Logistic Training Course

Hand Out

Water & Sanitation

LTC 1995

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This manual is only meant for internal MSF use. Most of the contents are compiled from material mentioned in the reference list.

MODULE WATER & SANITATION

1. INTRODUCTION

Water & Sanitation as part of environmental health engineering.

In the broadest context, water, sanitation and hygiene aim at the modification of the human environment in such a way as to reduce the risk of disease transmission and to promote individual and community health. Other relevant topics for environmental health are for example housing, drainage and irrigation schemes.

The improvement of community health is to a great extent dependant on the understanding and hence to the mastering of the infectious diseases. Most infectious diseases have been eliminated in the west but still continue to be the principal causes of poor health and death of many people in developing countries.

Diseases can be transmitted from one person to another or sometimes from or to an animal. They are caused by living organisms such as bacteria, viruses or parasitic worms.
Environmental health engineering is necessary to modify the human environment in such way as to prevent or reduce the transmission.

The realisation of a water and sanitation programme consists of two elements: the technical part and the educational part.

The aim of the technical part is to set up a system to provide enough and good drinking water with a reasonable distribution system and to set up a latrine construction programme and to look at technical solutions for garbage disposal and drainage.

The educational part is to get the population change their cultural behaviour in relation to hygiene. This means education in good hygiene practices, how to use water and to motivate people to use sanitation facilities. The last task is probably the most difficult but absolutely vital if the sanitation programme is to be succesful.

This Hand Out will give brief information on the different infectious diseases and how to change the environment to break the transmission cycle of these diseases.

2. CLASSIFICATION OF WATER AND SANITATION RELATED DISEASES

Classification of the infectious diseases in categories related to the various aspects of the environment:

2.1. Water related infections:

Classification of the transmission mechanism: ===> **Annex 1**

1. **Water-borne** mechanism occurs when pathogen in water are drunk by a person .
   Example: cholera, thypoid
   Note: Water-borne diseases can also be transmitted by any route permitting faeces to enter the mouth (via food!)

2. **Water-washed** mechanism: infections of the skin or the intestinal tract due to poor domestic or personal hygiene. Improvement depend greatly of availability of water and its use for personal hygiene.
   Quantity is more important than quality!
   Example: cholera, bacillary dysentery (faecal-oral), scabies, fungal infections, trachoma

3. **Water-based** disease: pathogen spends part of its life cycle in a snail or aquatic animal as an intermediate host, diseases are due to infection by parasitic worms (helminths).
   Example: schistosomiasis, guinea worm

4. **Insect vector** which breed in water or bite near water
   Example: malaria, yellow fiver, onchocerciasis (river blindness) and trypanosomiasis (transmission by tsetse fly)

2.2. Excreta related infections:

All diseases of the faecal-oral category plus most of the water-based diseases and several others not related to water are caused by pathogens in human excreta, normally faeces.

Excreta related and in the mean time water related diseases can be (partially) controlled by improvement in water supply, sanitation and hygiene. It is important to provide means of excreta disposal because, if this is not done, the accunulating excreta will soon become a health hazard. This means construction or improvement of toilets, choice of ways of transport, treatment, final disposal or re-use (compost).
Some of the pathogens are not infectious immediately after excretion, but first undergo a period of development in soil, cattle and/or pigs, or aquatic hosts. (persistence: characteristic of pathogen, how long it can survive in the environment)

Environmental classification of excreta-related infections ===> **Annex 2**

1. Faecal-oral (non-bacterial): Person to person, domestic hygiene

2. Faecal-oral (bacterial): Transmission by person to person but also by longer cycles i.e. contamination of food, crops, water with faeces

3. Soil transmitted helminths: Species of parasitic worms whose eggs are passed in faeces (development in moist soil). Eggs are not immediately infective. Personal hygiene has little effect on their transmission, but any kind of latrine which helps to avoid faecal contamination of the floor, yard or field will limit transmission.

4. Beef and tape worms: Those worms require a period in the body of an animal host before re-infecting man (insufficient cooking)

5. Water-based helminths: with exception of guinea worm all water-based diseases are caused by helminths passing in excreta into the body of e.g. snail. Re-infection of man through skin or from insufficient cooked fish etc.

6. Insect vectors:
   a. mosquitoes breeding in polluted water such as septic tanks transmitting filariasis.
   b. Flies and cockroaches near faeces, pathogens carried on or in their bodies

2.3. Housing related infections

Housing related infections occur mainly due to a lack of environmental hygiene where control of the insect vector plays a major role. The aim should be to make the local environment unfavourable for the development and survival of the vector. Combat is generally more effective if it is focused on immature forms of the vector.

Vectors that may pose significant health risks ===> **Annex 3**

Interactions between housing and health :

1. Location of a house relevant to vector borne diseases: malaria, sleeping sickness
2. House design and location with regard to domestic hygiene: faecal-oral and water washed infections
3. Influence of housing on airborne diseases: overcrowding, ventilation, air temperature, humidity f.e. respiratory infections
4. Presence of rats, insects and domestic animals in relation to housing.

3. WATER IN DEVELOPING COUNTRIES

The driving forces in the hydrological cycle are the sun's energy and the earth's gravity. Water from the atmosphere falls to the ground as rain, hail, snow or condensate. Part of it returns to the atmosphere as it evaporates from open water or via transpiration from plants.

Overview of earth's quantity of fresh and salt water ===> **Annex 4**
(source : World water balance and water resources of the earth, UNESCO, 1978)

The water cycle ===> **Annex 5**
(source : The worth of water, Intermediate Technology, 1991)

If we look at the chain of the water cycle rainwater is in most cases the purest water available and with proper catchment and storage good drinking water. Groundwater should be free from disease-causing organisms if taken from a depth of about 10 m. Water from a spring will have some slight contamination through the upper layer of the earth but is probably still good drinking water. Surface water is very likely to have been polluted.

It is of utmost importance to protect your water sources from any contamination and to keep them separated from sanitation facilities.

As water is being used and intercepted by people for drinking, cooking, washing, personal hygiene, food growing, industrial use, etc., water becomes polluted. The contamination can partly be cleansed by nature during the cycle (i.e. after percolation as part of the ground water flow).
Factors contributing to the non-degradable domestic, agricultural and industrial waste are:

- Overpopulation
- natural catastrophes such as droughts
- Industrialization
- Chemicals in agriculture , etc.

According to WHO figures 55% of urban population have house connections and about 20% access to public stand posts. Of the rural population only 25% have access to safe water! In total 62% of people in developing countries lack an adequate water supply.

3.1. Water needs

Under normal circumstances the amount of water used depend strongly on the climate and habits of the population. In Europe 160 liters/person/day is very common.
Typical domestic water usage ===> **Annex 6**

In situations where we have a high concentration of people like in refugee camps the need for good quality water in sufficient quantity is even greater as the risk for pollution and epidemics increases. Generally the quantity of water available has relatively more importance than its quality although quality should not be neglected.

Nevertheless, it may be assumed that ten litres per person per day is a minimum need while aiming to reach the following targets as soon as possible (UNHCR 1982):

Domestic consumption	: 15 - 20 liters/person/day
Collective feeding centers	: 20 - 30 litres/person/day
Hospitals	: 40 - 60 litres/person/day

If sufficient quantity of water is not available near the site moving the camp should be considered.

3.2. Water quality

Basic requirements for drinking water are :

- Free from pathogenic organisms
- containing no compounds that have an adverse effect on human health
- Low turbidity
- Not saline
- No offensive smell or taste
- No corrosion or staining

The most important parameter of drinking water quality is the bacteriological quality (presence of bacteria and viruses). Examination of bacteria which originates in large numbers from human and animal excreta: coliform or known as e-coli (escherichia-coli) and faecal streptococci.

When detected, e-coli is indicative of recent contamination and thus the possibility of the presence of pathogenic bacteria and viruses.

Bacteriological quality ===> **Annex 7**

The major danger is pollution of water by faecal matter.Everything possible should be done to prevent such pollution. Nevertheless, it is still preferable to have a lot of water of average quality than a little water of high quality.

3.3. Water treatment

Purpose of water treatment is to convert the "raw water" into drinking water for domestic use. Most important is the removal of pathogenic organisms and toxic substances such as heavy metals. But also suspended matters causing turbidity, iron and manganese imparting a bitter taste and carbon dioxide corroding concrete and metal parts.

Effectiveness of various treatment processes ===> **Annex 8**

Treatment processes suitable and appropriate for developing countries:

1. Aeration: removal unpleasant taste and odours
2. Sedimentation: reducing suspended matter and bacteria
3. Coagulation and flocculation: removal of finely dispersed suspended and colloidal particles (turbidity and colour) with aluminium and iron salts
4. Filtration: deliberate passage of polluted water through a porous medium:
   - Slow sand filter : v (velocity) = 0.1 - 0.3 m/h (meters/hour)
   - Rapid filtration : v = 4 - 15 m/h
   - ceramic filters (e.g. porcelain) with pore sizes between 0.3 μm and 50 μm. In case size is $<$ 1.5 μm all pathogens are removed with certainty beside cysts and worm eggs.
5. Chlorination: Disinfection of drinking water with chlorine (chlorine gas or sodium or calcium hypochlorite)

3.3.a. CHLORINATION :

Chlorination is probably one of the simplest and most effective methods of water treatment as long as the water is not too turbid. Turbid water needs pretreatment such as sedimentation or filtration.
Chlorination is effective against practically all pathogenic micro-organisms in water. The only way to be sure of this is to measure the "Free Residual Chlorine" (FRC) left in the water after chlorination. The principle is to add enough chlorine generating product to destroy most pathogenes contained in the water to leave a small fraction of chlorine available for dealing with any possible reintroduction of pathogenes. If the water is turbid suspended particles can protect micro-organisms although the free residual chlorine is satisfactory. Also the dosage of the same amount of water may vary over time with unexpected changes. Therefore it is important to measure the free residual chlorine frequently.

To determine how much chlorine product to add the chlorine demand is measured :

1. Prepare a 1% chlorine solution ===> **Annex 9a**
2. Take 3 or 4 plastic buckets of same volume (e.g. 20 l)
3. Fill the containers with some of the water to be treated
4. Add to each bucket a progressively greater dose of the 1% solution with a syringe :
   1st container : 1.0 ml
   2nd container : 1.5 ml
   3rd container : 2.0 ml
   4th container : 2.5 ml
5. Wait for 30 minutes (essential: this is the minimum contact time for chlorine to react)
6. Measure the free residual in each bucket with a pooltester (see monitoring chlorination)
7. Choose the sample which shows a free residual chlorine level between 0.2 and 0.5 mg/l (1 mg/l = 1ppm, part per million)
8. Extrapolate the 1% dose to the volume of water to be treated
9. Pour the solution into the reservoir, mix well (during filling) and wait for 30 minutes before measuring the FRC and than distributing

Concentrated chlorine products should be kept in a dry, shaded place, and guarded. When in contact with air chlorine produces a corrosive and toxic gas heavier than air. Keep the chlorine store ventilated at the bottom.
Metal consumes chlorine, so never prepare strong solutions in metal containers (unless they are enamelled or painted) and do not use metal spoons.

3.3.b. MONITORING CHLORINATION :

The simplest and surest way of monitoring the effectiveness of chlorination of drinking water is to measure Free Residual Chlorine (FRC). The presence of FRC in the water proves that enough chlorine has been added to oxidise most pathogenes plus leaving an excess of chlorine available to deal with possible recontamination. The measurement can be easily done with a "Pooltester" : ===> **Annex 9b**

1. Rinse the pooltester 3 times with the water to be tested
2. Fill the three compartments completely with water
3. Put one "Phenol Red" tablet in the left hand compartment (measure pH)
4. Put one "DPD1" tablet in the right hand compartment (measure FRC)
5. Replace the cover
6. Shake until the tablets are completely dissolved (about 20 secs)
7. Read the results in the light, comparing the colours in the outside compartments (samples) with those in the central compartment (reference)

Never touch the tablets with the fingers: this could affect the result.
Read the results within 60 seconds of the tablets dissolving to be sure of a reliable measurement and read in good light.
The pH need not be measured every time, but need to be known to adjust chlorination in case the pH is above 8. The effectiveness of chlorination is than less and the FRC level should be doubled at this stage.

Comments on the pH of water :

$pH = 7$: neutral
$pH < 7$: acidic
$pH > 7$: alkaline (basic)

The decomposition of chlorine in water :

Total residual chlorine = Free residual + combined residual chlorine

Free residual chlorine (FRC) is measured with DPD1
Combined residual chlorine (CRS) is measured with DPD3

4. SANITATION

4.1. Sanitation and health:

Sanitation includes the disposal of all organic waste produced by a community such as:

Excreta disposal (urine and faeces)
Refuse disposal (solid waste)
Sullage disposal (waste water)

Hygienic disposal of human excreta is of utmost importance to health and also one of the most effective measures to control infectious diseases. It is however extremely difficult to achieve changes in excreta disposal practices. Social and cultural aspects should be taken into account. Therefore the realisation of a sanitation programme is not only technical but more an educational issue especially for women and children who are most at risk. In fact total community involvement should be aimed at : planning, construction, operating and maintenance.

One should be aware of the fact that any uncontrolled disposal can lead to health hazards, e.g. breeding of insect vector, spread of pathogenic agents, chem. contamination of ground water, bad smell.

4.2. Excreta disposal

Technical realizations for emergency excreta disposal are limited and simple. However if they are to work they must be well constructed and managed and most importantly must be supported and understood by the community.

Immediate measures on arrival :

1. Consult with all interested parties including (refugee) representatives, aid agencies, government officials. Hire a **good** translator.
2. Survey the site to gather information on existing facilities, site layout, population clusters, topography, ground conditions and available construction materials.
3. Prevent defecation in areas that are likely to affect the food chain or water supplies.
4. Select areas where defecation could be safely allowed (defecation fields).

4.2.a. DEFECATION AREAS OR SHITTING FIELDS

A short term solution for containing excreta in areas where it cannot contaminate the food chain and limits the risk of cross contamination.

Although simple in concept, they are difficult to manage since they must be constantly policed and monitored and will only work with the full support of the refugees. Such latrines can be open fields but are better if subdivided and trenched. ===> **Annex 10a**

4.2.b. TRENCH LATRINES - PUBLIC LATRINES

Trench latrines are a simple and quick way of disposing safely of excreta provided they are properly build and maintained. They should be located away from habitation but not so far that people are unwilling to walk to them. Put them downhill of water sources at least 30 m and protect from surface water intrusion (earth walls, roof).

The objective should be to replace the trench latrines as quickly as possible with a more hygienic system (e.g. single pit or ventilated pit latrines).

Some measurements for :

Shallow trench latrine ===> **Annex 10b/c**
- Wide : 30 cm
- Deep : 90 - 150 cm
- Long : 3.5 meters (ca. for 100 persons)

Deep trench latrine ===> **Annex 10d/e**
- Wide : 75 - 90 cm
- Deep : 1.8 - 2.5 m (or more)
- Long : 3.5 meters (ca. for 100 persons)

The top 50 cm of the trench should be covered in plastic to help support the soil (or other reinforcement if necessary) and ease of cleaning. Fencing with local materials is needed for privacy. A (plastic) roof might be necessary during rainy seasons. For cleaning latrines disinfectants should not be poured into the trench. Use soils, ashes, chalk (or diesel oil) to control insect breeding and to reduce odour.

Trenches should be closed (covered with earth) when nearly full, ca. 50 cm from the surface. The soil should not be used for approximately 2 years.

4.2.c. PIT LATRINES - FAMILY LATRINES

Where space allows individual family latrines are preferable. In many cases the families can be provided with basic materials and allowed to construct their own latrines. Families should also be encouraged to keep their latrines clean and to construct new ones before the old ones become full.

The single pit sealed lid is the simplest and mostly used. Other possibilities are borehole latrines and for longer term solutions the ventilated improved pit (VIP) latrine, twin VIP latrine, pour flush etc.
(source: The Worth of Water, Intermediate Technology, 1991) ===> **Annex 11a**

The VIP latrine has proved to be suitable in many situations and should always be considered

as an option for long term depending on the budget.
(source: The Worth of Water, Intermediate Technology, 1991) ===> **Annex 11b**

Choose a site **downhill** from ground water abstraction points and at least **30 m** away; the latrine (or group of latrines) should be not less than 5 m and not more than 50 m from the dwellings.

Some measurements for pit latrines :

Wide : 1.0 - 1.5 m across (circle is best)
Deep : 2.0 - 2.5 m (or more)
Raise rim about 15 cm
Dig cut-off ditches of 30 cm wide (drainage)
Reinforce sides for about 1.0 m (if necessary)
solids accumulation rate is 0,04 m3 per year (25 persons : 1 m3/year), in refugee camps this might be two or three times higher

For cleaning latrines disinfectants should not be poured into the pit. Use soils, ashes, chalk (or diesel oil) to control insect breeding and to reduce odour.

Pits should be closed (covered with earth) when nearly full, ca. 50 cm from the surface. The soil should not be used for approximately 2 years.

4.3. Refuse disposal

The accumulation of household waste creates a public health risk as well as a pollution problem. The health risks are essentially to do with the encouragement of insect vectors and rodents :

1. The breeding of flies which play a major part in the transmission of faeco-oral diseases;
2. Mosquitos of the Aedes genus which lay eggs in water lying in empty tins, drums, tires, etc., and which are responsible for the transmission of dengue, yellow fevers and other arbiviruses;
3. Mosquitos of the Culex genus which breed in stagnant water heavily loaded with organic matter, and which are liable to transmit micro filariases;
4. Rodents which are directly or indirectly responsible for the transmission of various diseases such as plague, leptospirosis and salmonella, and whose presence attracts snakes.

In addition to these health risks, poor management of the collection and disposal of refuse may involve the pollution of surface water or ground water and increase the risk of fire. Lastly, the aesthetic aspects (sight and smell) are far from negligible.

These risks and nuisances are all the more serious at high population densities. Certain types of refuse (from medical activities) represent a particular risk and so need special attention.

Some disposal techniques are shown :

Garbage disposal (self-made dustbin) ===> **Annex 12a**
Disposal of waste in a refuse pit ===> **Annex 12b**
Disposal of medical waste ===> **Annex 12c**
Temporary incinerator (self-made) ===> **Annex 13**

(source: Public Health Technician, MSF, 1994)

4.4. Sullage disposal

Health risks are due to organic and biological pollution carried by waste water as well as the presence of stagnant water :

1. Breeding of insect vectors (anopheles, culex);
2. spread and multiplication of pathogenic agents such as cholera vibrio and schistosomonas, etc.;
3. chemical contamination of water (nitrates, detergents) and ecological disturbance of aquatic environments;
4. production of noxious and corrosive gases.

For every place supplied with water there should be a removal system which prevents stagnant water and local pollution. In practice such places are :

- stagnant water around a water point : well, tap, etc.,
- washing areas : bathing, cooking, laundry, etc.
- laboratory and health centre wastes, etc.

A removal system should be able to remove waste water, so as to avoid stagnant water, and to channel it to the disposal or treatment site without contaminating the local environment.

Some removal systems are listed here :

- Open channel : this is the most simple and least costly drainage system but entails maintenance problems (e.g. blockages,stagnant water, damage to the sides, etc.). Only used for rain water or waste water over short distances,
- Gravel drain : the open drain may be improved by lining it with plastic sheeting, filling it with coarse gravel, covering it with more plastic sheeting and then with earth. Useful in emergencies at a dispensary, laboratory or feeding center.
- Pipe drain : most effective of removing waste water but also most costly.

Treatment of waste water by infiltration uses the natural capacity of the soil to fix particles present in water by filtration, and to purify the water by a process of biological decomposition capable of destroying micro-organisms and chemical pollution.

Some simple infiltration systems :

- Soakaway pit : allows the disposal of waste water from a water point, kitchen, shower etc. by infiltration into permeable soil. ===> **Annex 14**
  (source: Public Health Technician, MSF, 1994)

- Infiltration trench : dispersal systems using simple or multiple trenches are an alternative to soakaway pits for less permeable soils, where there are large quantities of effluent, in a case of high water table or where there are rocky layers near the surface.

4.5. Disposal of the Dead

The main considerations in the disposal of the dead are social and cultural. Great sensitivity to the cultural practices of the community will prevent unnecessary conflicts. Other considerations will include the following :

1. The nature or cause of death
2. The water table at the burial site and the location of ground water sources in relation to burial ground
3. Distance from camp; burial ground should be at least 800 m away from any dwellings
4. If disposal is by incineration, the siting of the incinerator is very important to avoid nuisances from smoke and smell

4.5.a. BURIAL

1. The grave must be a minimum of 2 m deep to avoid bodies or coffins being dug up by wild animals or floods
2. The bottom of the grave should be at least 1.5 m above the water table and if possible on elevated ground
3. Wells and other ground water sources should be situated up the flow of ground water to prevent ground water pollution
4. Persons dying of infectious diseases like cholera should be buried as soon as possible (within hours of death) and clothes be burned. Families should be sympathetically but firmly informed of this and burial be done quickly by officials
5. Bodies of persons dying of cholera should be washed in a 2% chlorine solution, all orifices be sealed with cotton wool soaked in the same solution, the body placed in a plastic bag and buried

4.5.b. CREMATION

1. Cremation should be done in accordance with the deceased person's beliefs and culture
2. The remains of the deceased should be handed to the family
3. Cremation should be done without giving rise to nuisance
4. The siting of cremation should take into account the normal wind direction

4.6. Hygiene education

Water supply and sanitation programmes generally focus on prevention of diseases and promotion of environmental health. Beside provision of improved water and sanitation facilities, additional changes in hygiene conditions and behaviour are required. Hygiene education is therefore needed.

Hygiene education is aimed at changing attitudes and is part of a wider concept of health education. It must establish links between water and sanitation facilities and its usage. Great attention should be given to health education then even if adequate sanitation facilities are available (or under construction) people might not know how to use and maintain them. This might result in having highly contaminated sites which can cause big health hazards. Thus total population involvement is required especially women and children as they are most at risk from poor sanitation and hygiene. Hygiene education that focuses on one group only is bound to fail.
Further information on health education is given in reference No.3.

5. EMERGENCY WATER AND SANITATION GUIDELINES

UNHCR criteria ===> **Annex 15**
(source: Handbook for Emergencies, UNHCR, 1982)

General considerations for water ===> **Annex 16**
(sorce: Water Manual for Refugee Situations, UNHCR, 1992)

Sanitation specifications ===> **Annex 17**
(source: The Worth of Water, Intermediate Technology Publications, 1991)

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9. Environmental Health Engineering in the Tropics, Cairncross and Feachem, 1993

10. Sanitation Without Water, Winblad & Kilama, 1993

11. Public Health Technician, MSF (english), 1994

12. Water & Sanitation in Emergencies, Overseas Development Institute, 1994

Comment : Reference number 11 (english version) or number 8 (french version) is a must for a MSF sanitarian. Reference number 12 is very useful for anyone working on Water & Sanitation in a refugee situation.

THE FOUR MECHANISMS

OF

WATER RELATED INFECTION

TRANSMISSION AND THE PREVENTIVE STRATEGIES APPROPRIATE TO EACH MECHANISM

TRANSMISSION MECHANISM	PREVENTIVE STRATEGY
WATER-BORNE	Improve **quality** of drinking water Prevent casual use of unimproved sources
WATER-WASHED	Increase water **quantity** used Improve accessibility and reliability of domestic water supply Improve **hygiene**
WATER-BASED	Decrease need for **contact** with infected water(*) Control snail populations (*) Reduce contamination of surface waters by excreta
WATER-RELATED INSECT VECTOR	Improve surface water management Destroy breeding sites of insects Decrease need to visit breeding sites Use mosquito netting

(*) applies to schistosomiasis only

ENVIRONMENTAL CLASSIFICATION OF EXCRETA-RELATED INFECTIONS

CATEGORY	INFECTION	PATHOGENIC AGENT	DOMINANT TRANSMISSION MECHANISMS	MAJOR CONTROL MEASURES (ENGINEERING MEASURES IN ITALICS)
I Faecal-Oral (non-bacterial) Non-latent, low infectious dose	Poliomyelitis Hepatitis A Rotavirus diarrhoea Amoebic dysentery Giardiasis Balantidiasis Enterobiasis Hymenolepiasis	Virus Virus Virus Protozoon Protozoon Protozoon Helminth Helminth	Person to person contact Domestic contamination	*Domestic water supply* *Improved housing* *Provision of toilets* **Health education**
II Faecal-oral (bacterial) Non-latent, medium or high infectious dose, moderately persistent and able to multiply	Diarrhoeas and dysenteries Campylobacter enteritis Cholera E.coli diarrhoea Salmonellosis Shigellosis Yersiniosis Enteric fevers Typhoid Paratyphoid	 Bacterium Bacterium Bacterium Bacterium Bacterium Bacterium Bacterium Bacterium	Person to person contact Domestic contamination Water contamination Crop contamination	*Domestic water supply* *Improved housing* *Provision of toilets* *Excreta treatment prior to re-use or discharge* **Health education**

III Soil-transmitted helminths Latent and persistent with no intermediate host	Ascariasis Trichuriasis Hookworm Strongyloidiasis	Helminth Helminth Helminth Helminth	Yard contamintion Ground contamination in communal defaecation area Crop contmination	*Provision of toilets with clean floors* *Excreta treatment prior to land application*
IV Beef and pork tapeworms Latent and persistent with cow or pig intermediate host	Taeniasis	Helminth	Yard contamination Field contamination Fodder contamination	*Provision of toilets* *Excreta treatment prior to land application* Cooking and meat inspection
V Water-based helminths Latent and persistent with aquatic intermediate host(s)	Schistosomiasis Clonorchiasis Diphyllobothriasis Fasciolopsiasis Paragonimiasis	Helminth Helminth Helminth Helminth Helminth	Water contamination	*Provision of toilets* *Excreta treatment prior to discharge* *Control of animals harbouring infection*
VI Excreta-related insect vectors	Filariasis (transmitted by Culex pipiens mosquitoes) Infections in Categories I-V, especially I and II, which may be transmitted by flies and cockroaches	Helminth Miscel-laneous	Insects breed in various faecally contaminated sites	*Identification and elimination of potential breeding sites* Use of mosquito netting

POTENTIAL FOR CONTROL OF EXCRETA-RELATED INFECTIONS BY IMPROVEMENTS IN SANITATION AND PERSONAL HYGIENE

DISEASE CATEGORY	IMPACT OF SANITATION ALONE	IMPACT OF PERSONAL HYGIENE ALONE
I Non-bacterial faecal-oral	Negligible	Moderate
II Bacterial faecal-oral	Slight to moderate	Moderate
III Soil-transmitted helminths	Great	Negligible
IV Beef and pork tapeworms	Great	Negligible
V Insect vector	Moderate	Negligible
VI Water-based helminths	Slight to moderate	Negligible

VECTORS THAT MAY POSE SIGNIFICANT HEALTH RISKS

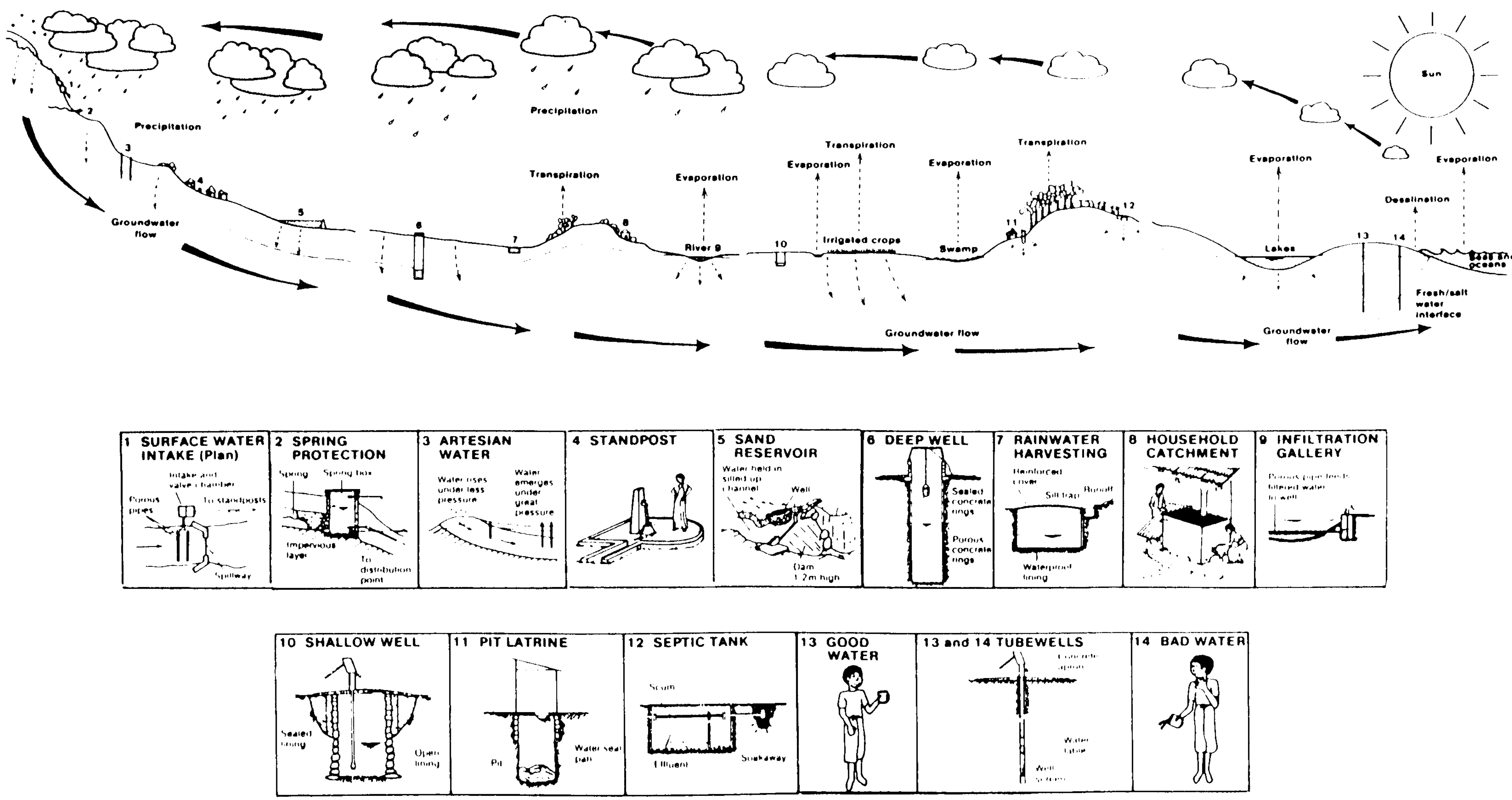
VECTOR	HEALTH RISKS	FAVOURABLE ENVIRONMENT
FLIES	Eye infections (particularly among infants and children) Diarrhoeal diseases Dysentry	Exposed food Excreta Garbage Dead animals
MOSQUITOS	Malaria Filariasis Encephalitis	Stagnant water especially in the periphery of inundated areas; Pools and slow moving water
	Yellow fever Dengue	Stored water in or around dwellings; Accumulations of rain water in old tins and other containers
COCKOACHES	Diarrhoea Dysentry salmonellosis	Excreta Filth in general
MITES	Scabies Scrub typhus	Overcrowding Poor personal hygiene
LICE	Epidemic typhus Relapsing fever	Idemdito
FLEAS	Plague (from infected rats) Endemic typhus	Idemdito
TICKS	Relapsing fever spotted fever	Idemdito
BED BUGS	Severe skin inflammation (children)	Idemdito
RODENTS	Rat bite fever Leptospirosis Salmonellosis	Inadequately protected food Exposed garbage Covered spaces

OVERVIEW OF QUANTITY OF FRESH AND SALT WATER

IDENTIFICATION	LOCATION	PER CENT (%)				CUBIC km
TOTAL WORLD WATER		100				1.386.000.000
SALT WATER		97.5				1.350.000.000
FRESH WATER		2.5				35.000.000
Comprising	Polar ice caps		68.7			24.100.000
	Groundwater		30.0			10.500.000
	(econom. extractable)			40.0		
	Lies up to 50m deep				75.0	
	Lies over 50m deep				25.0	
	Lakes		0.26			176.000
	Rivers & Marshes		0.03			12.000
	Soil moisture		0.05			17.000
	Atmosphere		0.04			13.000
RAINFALL	On land				20.0	109.000
	Over sea				80.0	458.000
EVAPORATION	From land				12.5	72.000
	From sea				87.5	505.000
RIVER RUN-OFF						45.000

Twenty per cent of water used is ground water
Eighty per cent of water used is surface water
Eighty per cent of water used is employed in agriculture

THE WATER CYCLE



TYPICAL DOMESTIC WATER USAGE

TYPE OF WATER SUPPLY	TYPICAL WATER CONSUMPTION (litres/capita/day)	RANGE (litres/capita/day)
COMMUNAL WATER POINT (e.g. village well,public standposts)		
- at considerable distance, > 1000m	7	5 - 10
- at medium distance, 500 - 1000m	12	10 - 15
VILLAGE WELL		
walking distance < 250m	20	15 - 25
COMMUNAL STANDPIPE		
walking distance < 250 m	30	20 - 50
YARD CONNECTION		
(tap placed in house-yard)	40	20 - 80
HOUSE CONNECTION		
- single tap	50	30 - 60
- multiple tap	150	70 - 250

BACTERIOLOGICAL QUALITY

FAECAL COLIFORMS/100ml	QUALITY
0 - 10	REASONABLE QUALITY drinkable as such
10 - 100	POLLUTED drinkable as such, but treatment recommended
100 - 1000	VERY POLLUTED not drinkable without treatment
Over 1000	GROSSLY POLLUTED not drinkable without heavy treatment

THE PH OF DRINKING WATER SHOULD LIE BETWEEN 7.0 - 8.5
THE ACCEPTABLE LIMITS ARE 6.5 - 9.2

EFFECTIVENESS OF VARIOUS TREATMENT PROCESSES

WATER QUALITY PARAMETER	TREATMENT PROCESS					
	AERATION	CHEMICAL COAGULATION AND FLOC	SEDIMENTATION	RAPID FILTRATION	SLOW SAND FILTRATION	CHLORINATION
DISSOLVED OXYGEN CONTENT	+	o	o	-	--	+
CARBON DIOXIDE REMOVAL	-	o	o	+	++	+
TURBIDITY REDUCTION	o	+++	+	+++	++++	o
COLOUR REDUCTION	o	++	+	+	++	++
TASTE AND ODOUR REMOVAL	++	+	+	++	++	+
BACTERIAL REMOVAL	o	+	++	++	++++	++++
IRON/MANGANESE REMOVAL	++	+	+	++++	++++	o
ORGANIC MATTER REMOVAL	+	+	++	+++	++++	+++

+ = increasing positive effect
- = increasing negative effect
o = no effect

WATER TREATMENT PROCESSES

	EFFICIENCY AGAINST			NECESSARY EQUIPMENT	MAINTE-NANCE	APPLICATIONS	REMARKS
	CYSTS EGGS	BAC-TERIA	VI-RUSES				
STORAGE SEDIMENTATION	++	+	o/+	Tank with outlet for evacuation of dirt. Pump	+	1.Treatment of slightly polluted water 2.Preparation of turbid water for filtration / chlorination	
SIMPLE SAND FILTRATION (mechanical purification)	+++	o/+	o	For small filters: Sand, gravel Drums	+	1.Preparation of turbid water for chlorination	
SLOW SAND FILTRATION (microbiological)	+++	++	o	Sand, gravel Receptacles: Drums for small filters, Prefabricated or hand made for large filters	++	1.Treatment of moderately polluted water 2.Preparation of very polluted water for chlorination	Not suitable for water too turbid or chlorinated water
CHLORINATION	0	+++	+	Product generating chlorine Receptacles: for continuous chlorination: pot or drip chlorinator	+++	1.Treatment of clear water 2.Complement to sedimen-tation/filtration of very turbid or polluted water	Must be preceded by sedimentation and/or filtration if water is turbid

PREPARATION OF CHLORINE SOLUTION

Starting with a product of n% active chlorine : a 1% solution of chlorine contains 10 grams of chlorine per litre, so it needs 10*(100/n) grams of product per litre of solution. Example: High Test Hypochlorite at 70% active chlorine: 10*(100/70) = 15 g/l of solution.

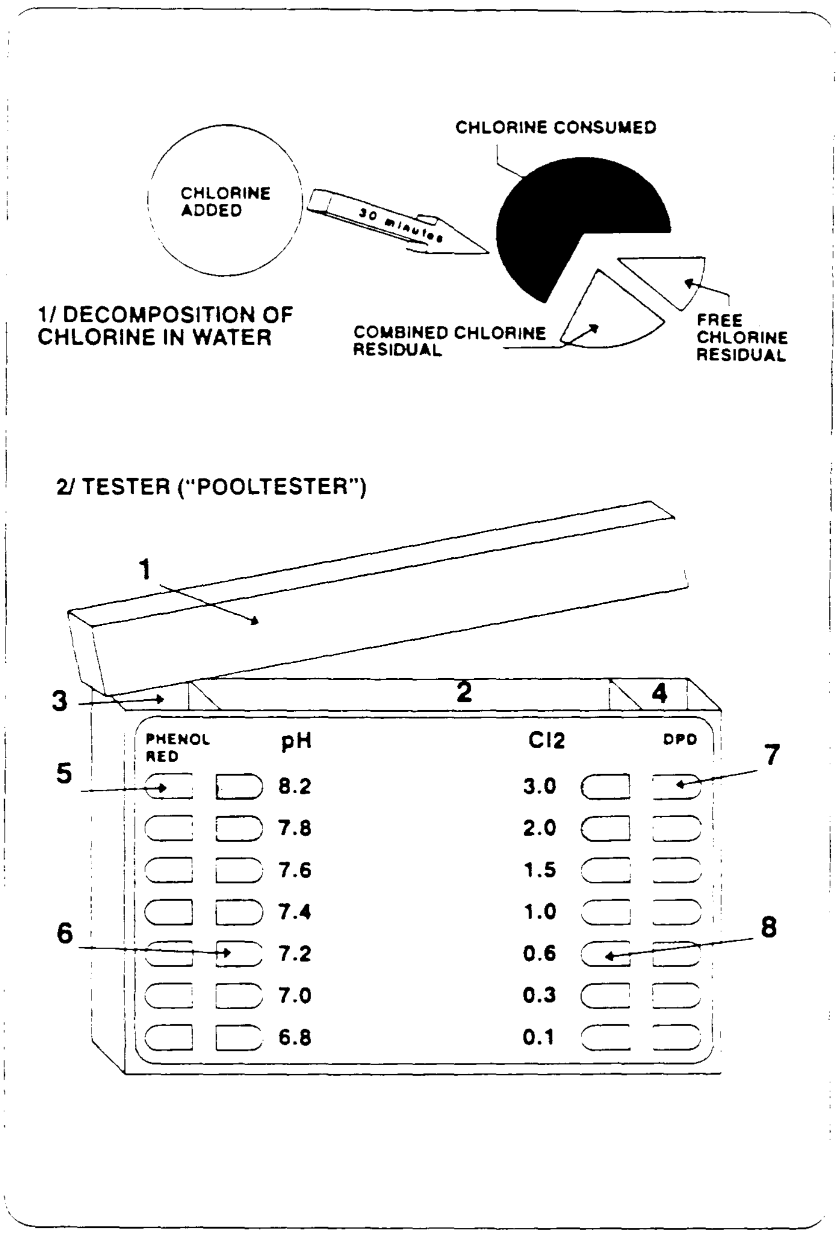
PRODUCT AT n% CHLORINE		QUANTITY REQUIRED		
CHEMICAL SOURCE	% AVAILABLE CHLORINE	10 litres of 0.02% solution	1 litre of 1% solution	REMARKS
BLEACHING POWDER	35	6 g	30 g	Let the deposit settle and use supernatant
STABILIZED / TROPICAL BLEACH	25	8 g	40 g	
HIGH TEST HYPOCHLORITE	70	3 g	14 g	
LIQUID LAUNDRY BLEACH	5	40 ml	200 ml	Expires rapidly: use within three months
LIQUID LAUNDRY BLEACH	7	30 ml	145 ml	
JAVELE WATER	1	200 ml	1 l (=1%)	
HADEX	5	40 ml	200 ml	

Keep the solution in an airtight, opaque, non-metallic receptacle protected from light and heat, and renew every 1 or 2 weeks depending on the temperature (high temperature: more often).

Avoid skin contact with any of the chemical sources or the stock solution, Avoid inhaling chlorine fumes.

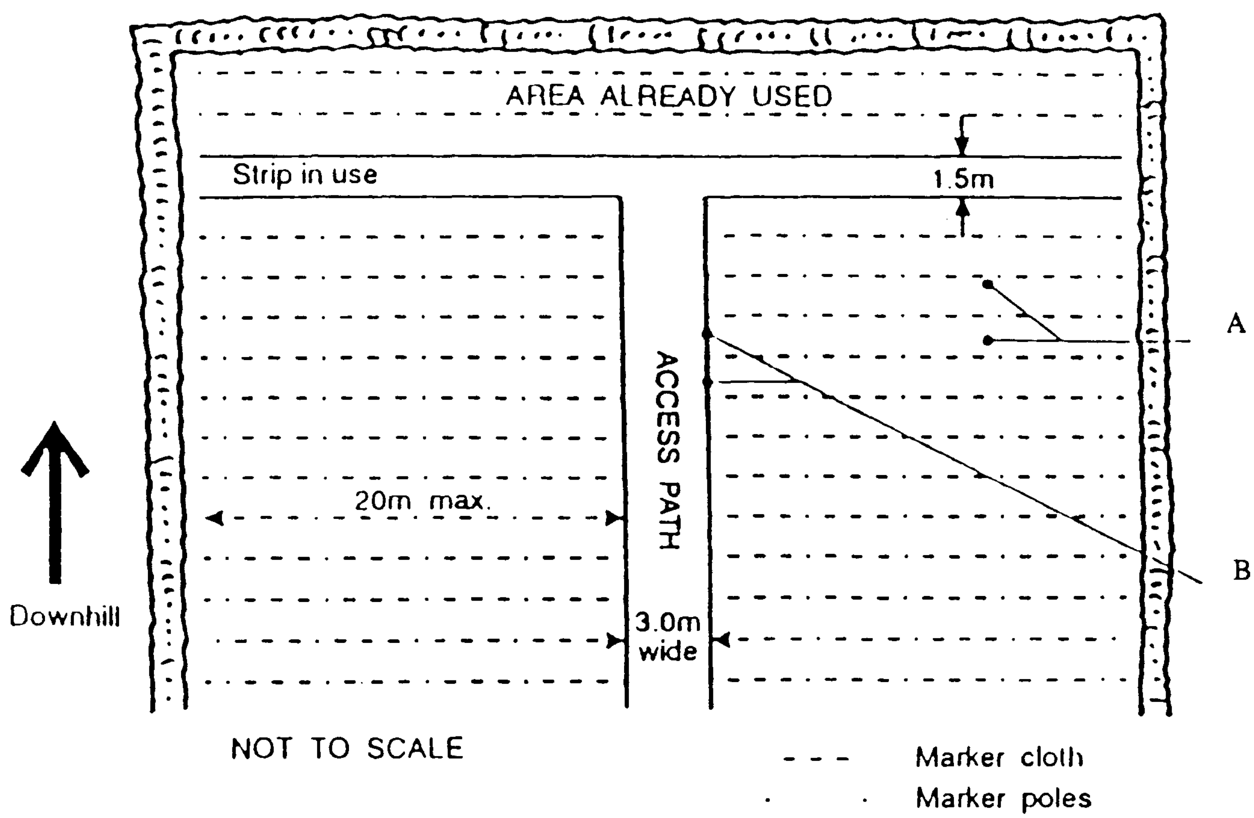
One level soupspoon of powder is about 15 grams
One level teaspoon of powder is about 3 grams

MONITORING CHLORINATION



1. Cover
2. Central compartment
3. pH compartment (phenol red tablet)
4. FRC compartment (DPD1 tablet)
5. pH reading scale
6. pH reference scale
7. FRC reading scale
8. FRC reference scale

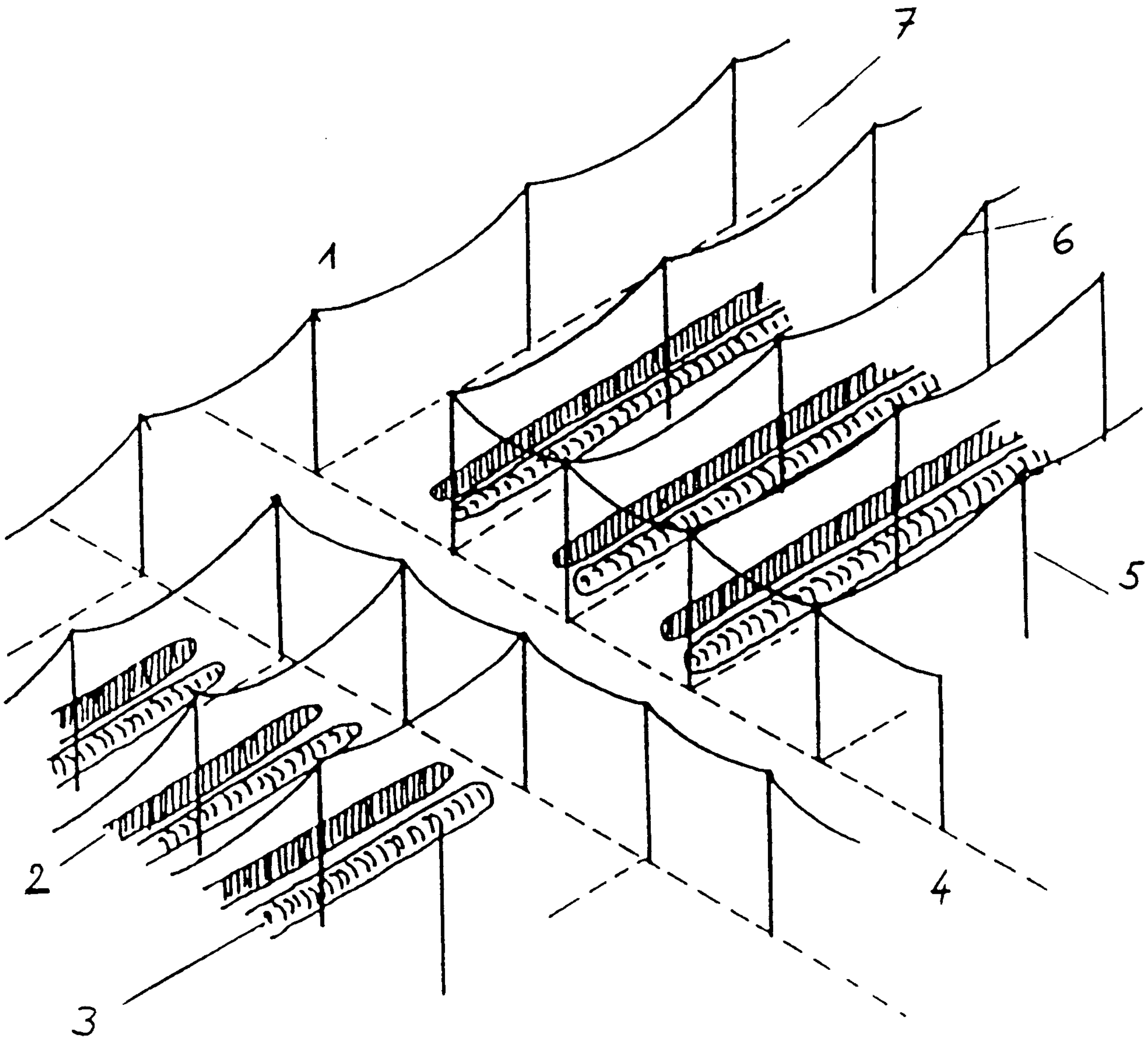
DEFECATION AREAS



A. Strips marked out ready for use

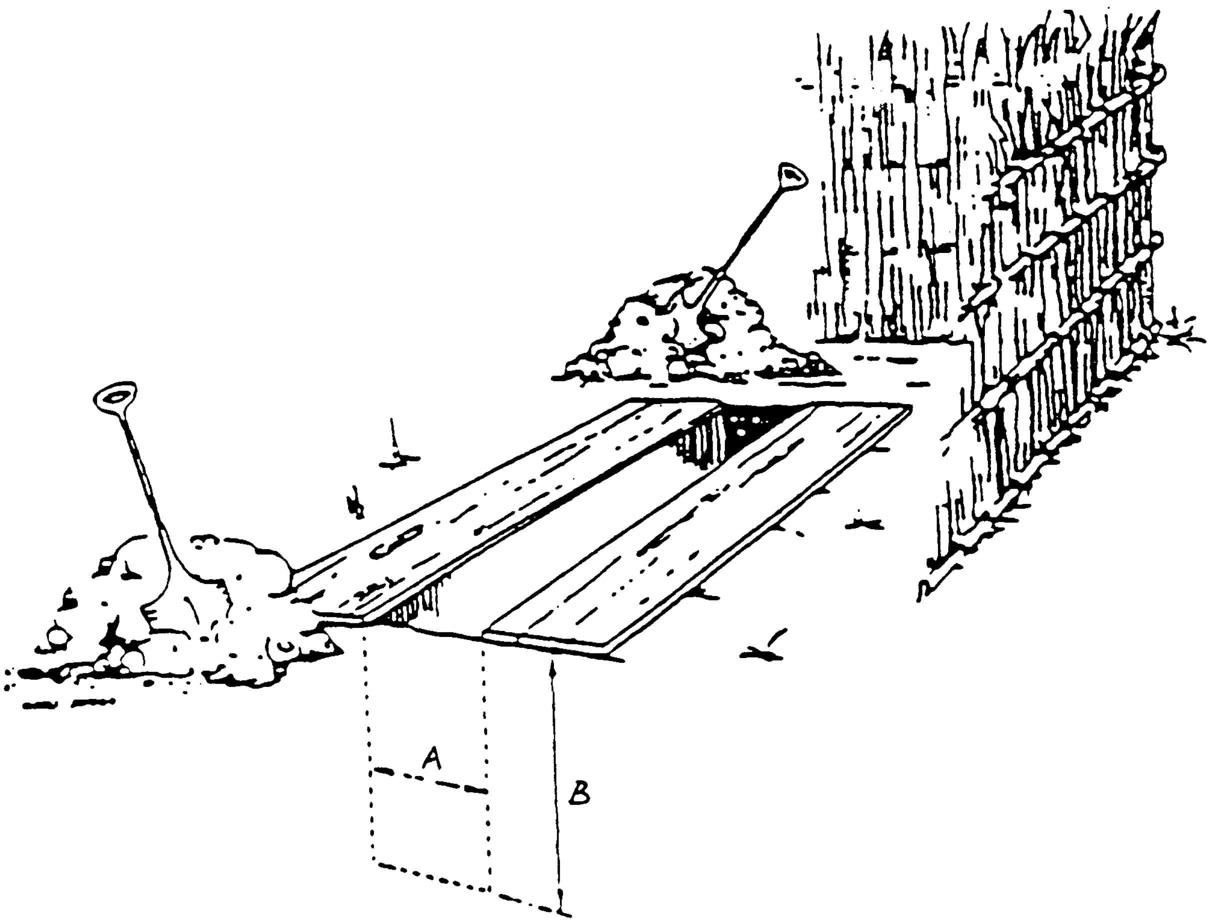
B. Access to unused strips blocked off

SHALLOW TRENCH



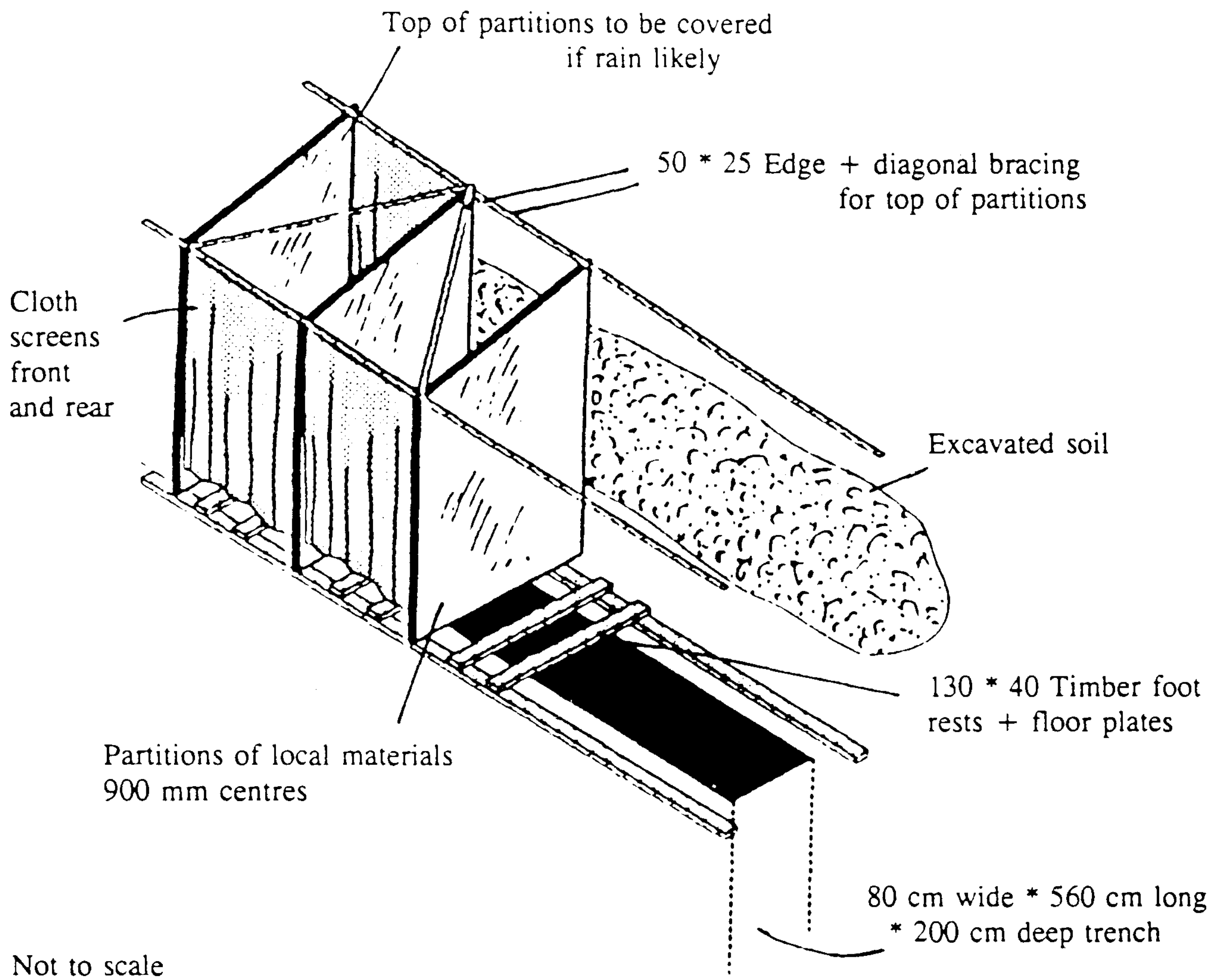
1. Used area
2. Trench
3. Soil mound
4. Access path
5. Marker poles
6. Marker tape
7. Strip in use

SHALLOW TRENCH



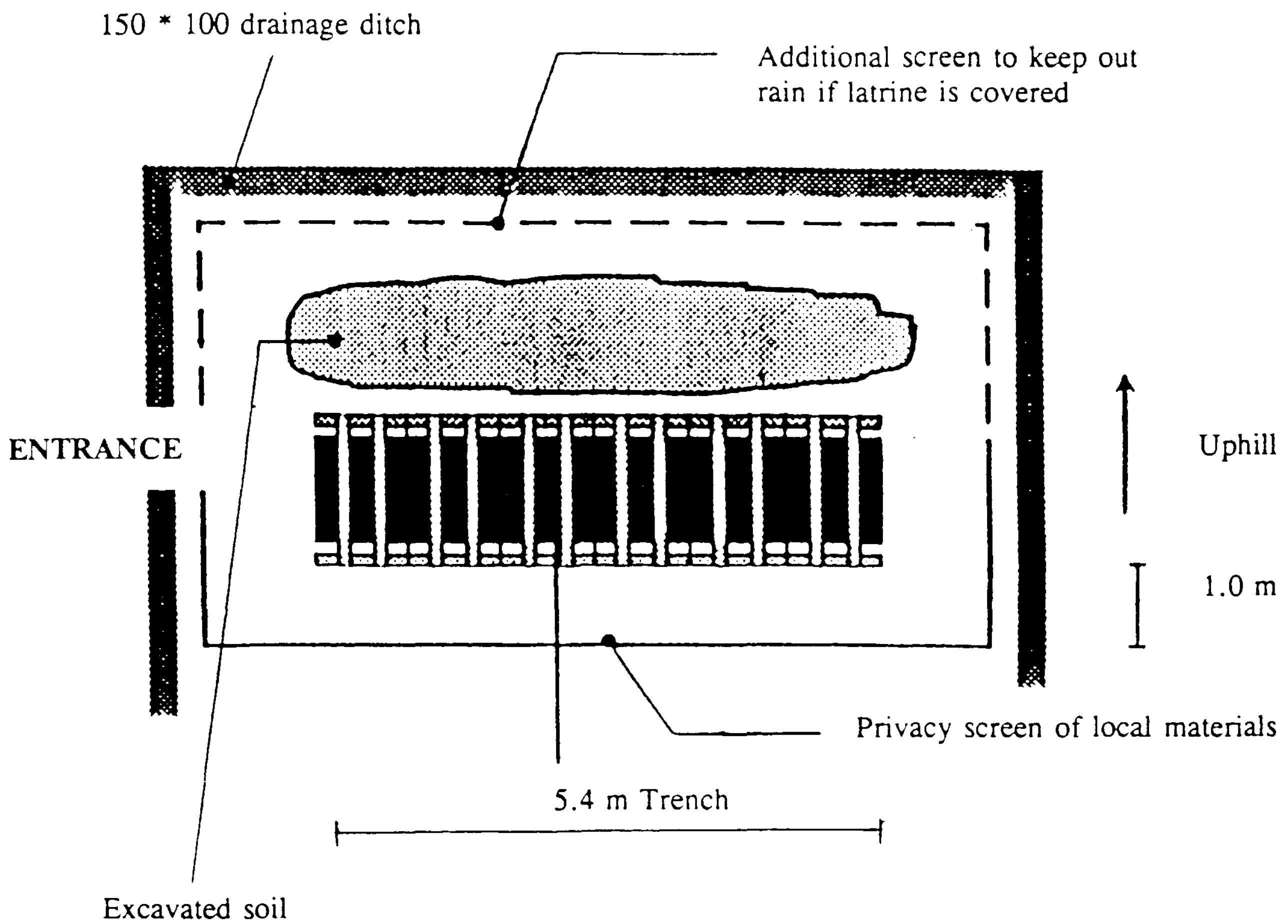
A. Width = 30 cm
B. Depth = 90 - 150 cm

DEEP TRENCH



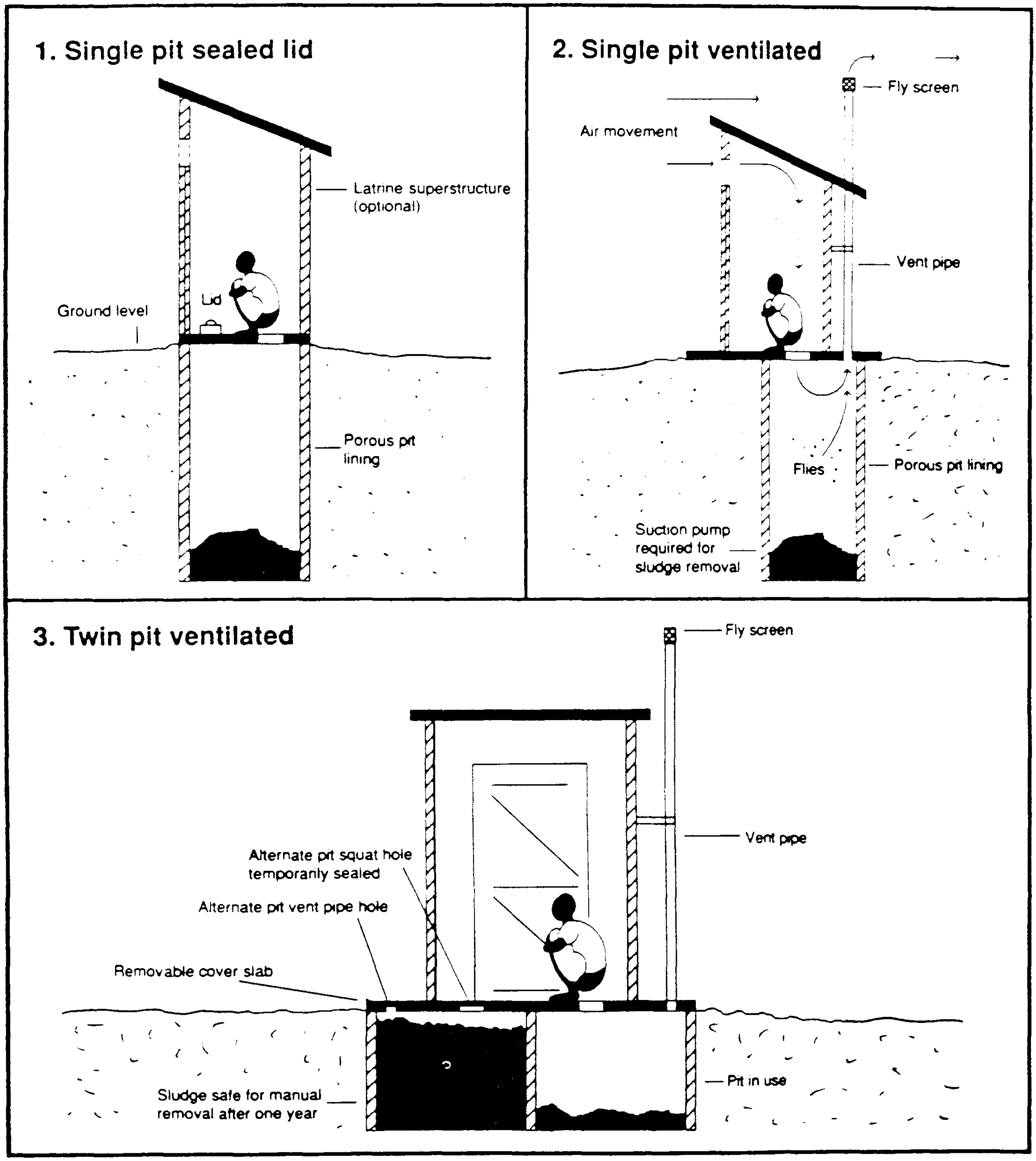
Partially constructed deep trench latrine superstructure

DEEP TRENCH



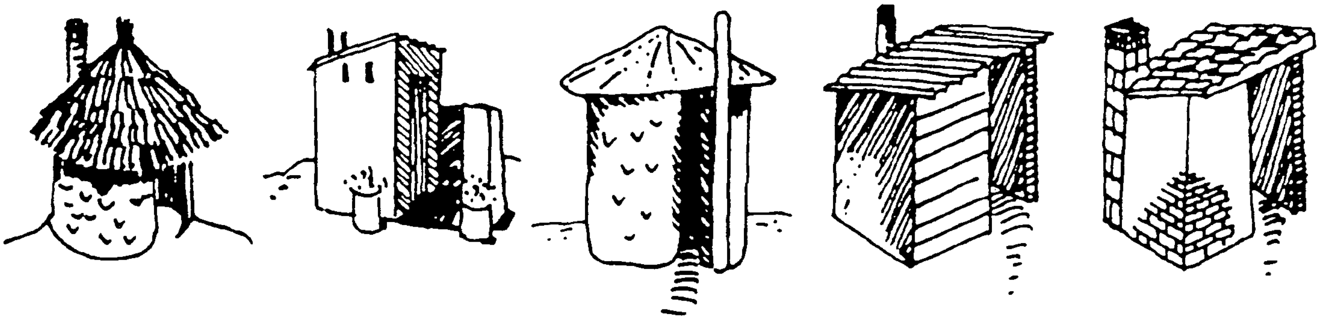
SCHEMATIC TOP VIEW OF DEEP TRENCH LATRINE

INTRODUCTION TO PIT LATRINES



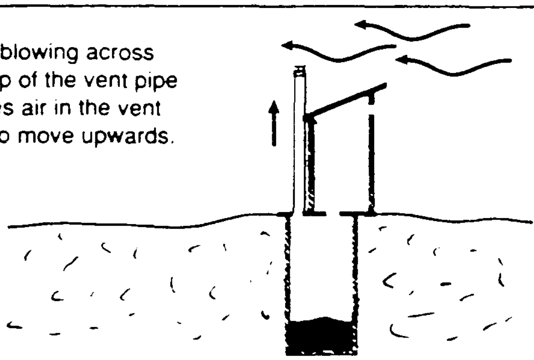
VARIETIES OF VIP LATRINE CONSTRUCTION

VIP latrines take various forms:

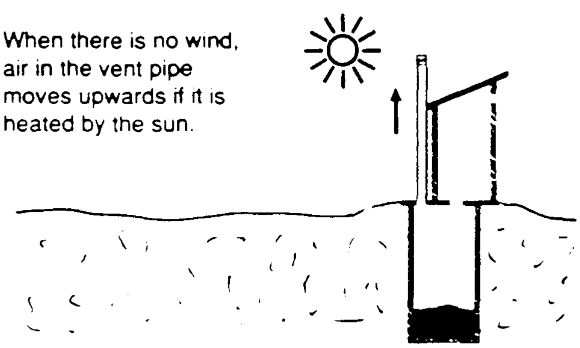


Ventilation is provided in VIP's by a vent pipe with flyproof netting at the top.

Wind blowing across the top of the vent pipe causes air in the vent pipe to move upwards.

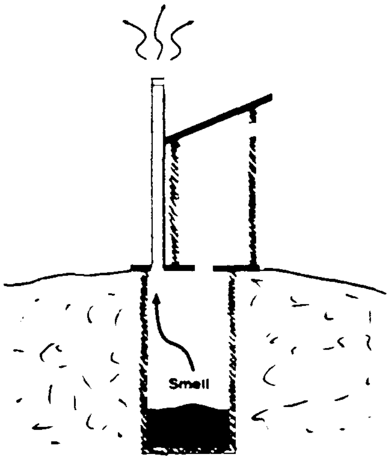


When there is no wind, air in the vent pipe moves upwards if it is heated by the sun.

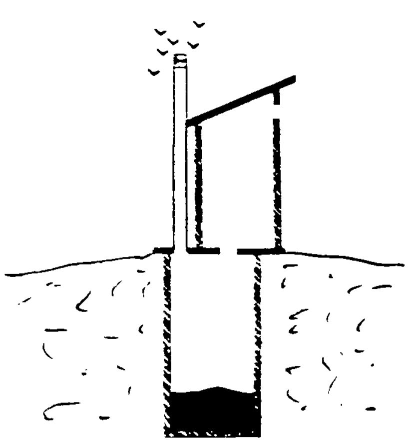


The upward movement of air in the vent pipe reduces nuisance from smells and insects.

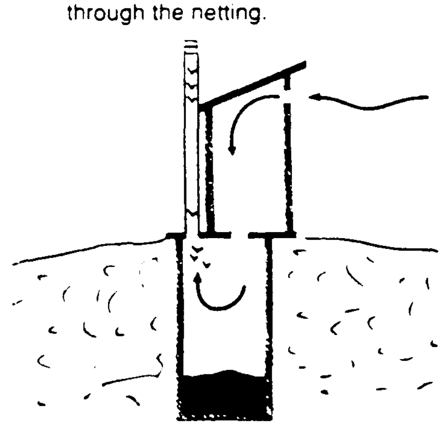
Smells from the pit are carried up the pipe and escape from the top.



Flies from outside are attracted to the pipe by the smell, but cannot get in through the netting.



Flies hatching in the pit are attracted by light at the top of the vent and fly upward, assisted by air movement, but cannot get out through the netting.



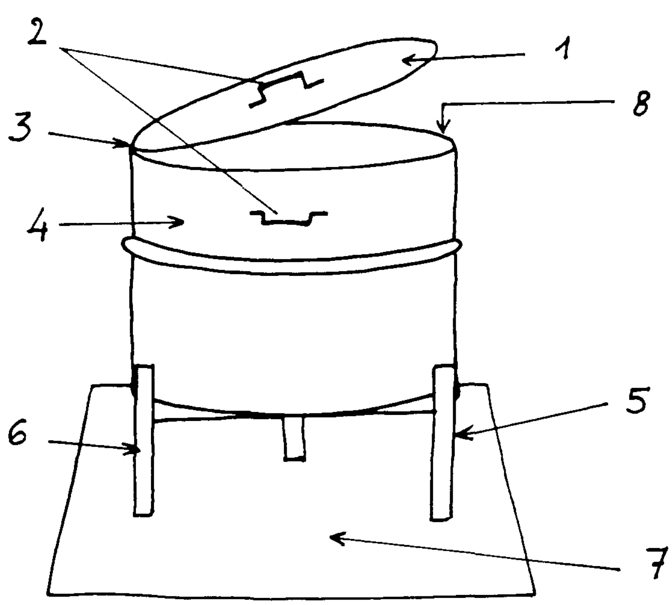
GARBAGE

Start garbage collection from the beginning; use the representatives to mobilize the population.

For garbage collection 200 litre drums cut in half can be used. Drill holes in the bottom.

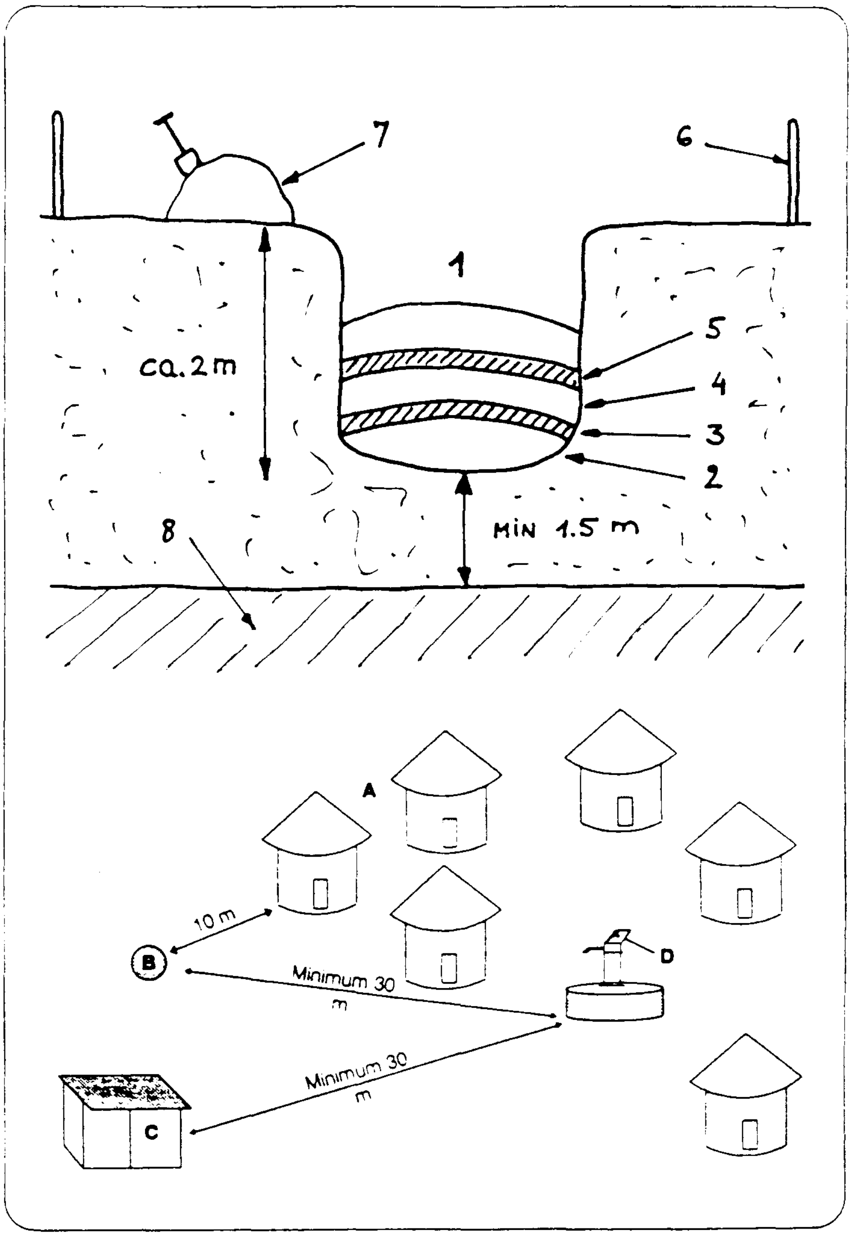
Use 1 container for 10 families and place them within 15 metres from any dwelling.

DUSTBIN



1. Cover
2. Handles
3. Hinge
4. 1/2 metal drum
5. Pierced bottom
6. Support
7. Stones (drainage)
8. Hammered edges

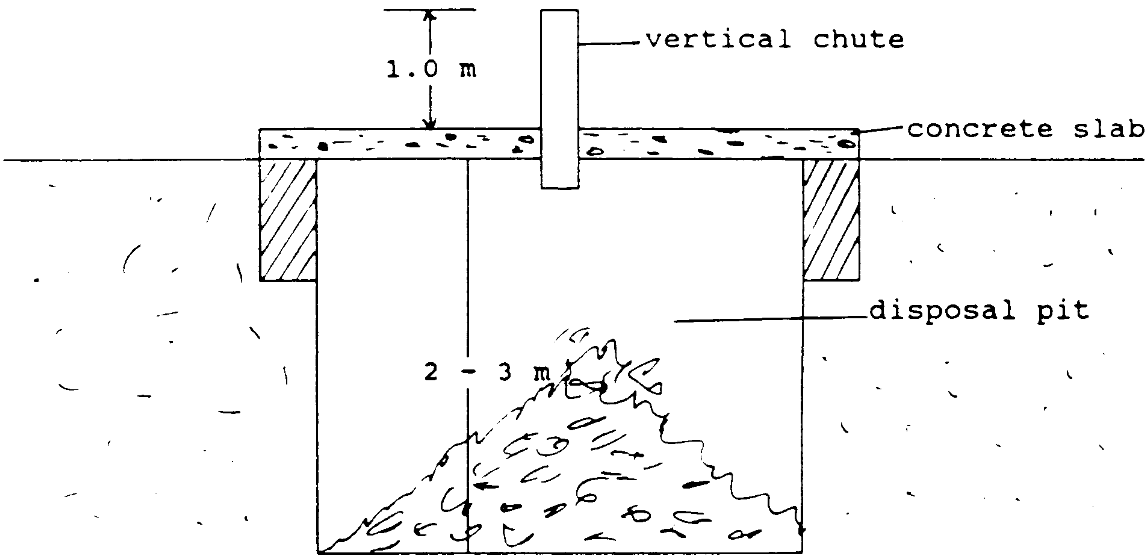
REFUSE PIT



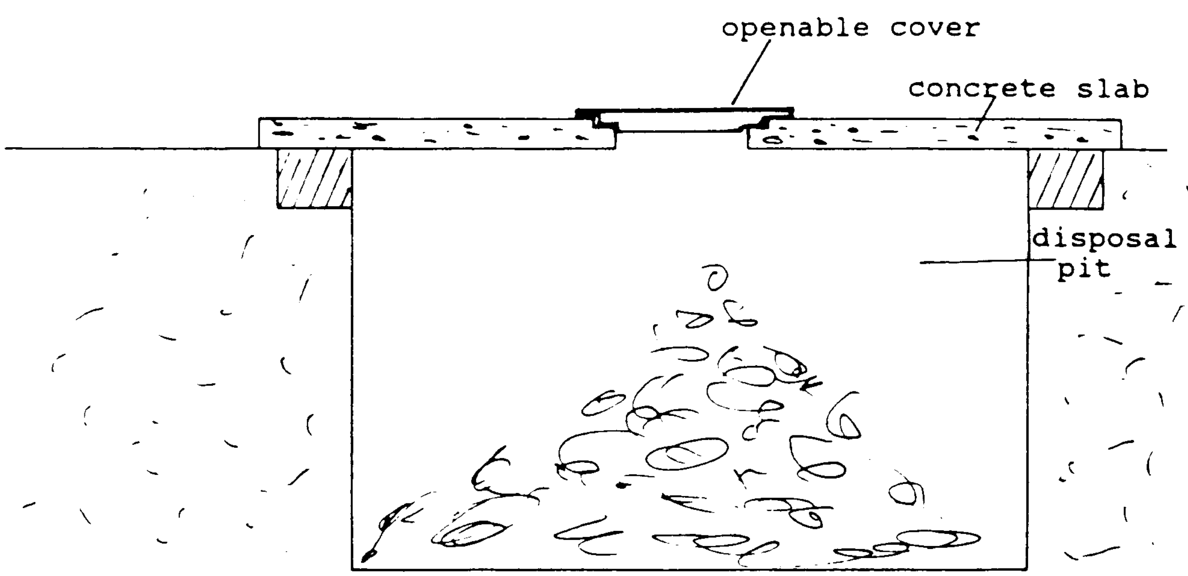
1. Pit
2. Refuse, day 1
3. Earth, day 1
4. Refuse, day 2
5. Earth, day 2
6. Fence
7. Excavated earth
8. Water table

A. Dwellings
B. Refuse pit
C. Latrine
D. Well

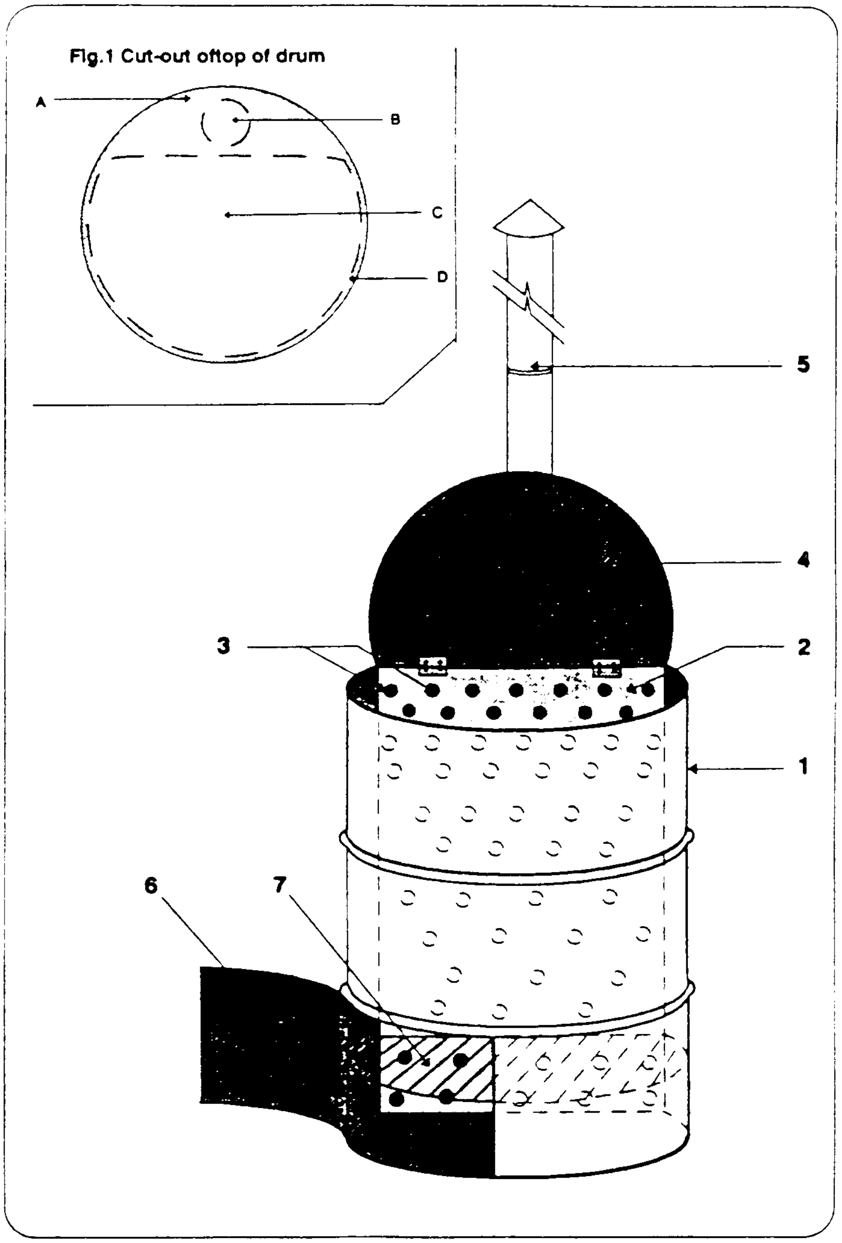
DISPOSAL PIT FOR MEDICAL WASTE



Disposal pit suitable for of "sharps" from a medical facility



TEMPORARY INCINERATOR



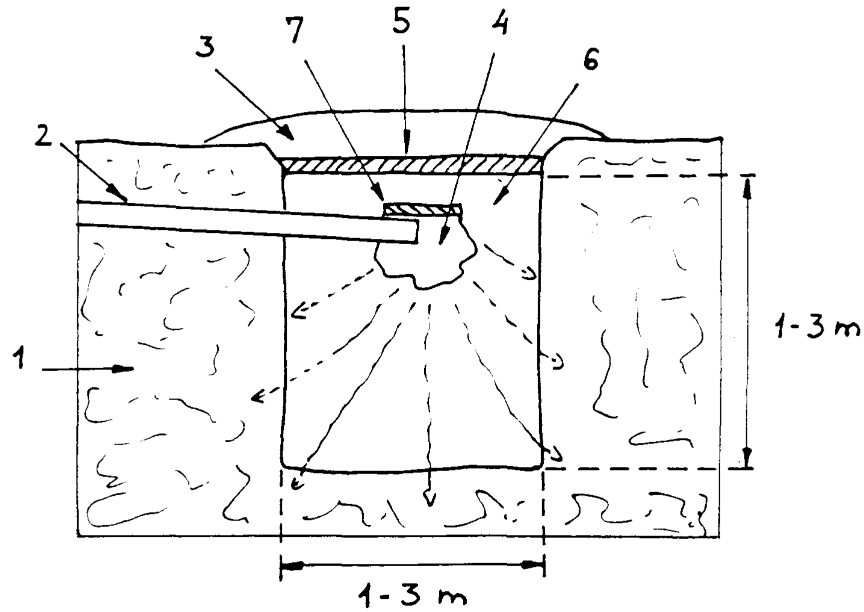
A. Top of drum (part not cut)
B. Hole cut for chimney

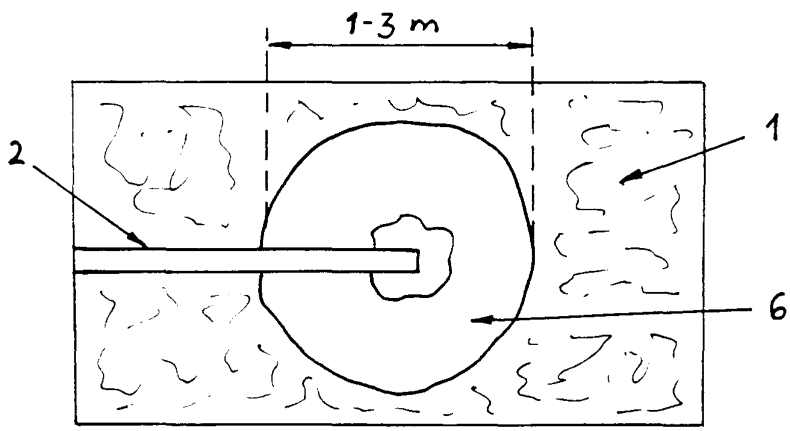
C. Large chamber (fir refuse)
D. Cut-out of cover

1. Metal drum, 200 l
2. Perforated metal plate
3. Perforations in the metal plate
6. Movable cover

5. Chimney
6. Fire chamber door
7. Metal grating or heavy mesh

SOAKAWAY PIT



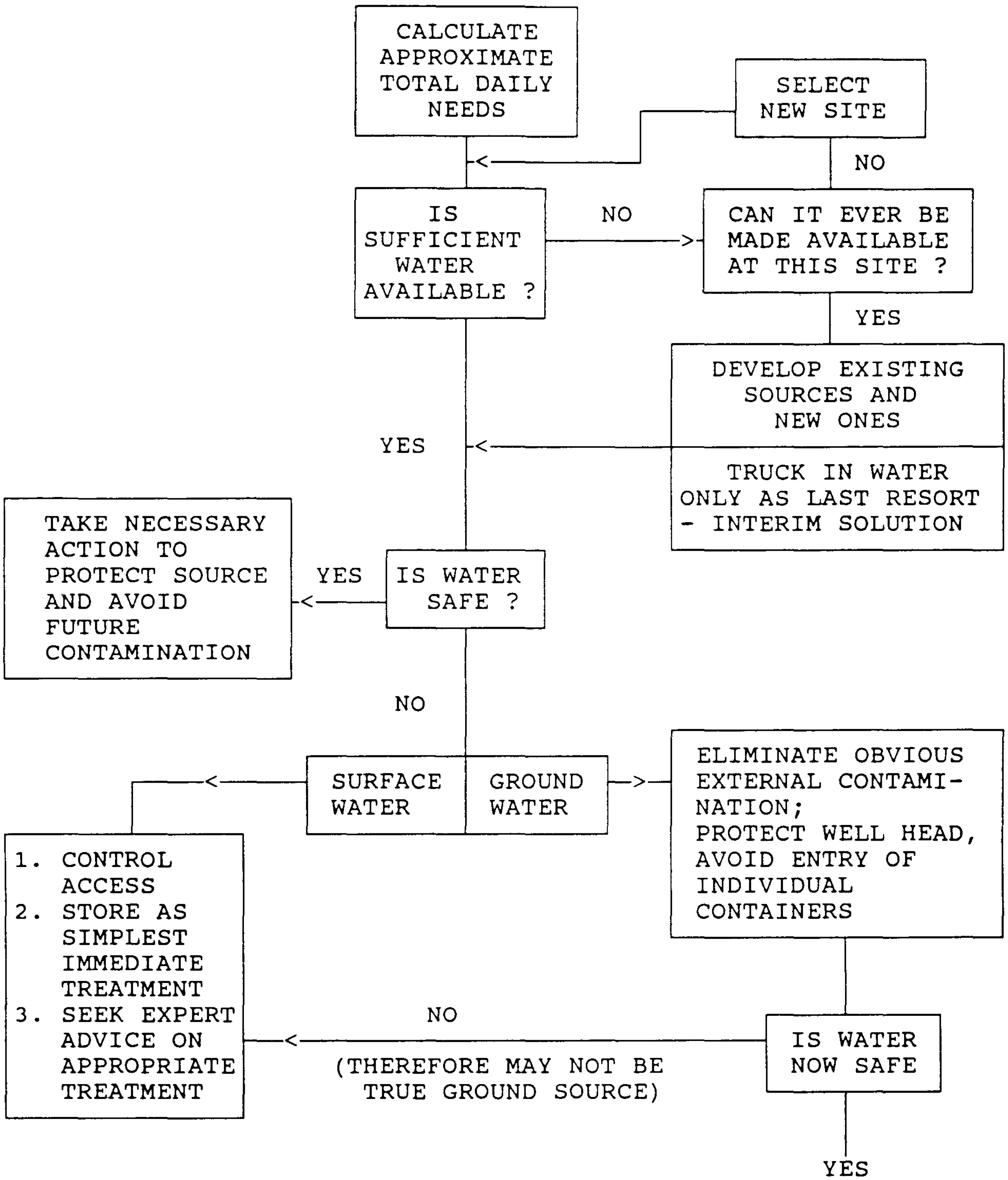


1. Permeable soil
2. Pipe (diameter 50-100mm)
3. Compacted earth
4. Cleared space at the end of the pipe
5. Straw or plastic sheet
6. Stones
7. Flat stone

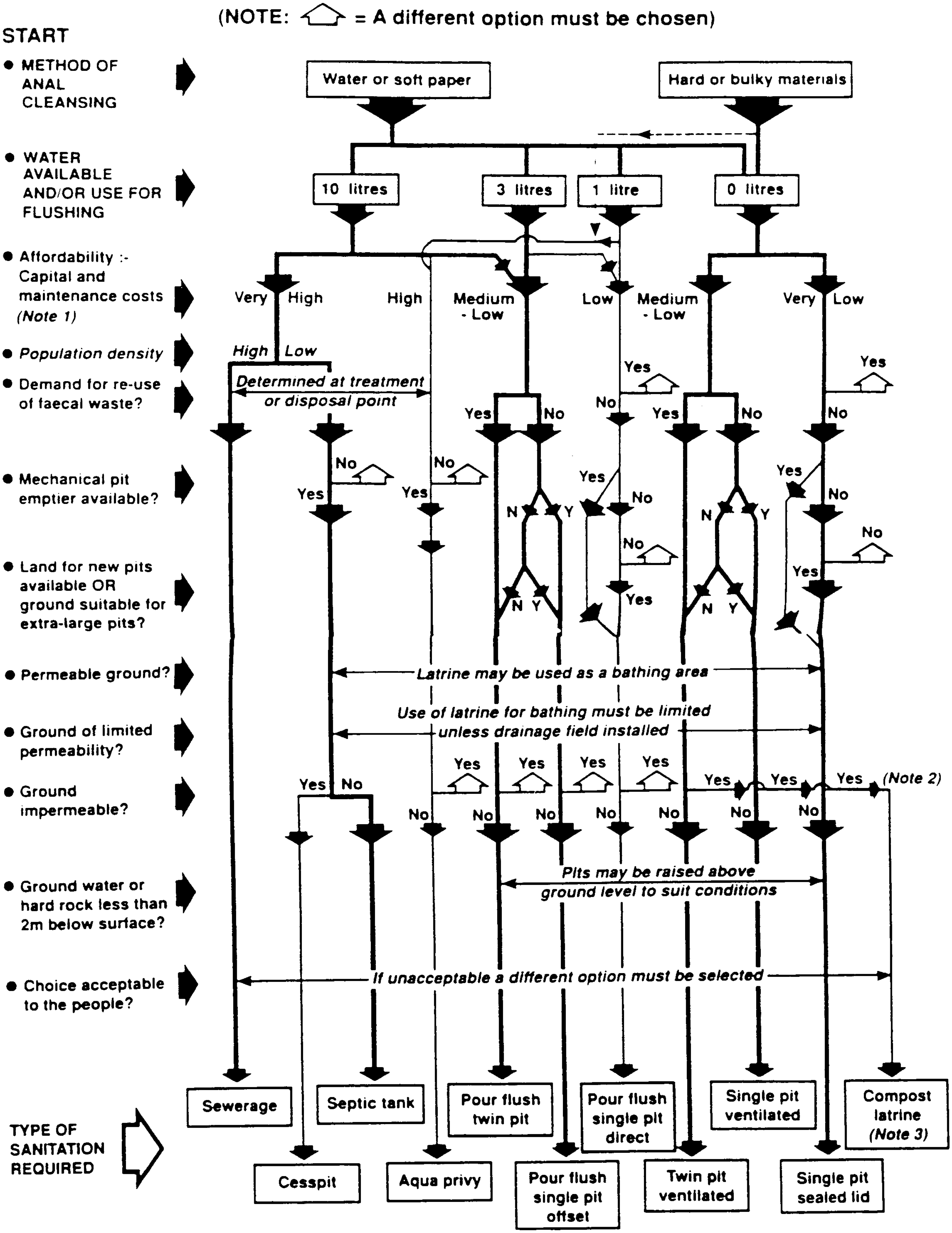
UNHCR CRITERIA FOR REFUGEE CAMP

TOPOGRAPHY	MAKE SURE THAT SITE GENTLY SLOPES (1-2%)
AREA	FOR A CAMP AS A WHOLE : 30 M2/PERSON SHELTER : 3.5 M2/PERSON
SHELTER	PROVIDE FOR PRIVACY FOR FAMILIES
FIREBREAK	50 METERS WIDE FOR EVERY 300 METERS BUILT UP AREA
NUTRITION	AVERAGE SURVIVAL RATION SHOULD PROVIDE 2000 KCAL
WATER	CONSUMPTION : 20 LITERS/PERSON/DAY 1 TAP FOR EVERY 200 - 250 PERSONS MAXIMUM DISTANCE HOUSE - WATER POINT IS 100 METERS
SANITATION	OPTIMAL : 1 LATRINE / FAMILY PUBLIC LATRINES : 12 - 25 PERSONS DISTANCE TO USER : MAXIMUM 40 METERS NOT LESS THAN 10 METERS IF PUBLIC NOT LESS THAN 5 METERS IF PRIVATE
GARBAGE	ONE CONTAINER FOR 10 FAMILIES PLACED WITHIN 15 METERS FROM ANY DWELLING
IMMUNIZATION	THE ONLY IMMUNIZATION IN THE EARLY WEEKS OF AN EMERGENCY IS OF YOUNG CHILDREN AGAINST MEASLES

GENERAL CONSIDERATIONS IN EMERGENCY WATER SUPPLY



From UNHCR : Water Manual for refugee situations



Note 1: *Not all possibilities are illustrated as it is assumed that water availability is related to affordability*

Note 2: *Use extra large pits or consider composting*

Note 3: *Also dependent on willingness to collect urine separately, demand for compost, availability of ash or vegetable matter etc.*