) options are not possible due to various reasons.
This chapter deals with several key issues which must be addressed if a camp is to provide a successful TS option. They are:

Site selection presents a decision-making tool to help aid organisations to identify appropriate sites for transit facilities and camps.

Site planning presents standards and guidance on developing a master plan for a site, with a detailed consideration of family plots, community and infrastructure layouts, and typical communal facilities.

Site-selection process

> **Important:**
> **Site planning is a brief process that has long term consequences – get expert help**

There are three steps in the site-selection process;

Step 1: assessments

Site-selection assessment should take following steps:
• involvement: site-selection teams
• reference: strategic planning
• livelihoods: profiling local and displaced populations
• capacities: potential sites
• resources: the carrying capacities of the local environment.

Involvement: site-selection teams

A site-selection team should ideally comprise representatives of the displaced and host populations, the host government, the lead agency, implementing aid organisations, and sector specialists, such as water engineers. The team needs a leader who is experienced in site selection and camp planning.

Reference: strategic planning

Site selection and supporting camps should be considered only in the context of a wider Transitional Shelter strategy. The process of site selection must inform this strategy.

Livelihoods: profiling local and displaced populations

It is essential to form an understanding of the type of camp that the displaced population would like to live in, regardless of the sites that are available: for example, are they mainly farmers bringing livestock

with them, or traders or urban population who have lost everything? When developing a list of criteria for assessing the displaced population, following criteria could be used:
• their protection and security
• their origin, whether they are urban or rural, their livelihoods, the communal services and facilities in their settlements and how they were maintained, and the structure of their communities
• the demographics of the group, the presence of subgroups and vulnerable families and individuals, different cultures and religions.

Capacities: potential sites

Identify as many potential sites as possible, provided that they seem appropriate and have sufficient capacity. It is essential to involve local authorities and community leaders in the assessment of potential sites, partly because of their local knowledge, and partly because permissions and acceptance by the local community are required before any site can be used.

When developing a list of technical criteria for assessing potential sites, consider the following:
• security,
• the accessibility of the site for displaced people, for people living in local settlements, and for deliveries via all-weather roads, sea ports, rail heads, and air ports or air strips
• the availability of water, including the variety of sources
• the availability of other natural resources, such as fuel wood
• topographic characteristics, such as rocky ground, which complicates the construction of shelters and latrines, and the creation of kitchen gardens and very steep ground, which should be avoided for similar reasons.

If no potential sites meet the technical criteria identified, the results should be communicated immediately to the strategic planning process.

The Sphere Project gives the following guidance in 'Shelter and settlement standard 2: physical planning':
Topography and ground conditions: for temporary planned camps the site gradient should not exceed 6%, unless extensive drainage and erosion control measures are taken, or be less than 1% to provide for adequate drainage. Drainage channels may still be required to minimize flooding or ponding. The lowest point of the site should be not less than 3 metres above the estimated level of the water table in the rainy season. Ground conditions should also inform the locations of toilets and other facilities and hence the planning of settlements e.g. fissured rock may disperse toilet waste widely; fine clays provide poor percolation and the early failure of toilet pits; volcanic rock makes the excavation of toilet pits difficult. Sphere Project (2004), chapter 4, p. 218

Resources: local environmental carrying capacities

The carrying capacities of the local environment are determined by the amount and volume of various resources that can be harvested sustainably. Assessment of these capacities is essential in order to determine the viability of Transitional Settlement options. The majority of resources necessary to construct and maintain camps must come from the local region, if supporting camps is to be a viable TS option. Importing all water, fuel, and construction materials would be a significant challenge, in practical and economic terms. If no alternative sites can be found, the importing of some resources may have to be considered. Importing drinking water by truck, for example, has been undertaken for extended periods, but at very high cost and with considerable damage to the road infrastructure.

Site selection should take NRM into account, with the following aims:

- minimising negative impacts on the local host population
- avoiding damaging impacts on the local environment, by locating camps away from fragile ecosystems, ideally no less than one day's walk away
- controlling access to natural resources through the dispersal of camps, thereby determining, in consultation with all stakeholders, whether a given affected population will be settled in one large camp or in a series of smaller camps which will spread demands upon natural resources more widely
- locating a camp in an area where sufficient natural resources are available
- minimising distances travelled by displaced people to obtain basic natural resources, such as water and cooking fuel.

Once an appropriate site has been selected, site development may contribute to NRM in the following ways:

- minimising the clearance of on-site vegetation, in order to reduce soil erosion and to maximise shade and wind protection
- minimising soil erosion by building access roads along contour lines, or at a suitable gradient, with appropriate culverts,

surface-water drainage, run-offs, and soak-aways

- minimising the amount of construction material that needs to be harvested locally: for example, by importing materials such as construction timber and plastic sheeting from the surrounding region, or from another country.

Step 2: scenarios

The site-selection process seeks to identify a range of sites which will meet the requirements of the various likely scenarios predicted by planners. It is very unlikely that the circumstances of a specific displacement of people will remain static, so scenarios must anticipate changes in circumstances, such as new influxes, or movements of displaced groups from one TS option to another. The goal of scenario planning, both strategically and within the site selection process, is to maximise the opportunities and options available to the displaced and local populations, while minimizing the negative impacts on both. In general, scenario planning consists of considering possible changes in certain circumstances and assessing their likely effects on displaced and local populations.

Step 3: indicators

Within the site-selection scenarios, indicators should be identified and agreed, to enable planners to recognise when one scenario is becoming more likely than another: for example, if displaced people's rate of influx rises above, or drops below, an agreed figure. Identifying indicators has two main purposes: enabling the planners and implementers of aid operations to decide which scenario they should adopt as the basis for their decision-making; and determining whether additional key information should alter the scenario, add more detail to the scenario, or require more specific field assessment. The site-selection scenario indicator should be communicated immediately to the strategic planning process, along with the details and assumptions of the scenarios.

Camp site planning

Once a site has been selected and a transitional settlement programme for camps has been planned the sites themselves need to be planned (the sequence activities may not be leaner as it seems).

Camps have to be planned rapidly, but they also need to respond to many of the same challenges that towns and cities face, such as the need to leave space within the original infrastructure for later expansion. Site planning is a complex activity which should be undertaken only by experienced specialists. Site planning significantly influences the financial, social, and environmental impacts of a camp. Layouts that allow efficient delivery of services to the population will be easier to manage and cheaper to run, especially in the long term. Layouts that support social hierarchies already in place within the displaced population will encourage community development. For example, cluster planning creates communal spaces used by only a few families, encouraging ownership and maintenance of facilities, and reducing opportunities for crime.

Table: Site Layout

	Sphere Project (2004)	UNHCR (2000)
space required		
minimum surface area of camp per person	45m², inc. infrastructure but excluding land for agriculture	45m² (30m² including infrastructure + 15m² for agriculture)
minimum covered floor area per person	3.5–4.5m²	3.5m² in warm climate 4.5–5.5m² in cold climate or urban area
fire breaks		
minimum distance between buildings	2m	2 times structure height 3–4 times structure height if highly flammable
minimum distance between clusters of dwellings	6m	
minimum distance between blocks of clusters of dwellings	15m	30m per built-up 300m
water supply		
minimum quantity of water available (litres per person per day)	15	7 minimum for survival 15–20 as soon as possible
people per tap-stand (1)	maximum 250	1 community, 80–100 persons (2) 200 per hand-pump/well
distance from dwellings to taps	maximum 500m	maximum 100m or a few minutes' walk
sanitation		
maximum people per latrine (UNHCR specifies in order of preference, 1–3	20 people (if sex-segregated public toilets)	(1) family (6–10 persons) (2) 20 persons (3) 100 persons (or a defecation field)

	Sphere Project (2004)	UNHCR (2000)
distance from dwelling to toilet (sited to pose minimum threats to users, esp. at nights)	maximum 50m or one-minute walk	6–50m
minimum distance between latrines and soak-aways and ground-water source [3]	30m	30m
distance from bottom of pit to water table[3]	minimum 1.5m	minimum 1.5m
refuse		
distance from dwellings to refuse disposal	< 15m to container or household pit; or < 100m to communal pit	
people per 100-litre refuse container	maximum 10 families	10 families or 50 persons
people per 2m x 5m x 2m communal refuse pit		500

Notes to above table

1 Sphere elaborates: people per 16.6 litres per minute (lpm) hand-pump = 500 max. people per 12.5 lpm well = 400 max. people sharing one washbasin = 100 max.

2 UNHCR definition of groupings within camps: family = 4–6 people community = 16 families = 80 people block = 16 communities = 1,250 people sector = 4 blocks = 5,000 people camp module = 4 sectors = 20,000 people

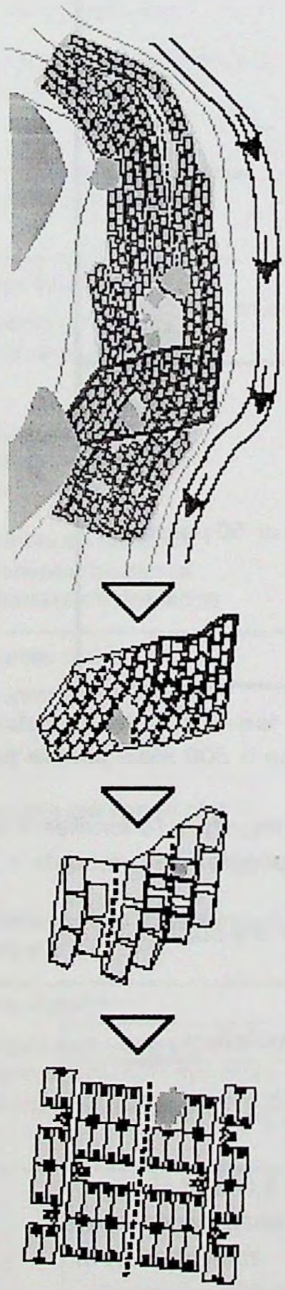
3 Distances may be increased for fissured rock/limestone, or reduced for fine soil.

Table: minimum provision of communal facilities

facilities required	per number of sites	estimated population
1 hospital	10	200,000
1 health centre	1.5	30,000 (1 bed per 2,000–5,000 refugees)
1 health post	(per sector)	approximately 5,000 or clinic (1 community health worker per 1,000 and 1 traditional birth attendant per 3,000 refugees)
4 commodity distribution sites	1	20,000
1 market	1	20,000
1 school	(per sector)	5,000

UNHCR 2000

Figure: **camp sub-divided into sectors, blocks, and communities**



camp: approximately 20,000 inhabitants
4 sectors

- fire breaks: 30m per built-up 300m
- roads follow contours and lead out from centre
- run-off water also follows contours
- features used to break repeating pattern
- administrative centre located at the centre of the camp.

sector: approximately 5,000 inhabitants
4 blocks

- fire breaks: 15m between blocks
- should contain central recreational/commercial spaces

block: approximately 1,250 inhabitants
16 communities

- fire breaks: 6m (pathways)

community: approximately 80 inhabitants
16 plots with 16 shelters

- fire breaks: 2m between dwellings
- drainage should be well planned and maintained
- drain water must not pollute existing surface water or groundwater, or cause erosion.

Source Document: transitional settlement: displaced populations, www.shelterproject.org

Terms:

Transitional settlement: settlement and shelter resulting from conflict and natural disasters, ranging from emergency response to durable solutions