Chapter 6

Excreta disposal

Excreta disposal is undoubtedly one of the key elements of any emergency sanitation programme. Containment and safe disposal of human excreta is the primary barrier to transmission of excreta-related disease. Implementing agencies often focus solely on the quantity of toilets in emergency situations, however, and pay scant attention to their quality and usage.

6.1 Associated risks

6.1.1 Sources of disease

Inadequate and unsafe disposal of human faeces can lead to the contamination of ground and water sources, and can provide breeding sites for flies and mosquitoes which may carry infection. In addition, faeces may attract domestic animals and vermin which can both increase the potential for disease. It can also create an unpleasant environment in terms of odour and sight.

The introduction of safe excreta disposal can reduce the incidence of intestinal infections and helminth infestations. Excreta-related communicable diseases include cholera, typhoid, dysentery (including shigellosis), diarrhoea, hookworm, schistosomiasis and filariasis (Franceys et al., 1992). The likelihood of all these diseases, and especially epidemics such as cholera, increases significantly when a population is displaced.

6.1.2 Transmission of disease

Transmission of excreta-related diseases is largely faecal–oral or through skin penetration. Figure 6.1 illustrates the potential transmission routes for pathogens found in excreta.

Poor hygiene practice, particularly involving food and hands, may be a major cause of disease transmission, even where appropriate excreta disposal facilities are in place. For this reason it is difficult to obtain a direct correlation between the incidence of excreta-related disease and the provision of appropriate facilities.

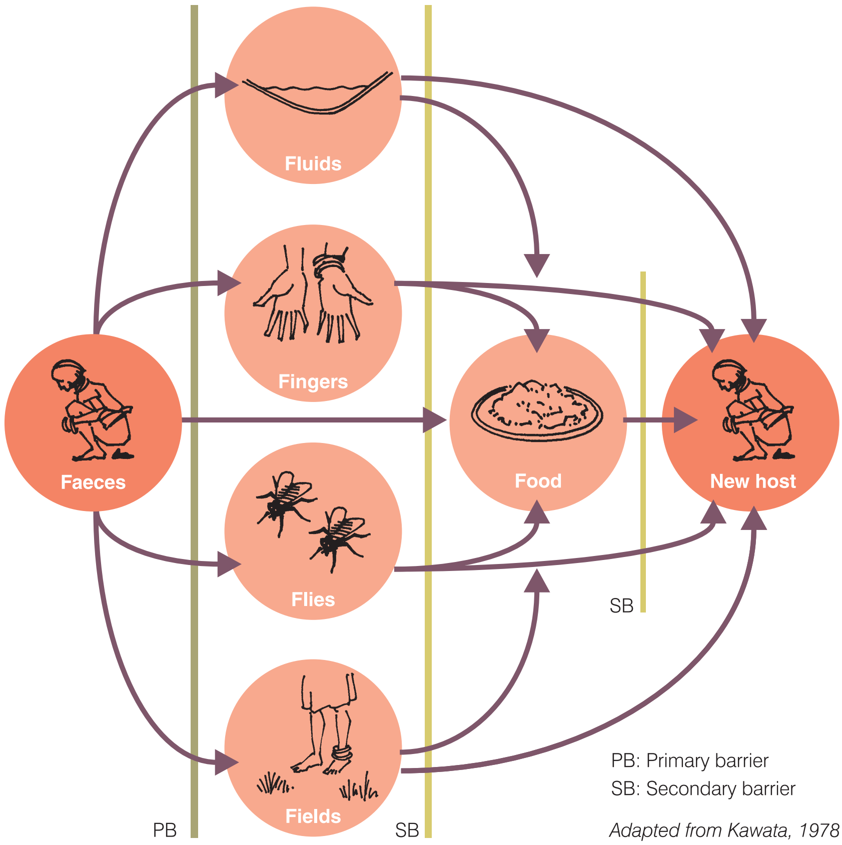

Figure 6.1. Transmission of disease from faeces

6.1.3 High-risk groups

Children under five years of age are most at risk from communicable diseases since their immune systems have not developed. Increased malnutrition, as is common in emergencies, increases this risk further. Since young children are unaware of the health risks associated with contact with faeces it is essential that faeces are safely contained.

Severely malnourished children and adults are at increased risk from diarrhoeal disease, as are elderly people especially if exhausted after travelling considerable distances.

6.2 Selection criteria for excreta disposal

In selecting appropriate excreta disposal interventions there are many criteria that must be considered. These include:

- Socio-political factors
- Socio-cultural factors
- Available space

- Ground conditions
- Water availability
- Anal cleansing material
- Menstruation
- User-friendliness (for children, etc.)
- Time constraints
- Design life
- Mandate of agency
- Financial constraints
- Availability of local materials
- Transportation means
- Human resources
- Operation and maintenance

6.2.1 Socio-political factors

The host country or central authorities are often reluctant to allow family units or long-term solutions to be provided for a displaced population. This is often because they do not want the affected population to feel that they are going to stay permanently in the affected area. This is generally unnecessary since people do not want to stay anyway, but where the authorities believe this, temporary communal facilities may have to be provided. If appropriate, permission for family or shared facilities should still be sought.

6.2.2 Socio-cultural aspects

The facilities provided should be as compatible as possible with the previous practices of the affected population and, where people have been displaced, also with those of the indigenous society. People are much more likely to use latrines if they are accustomed to the type of technology used. In addition, in some cultures it is unacceptable for different cultural groups to use the same latrine and this must be considered. Consultation with different groups within the affected community is essential to ascertain these factors.

6.2.3 Space

The availability of space will influence the type, design and density of latrines. For example, where space is limited family latrines may not be an option. Also, there may not be enough space to replace full pit latrines, meaning that some provision for pit emptying is required (see 6.9), or the distribution of latrines within the site may be severely limited.

6.2.4 Ground conditions

Ground conditions have a particular impact on latrines that rely on soil infiltration (such as pit latrines). The main considerations are:

- Bearing capacity of the soil (to support superstructure)
- Soil stability (to prevent pit collapse and allow excavation)
- Depth and ease of excavation possible
- Infiltration rate
- Groundwater pollution risk

See Chapter 4 for more detailed information.

6.2.5 Water availability

An important constraint in deciding on wet or dry excreta disposal systems is the availability of water in the area. Often the quantity of water available in emergency situations is severely limited. If this is the case it is likely to be inappropriate to use latrines which rely on heavy water use, such as water closets. This factor must be weighed against whether the population will use dry systems, however. Where the local custom is to use water for anal cleansing this must be also be considered.

6.2.6 Anal cleansing material

The importance of anal cleansing materials should not be underestimated. These can have a big effect on sludge accumulation rates (see 6.8.9) and water use. It is important to consider the materials the community members usually use and the materials currently available. Care should be taken to avoid making assumptions by speaking to community members and inspecting existing defecation sites to determine what materials are being used in the present situation.

6.2.7 Menstruation

Women and girls of reproductive age need access to appropriate materials for the absorption and disposal of menstrual blood. Latrines should therefore allow for the disposal of women's sanitary protection, or provide women with the necessary privacy for washing and drying sanitary protection cloths in a hygienic manner. There may also be a need to supply appropriate materials for this use.

6.2.8 Time constraints

Time is especially important in the immediate stage of an emergency, when the aim is to provide facilities rapidly in order to minimise the spread of excreta-related disease in the affected area. Possible time-constrained scenarios include:

- the sudden occurrence of a natural disaster where most infrastructure is destroyed (e.g. flood or earthquake); and
- the mass movement of an affected population to an area where there are no facilities (i.e. movement of refugees or internally displaced people).

In the above scenarios, it is likely to be appropriate to begin with the provision of simple communal facilities which can be constructed quickly. The life span of these facilities will depend on how quickly the affected population can be mobilised to construct improved family units and how long the people are likely to be displaced.

Another time constraint could be the time taken to procure equipment and materials due to the scarcity of local resources. Where this is the case, immediate emergency measures should be taken until appropriate materials can be obtained.

6.2.9 Design life

The design life of the facilities to be constructed must be considered from the onset. If the affected population is staying in a temporary camp and it is known that they will be moving within a fixed period of time, temporary facilities must be designed accordingly. Conversely, if it known that the population will be staying in the area indefinitely, solutions must be designed for long-term use. Often it is not known how long a situation will last and this is a frequent cause of controversy. Latrine programmes, therefore, should be designed in such a way that they can be adapted to suit changing circumstances.

6.2.10 Mandate of agency

Some implementing agencies have a mandate to deal with the initial stages of an emergency and after that to withdraw from the affected area or hand over activities to another agency. Furthermore, if the mandate of the agency is 'direct emergency response' then a relationship has to be worked out between it and those responsible for longer term solutions, otherwise tension may be created which could adversely affect the population concerned.

It is therefore essential that all agencies should consider a long-term solution in their outline design, allowing flexibility for upgrading even if they do not have any intention of implementing these plans themselves. Such an approach will help to ensure continuity from direct response to long-term solutions.

6.2.11 Financial constraints

The financial resources available to the implementing agency may influence the choice between communal or family facilities, and the type and quality of latrine selected. For this reason it is important that a draft budget is produced in the outline programme design and that materials (including transportation) and labour are properly costed.

6.2.12 Availability of local materials and tools

If facilities can be constructed from local materials this may reduce the implementation time and cost considerably. For these reasons it is important to ascertain what resources are available and whether they can be used without adverse effect on the local environment and economy. Detailed designs that rely on high-quality imported materials may be totally inappropriate when the logistics of procuring and transporting these items is considered.

6.2.13 Human resources

The skills and experience of the available personnel may be important constraints or opportunities for selecting appropriate interventions. Complex technical designs may be inappropriate if construction personnel are unable to implement them. If staff have solid experience of particular construction techniques, however, it may be appropriate to use these, although the high turnover of staff in some situations should be considered.

6.2.14 Operation and maintenance

The operation and maintenance (O&M) of latrines should be given equal emphasis to their construction. If responsibility for O&M has to be taken by the implementing agency (i.e. the end-users will not, or cannot, clean and maintain facilities) then only communal facilities should be provided. If community members are willing to take on the responsibility for O&M, however, family latrines may be a more appropriate option.

The availability of cleaning materials, the ease of cleaning of latrine slabs or basins, and facilities for emptying pits must also be considered in latrine selection and design.

6.3 Communal or family latrines?

It is widely accepted that family excreta disposal facilities are preferable to communal facilities. Many of the factors outlined in Section 6.2 may influence this decision, however.

6.3.1 Operation and maintenance

Perhaps the most important factor concerning the choice between communal and family latrines is operation and maintenance. Field experience tends to indicate that there is a direct relationship between the ratio of facilities to the affected population and the involvement of

Table 6.1. Advantages and disadvantages of communal and family latrines (adapted from Adams, 1999)

Factor	*Communal*	*Family*
Speed of construction	Can be constructed fast by well-trained and well-equipped team, although rate of construction limited by number of staff and equipment.	May take considerable time to train families in the initial stages, but large numbers of latrines may be built quickly.
Technical quality	Quality of design and construction easier to control but innovative ideas from users may be missed.	Potential for innovative ideas of users, but more difficult to ensure good siting and construction.
Construction costs	Use of materials can be easily controlled but labour must be paid for.	Construction labour and some materials may be free of charge, but families may not have the time or the right skills.
Maintenance costs	Maintenance, repair and replacement costs are easier to predict and plan, but staff are required to clean and maintain facilities in long-term.	Users take responsibility for cleaning and maintenance but recurrent costs are less predict-able.
Technical possibilities	Heavy equipment and specialised techniques may be used where necessary (e.g. rocky ground).	Families may not be able to dig in hard rock or build raised pit latrines where the water table is high.
Cleaning and hygiene	Users do not have to clean latrines, but these are often dirty, and a greater mix of users increases the risk of disease transmission.	Latrines are often cleaner but many users may prefer not to be responsible for construction, cleaning and maintenance.
Access and security	Latrines may be less accessible and more insecure, particularly for women.	Latrines are often more accessi-ble (closer to dwellings) and safer.
Development issues	People may lose or not acquire the habit of looking after their own latrine.	People keep or develop the habit of managing their own latrine.

that population in O&M activities. Responsibility for O&M of communal latrines is often the source of tension or resentment, and as a result facilities may not be adequately maintained leading to increased health hazards.

It is also important to consider that it is possible to implement one type of facility parallel to another in such a way that they complement each other. For example, communal latrines may be provided for new arrivals at a refugee camp but after a short period of time these are replaced with family latrines.

6.3.2 Advantages and disadvantages

There are many advantages and disadvantages of both communal and family latrines. The final decision will depend on a variety of factors as outlined in Table 6.1.

6.3.3 Communal latrine scenarios

It is likely that in the following scenarios communal latrines will be the most appropriate or only option:

- Hard shelters (schools, public buildings, factory buildings, emergency centres)
- Enclosed centres (prisons, hospitals, orphanages, feeding centres, etc.)
- Difficult physical conditions (e.g. rocky ground, high water table level)
- Over-crowded peri-urban areas
- Crowded camps with little available space (population density >300 per hectare)
- Transit camps where facilities are temporary
- Where the local authorities do not permit family units

6.4 Immediate measures

Immediate measures are designed for use in the initial stage of an emergency only.

6.4.1 Clearing of scattered excreta

Where indiscriminate open defecation is practiced the first step in excreta disposal is to provide designated defecation sites and clear existing scattered faeces. This is an unpleasant task and in some cultures it may be especially difficult to find willing and suitable personnel, but it is essential to minimise the spread of faecal-oral disease. Faeces can be covered with lime and should be removed to a safe disposal site such as a pit. Workers must be provided with appropriate tools and protective clothing.

6.4.2 Controlled open field defecation

In the initial stages of an emergency, areas where people **can** defecate, rather than where they cannot, should be provided immediately. These should be located where excreta cannot contaminate the food chain or water sources. Open areas or fields surrounded by screening may be set up (Figure 6.2), with segregated sites for each sex. People should be encouraged to use one strip of land at a time and used areas must be clearly marked. It is also possible to use internal partitions to provide more privacy and encourage greater use.

It is essential that defecation areas are:

- far from water storage and treatment facilities;
- at least 50m from water sources;
- downhill of settlements and water sources;
- far from public buildings or roads;
- not in field crops grown for human consumption; and
- far from food storage or preparation areas.

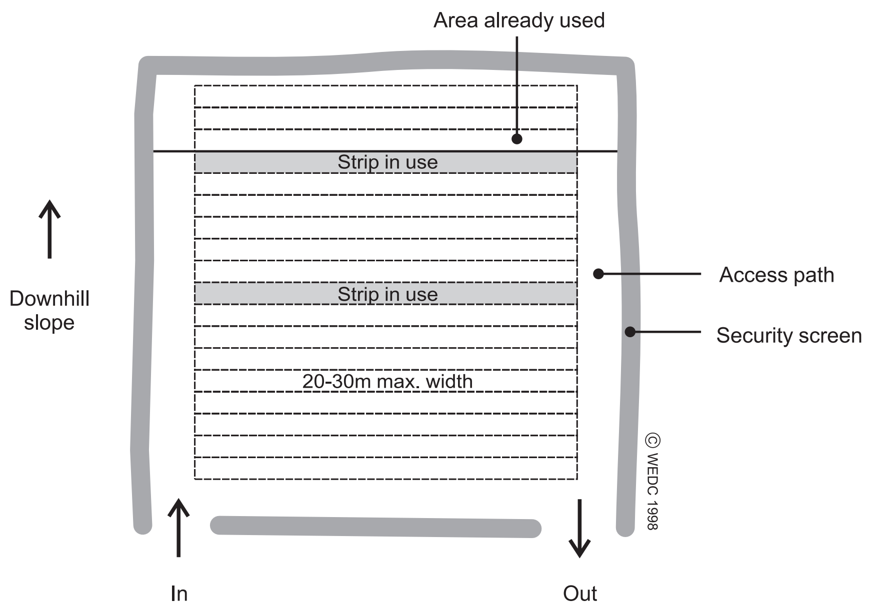

Figure 6.2. Open defecation field

Advantages: It is rapid to implement; minimal resources are required; and it minimises indiscriminate open defecation.

Constraints: There is a lack of privacy for users; considerable space is required; it is difficult to manage; ther is potential for cross-contamination of users; and it is better suited to hot dry climates.

6.4.3 Shallow trench latrines

A simple improvement on open defecation fields is to provide shallow trenches in which people can defecate (Figure 6.3). This allows users to cover faeces and improves the overall hygiene and convenience of an open defecation system. Trenches need only be 20-30cm wide and 15cm deep, and shovels may be provided to allow each user to cover their excreta with soil.

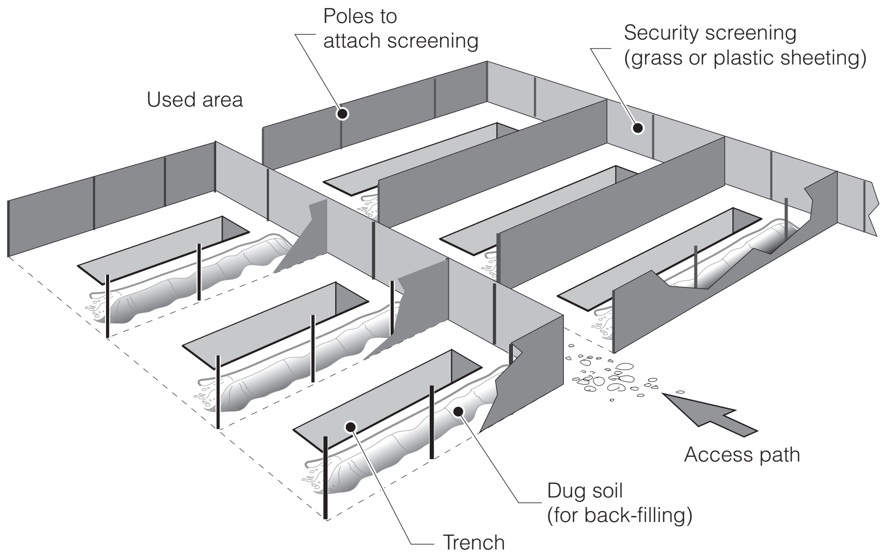

Figure 6.3. Trench defecation field

Advantages: It is rapid to implement (one worker can dig 50m of trench per day); and faeces can be covered easily with soil.

Constraints: There is limited privacy; a short life-span; and considerable space is required.

6.4.4 Deep trench latrines

Deep trench latrines are often constructed in the immediate stage of an emergency and will be appropriate if there are sufficient tools, materials and human resources available (see 6.5.3).

6.4.5 Shallow family latrines

In some situations it may be more appropriate to provide shallow family (rather than trench) latrines. This is particularly suitable where people are keen to build their own latrines or have experience of latrine construction. A shallow pit of approximately 0.3m x 0.5m and 1m deep may be excavated. Wooden foot rests or a latrine slab (approximately 0.8m x 0.6m) can be placed over this, overlapping by at least 15cm on each side. This latrine should be an immediate measure only and back-filling should occur when the pit is full to within 0.2m of the slab. A simple superstructure for privacy can be made from local materials (Figure 6.4).

Advantages: There is increased privacy; it is rapid to implement; reduced labour input is required from agency; and it allows people to actively participate in finding an appropriate solution.

Constraints: The community must be willing and able to construct family latrines; it can be difficult to manage siting and back-filling of pits; and large tools and materials required.

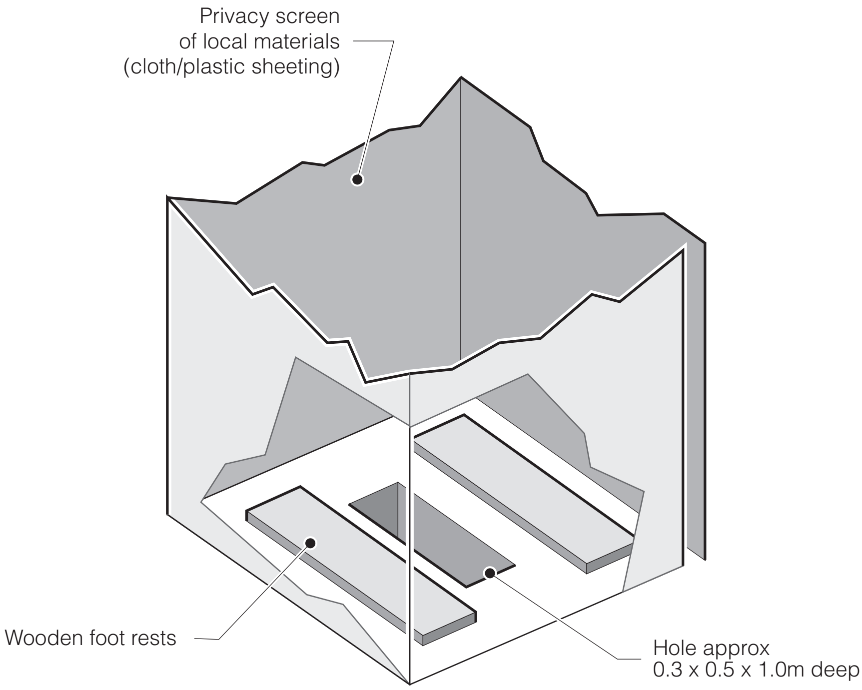

Figure 6.4. Shallow family latrine

6.4.6 Bucket/container latrines

In situations where there is limited space it may be appropriate to provide buckets or containers in which people can defecate. These should have tight-fitting lids and should be emptied at least daily. Disinfectant may be added to reduce contamination risks and odour. Containers can be emptied into a sewerage system, a landfill site or waste-stabilisation ponds. This measure will only be appropriate where there are no other immediate action options and users find the method acceptable, so it is not used in most situations.

Advantages: Defecation containers can be procured easily and transported; once the containers are provided only the final disposal system need be constructed; and they can be used in flooded areas.

Constraints: Many people find the method unacceptable; large quantities of containers and disinfectant are required; extensive education regarding final disposal is required; and containers may be used for alternative purposes.

6.4.7 Storage tank latrines

In some emergency situations, such as in flooded areas or where ground excavation is difficult, large storage tanks can be situated above ground with wooden platforms and a simple superstructure fitted above. Here the user must climb steps to the latrine and the effluent is collected in the tank. This is suitable as an immediate or short-term measure only and the tank is likely to require regular emptying. A suitable emptying mechanism and final disposal site are therefore needed from the onset.

Advantages: Large storage tanks are often available in relief shipments; they are rapid to construct; and they can be used on rocky ground or in flooded areas.

Constraints: Regular emptying is required; a large number of tanks may be needed which could be used for other purposes; and appropriate materials must be available to build steps and simple superstructures.

6.4.8 Packet latrines

In some emergency situations relief agencies have provided disposable packet latrines. These are plastic packets (similar in appearance to a plastic bag) in which the user can defecate. The packets contain a blend of enzymes which assists the breakdown of the excreta and must be disposed of in a safe place.

Advantages: Packets are lightweight and easy to transport; and may be used where space is severely limited or in flooded areas.

Constraints: The method may not be acceptable to affected population; and final disposal site must be clearly marked, accessible and used.

6.4.9 Chemical toilets

Chemical toilets are commonly used on a temporary basis in developed countries. These are normally single prefabricated plastic units incorporating a sit-down toilet, lockable door and effluent tank containing chemicals to aid digestion and reduce odour. They have been used in emergency situations such as the Kosova refugee crisis in 1999. In general, however, they are an expensive and unsustainable solution.

Advantages: They are hygienic; and odour is minimised.

Constraints: They are high cost; difficult to transport; and require regular emptying.

6.4.10 Repair or upgrading of existing facilities

In some emergency situations the affected community may remain or be displaced in sites where there are existing sanitation facilities. These facilities may have been damaged, however, or may be inappropriate for the changed circumstances. In such cases the repair or upgrading of these facilities is likely to be the most appropriate intervention measure, but it will depend on how quickly this can be implemented as to whether this may be an appropriate immediate measure.

Advantages: The basic infrastructure is in place to build on; and indigenous technology and materials are used.

Constraints: There are limited expansion possibilities; and repair and upgrading may take time.

6

6.5 Technology choice: Longer term intervention

Once it has been decided whether communal or family facilities should be provided, and what the design life of these should be, the choice of technology must be made. The selection criteria outlined in Section 6.2 should be used to make this decision.

6.5.1 Open defecation

In some emergency situations it may be perfectly acceptable for the affected population to practice open defecation. Indeed, in some cultures defecating inside a latrine superstructure is unacceptable. Where people are accustomed to open defecation it may be appropriate to continue this, providing there is adequate space and vegetation to allow people to find an appropriate defecation space so that the risk of disease transmission is minimised. Such situations can be assessed in terms of excreta disposal space rather than facilities.

Advantages: There is no cost; and no construction activities are required.
Constraints: Practice is unsuitable where people are living in overcrowded conditions; large space is needed; and this is only acceptable if the population is already accustomed to such practice.

6.5.2 Simple pit latrines

Pit latrines are by far the most common technology choice adopted in emergency scenarios. This is because they are simple, quick to construct and generally inexpensive. Figure 6.5 shows a typical simple pit latrine.

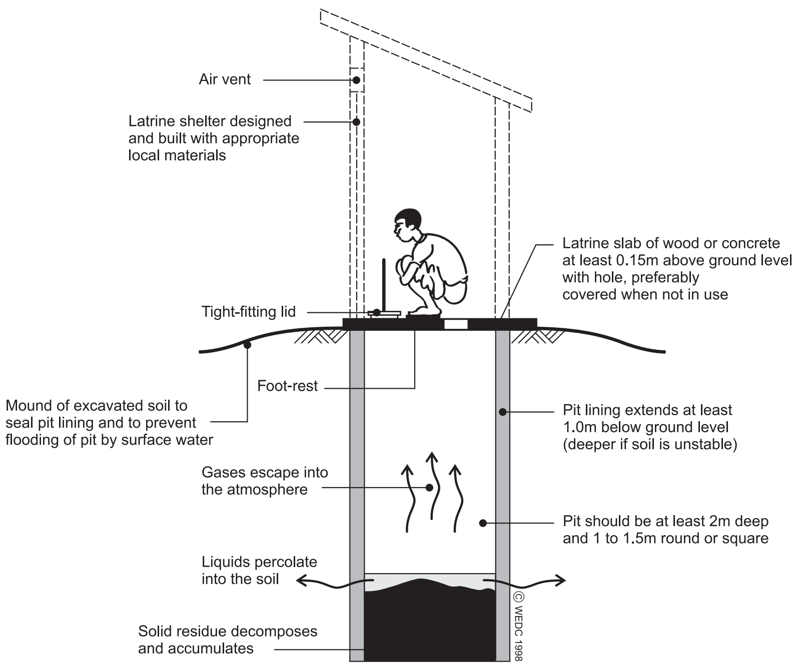

Figure 6.5. Simple pit latrine

The pit should be 2m or more in depth and covered by a latrine slab. The slab should be firmly supported on all sides and raised above the surrounding ground level to prevent surface water entering the pit. If the soil is unstable, the pit should be lined to prevent collapse (see 6.8.7). A squat or drophole is provided in the slab which allows excreta to fall directly into the pit. This can be covered with a removable lid to minimise flies and odour.

The superstructure can be made from materials available locally, such as wood, mud and grass, or can be a more permanent structure of bricks and mortar. The rate at which pits fill will depend on the sludge accumulation rate and the infiltration rate of the soil. Design and construction details can be found in Section 6.8.

Advantages: They are cheap; quick to construct; operate without water; and easily understood.

Constraints: They are unsuitable where the water table is high, soil is too unstable to dig or ground is very rocky; and often have odour problems.

6.5.3 Deep trench latrines

If communal latrines are to be constructed, a common option is the construction of deep trench latrines (Figure 6.6). These operate on exactly the same principle as the simple pit latrine but involve the siting of several cubicles above a single trench. Care should be taken to not put too many latrines side by side. The recommended maximum length of trench is 6m, providing six cubicles.

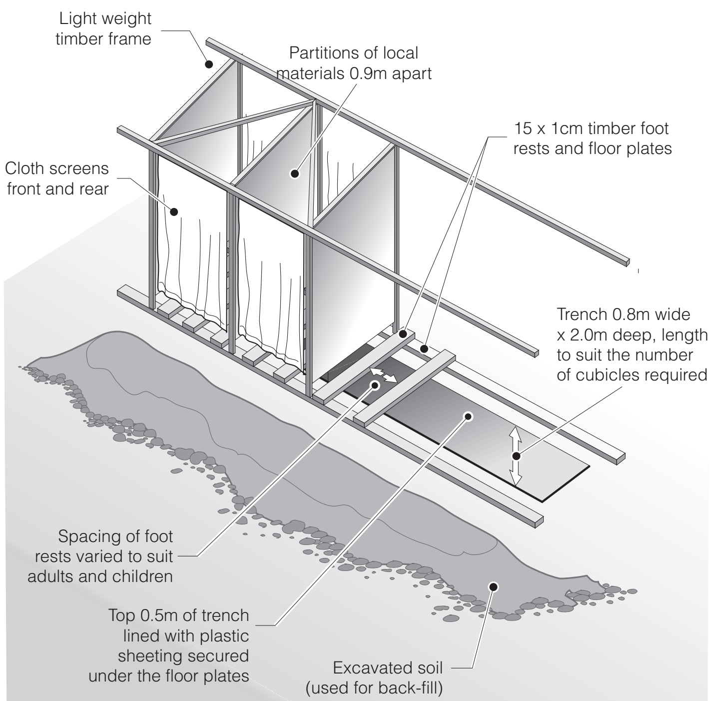

Figure 6.6. Deep trench latrines

Trenches should be about 0.8m wide and at least the top 0.5m of the pit should be lined. Wooden platforms can be used above the trench and covered with plastic sheeting and soil. Simple wooden footrests may be used beside each drophole in the immediate stage, to be replaced with plastic or concrete latrine slabs later.

Advantages: The same advantages as simple pit latrine.

Constraints: The same constraints as simple pit latrine; and cleaning and maintenance of communal trench latrines are often poorly carried out by users.

Simple trench latrines, Bangladesh

6.5.4 VIP latrines

The Ventilated Improved Pit (VIP) latrine (Figure 6.7) is an improved pit latrine designed to minimise odour and flies. A vent pipe is incorporated into the design to remove odourous gases from the pit. This should ideally be situated outside the latrine interior, should extend at least 50cm above the latrine superstructure, and should be painted black to increase solar heating of the air in the vent pipe, causing it to rise (see 6.8.7 for more details). Air should be able to flow freely through the squat hole and vent pipe, therefore no drophole cover is required.

The open end of the pipe is covered with a gauze mesh or fly-proof netting which is designed to prevent flies entering the pit and to trap any flies trying to leave.

The superstructure interior should be kept reasonably dark to deter flies, but there should be a gap, usually above the door, to allow air to enter. This gap should be at least three times the cross-sectional area of the vent pipe (Franceys et al., 1992). Air flow can be increased by facing the door of the superstructure towards the prevailing wind. Each drophole should have its own compartment and there should always be **one vent pipe per compartment.**

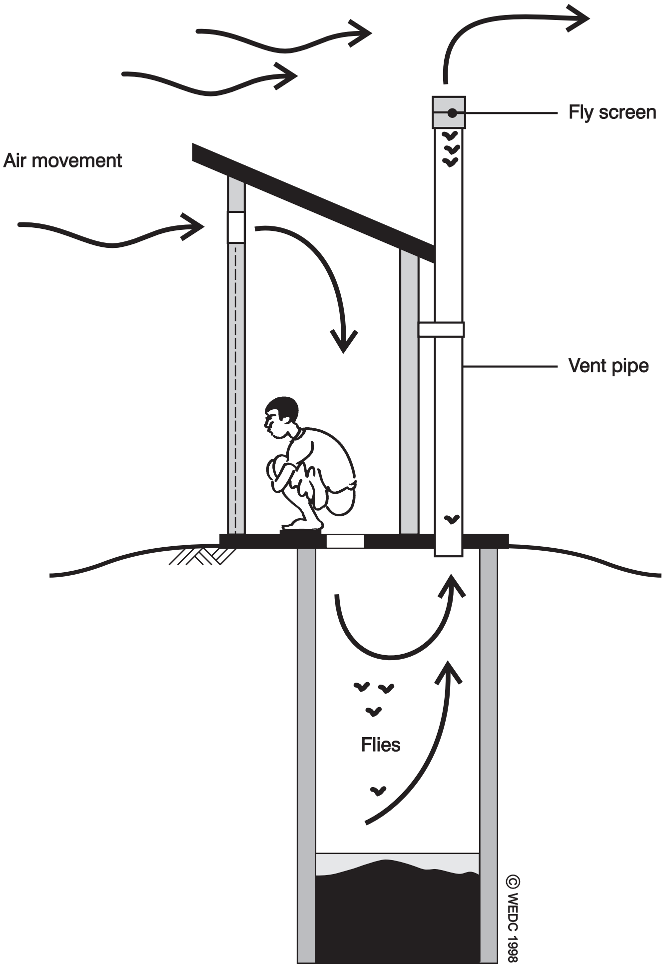

Figure 6.7. Ventilated improved pit latrine

Advantages: Odour and flies are reduced; and a good quality long-term solution.

Constraints: VIPs are difficult and expensive to construct properly; design and operation are often not fully understood; construction may take time; dark interior may deter young children from using the latrine; design does not deter mosquitoes; and there is an increased odour outside.

6.5.5 Pour-flush latrines

Pour-flush latrines rely on water to act as a hygienic seal and to help remove excreta to a wet or dry disposal system. The most simple pour-flush latrines use a latrine pan incorporating a shallow U-bend which retains the water (Figure 6.8). After defecation, a few litres of water must be poured, or thrown, into the bowl in order to flush the excreta into the pit or sewerage system below.

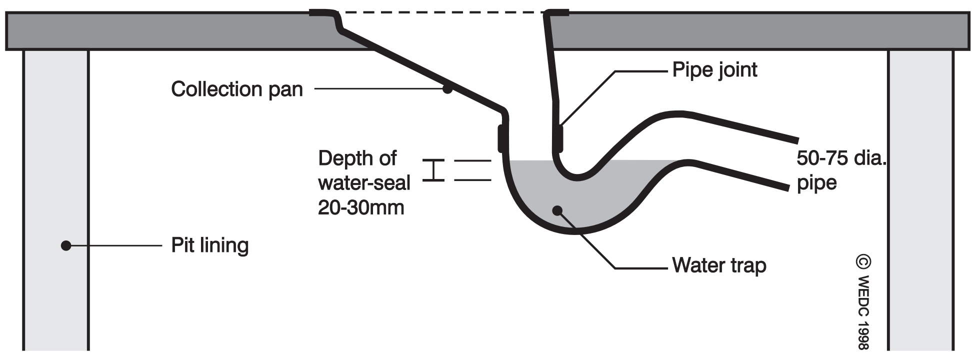

Figure 6.8. Cross-section of typical water-seal pan

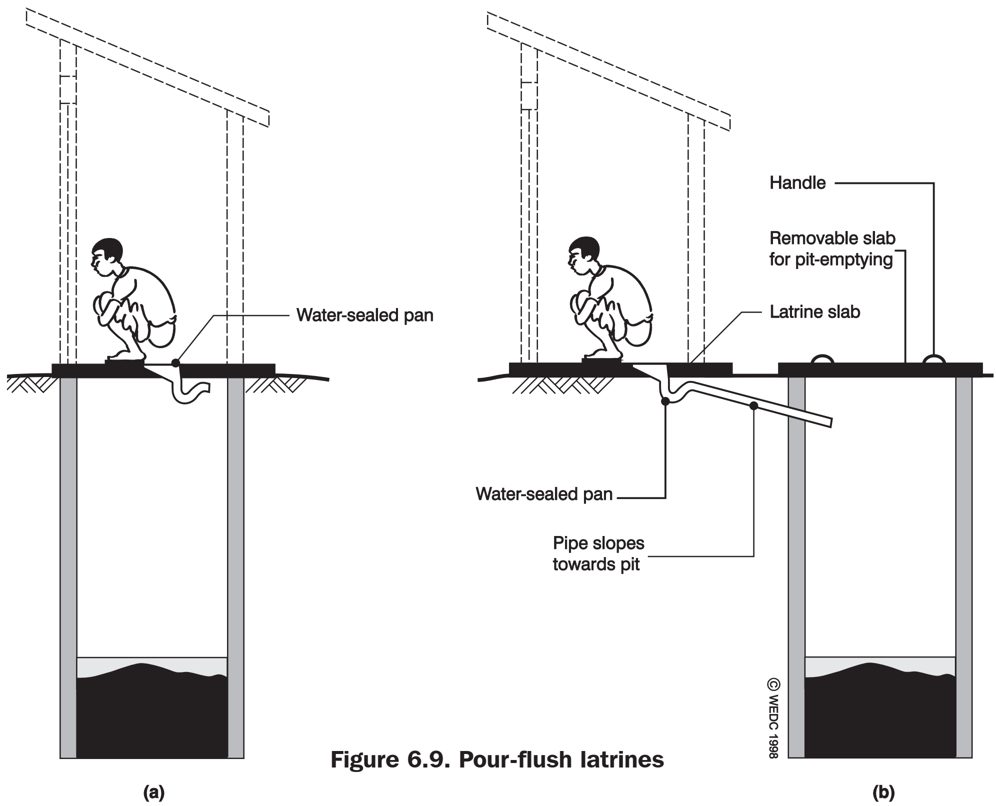

Figure 6.9. Pour-flush latrines

Pour-flush latrines may be constructed directly above a pit or may be offset, whereby the waste travels through a discharge pipe to a pit or septic tank (Figure 6.9).

Advantages: There is a lack of odour, ideal where water is used for anal cleansing; and they are easy to clean.

Constraints: An increased quantity of water required; solid anal cleansing materials may cause blockages; and they are more expensive than simple pit latrines.

6.5.6 Over-hung latrines

An over-hung latrine consists of a superstructure and floor built over water (Figure 6.10). A squat hole in the floor allows excreta to fall directly, or via a chute, into the water below. Over-hung latrines are rarely appropriate and should only be considered if other options are not possible, such as in areas prone to continued flooding. The receiving water must be sufficiently deep throughout the year, preferably should be saline to prevent human consumption, and should be flowing away from settlements.

Advantages: May be the only option in flooded areas.

Constraints: Can only be used where the contamination of the watercourse will have no adverse effect downstream; cannot be used over still water or where water is used for recreation, washing etc.; and superstructure must be solidly constructed and safe for users.

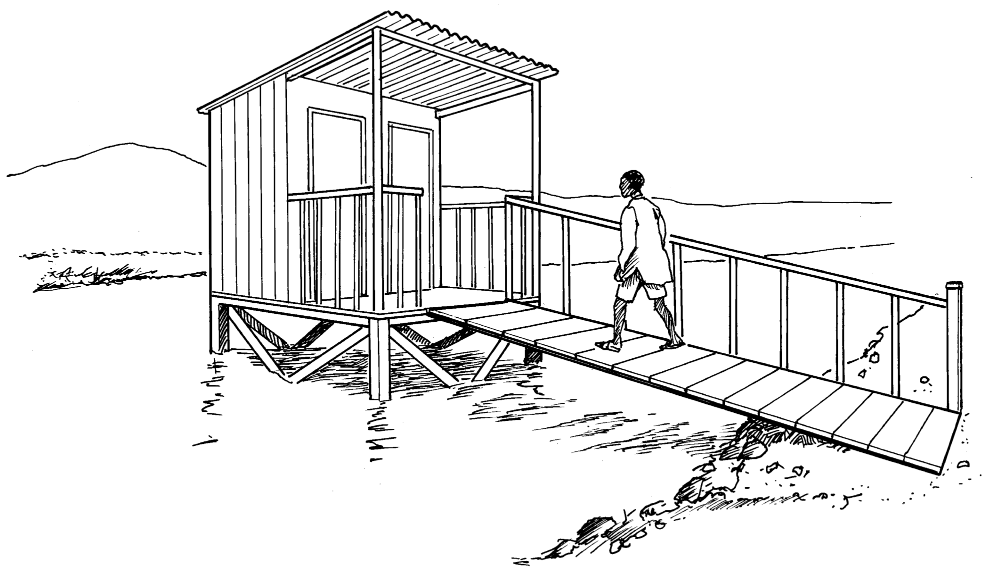

Figure 6.10. Over-hung latrine

Overhung latrine, Bangladesh

6.5.7 Borehole latrines

A borehole drilled by machine or hand-powered auger can be used as a latrine (Figure 6.11). This has a typical diameter of 400mm and a depth of 4-8m. At least the top 0.5 m should be lined although it is rarely necessary or appropriate to line the entire depth.

Borehole latrines are most appropriate in situations where boring/drilling equipment is readily available, where a large number of latrines must be constructed rapidly, and where pits are difficult to excavate, either due to ground conditions or lack of a suitable labour force.

Advantages: The borehole can be excavated quickly if boring equipment is available; suitable in hard ground conditions (where there are no large stones or rocks); and appropriate where only a small workforce is available.

Constraints: Drilling equipment is required; there is a greater risk of groundwater pollution; life span is short; sides are liable to be fouled, attracting flies; and there is a high likelihood of blockages.

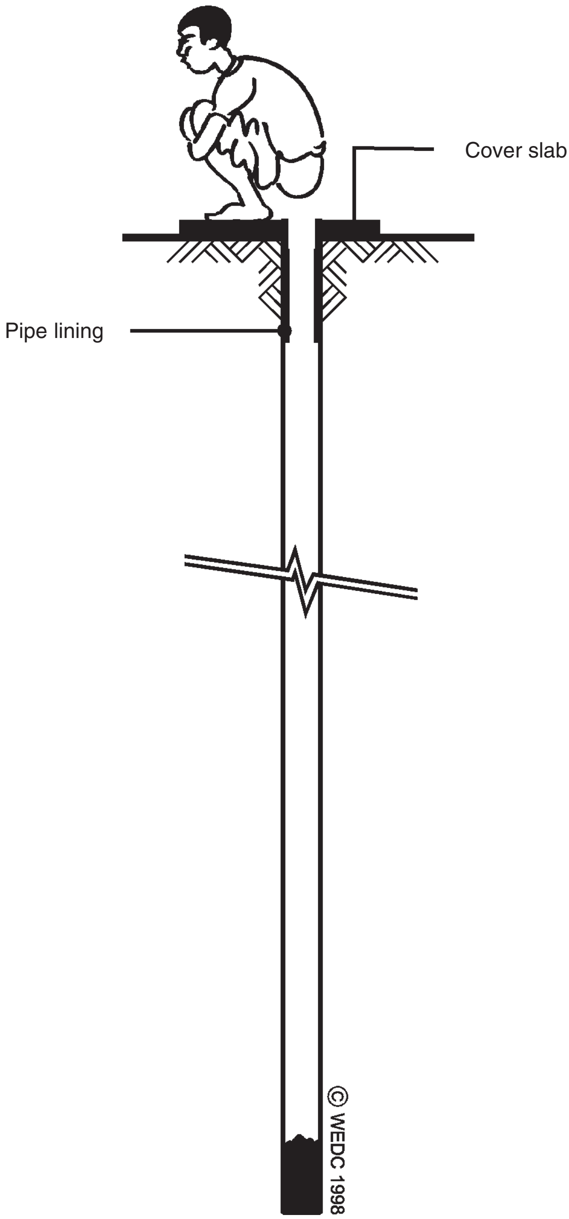

Figure 6.11. Borehole latrine

Drilling boreholes for latrines, Bangladesh

Borehole latrines nearing completion, Bangladesh

6.5.8 Sewerage systems

In sites with existing sewerage systems it is logical to make use of this by constructing toilet blocks directly over or slightly offset from sewers (Figure 6.12). Checks should be made to ensure that the system is functioning properly and is able to cope with the increased load. An adequate quantity of water (20-40 litres per user per day) is also required for flushing.

Advantages: An existing disposal system is already in place; and system is relatively quick to implement.

Constraints: Expansion possibilities may be limited; may cause problems due to overloading of system or after the population has moved on; an adequate water supply required for flushing; and freezing may cause blockages.

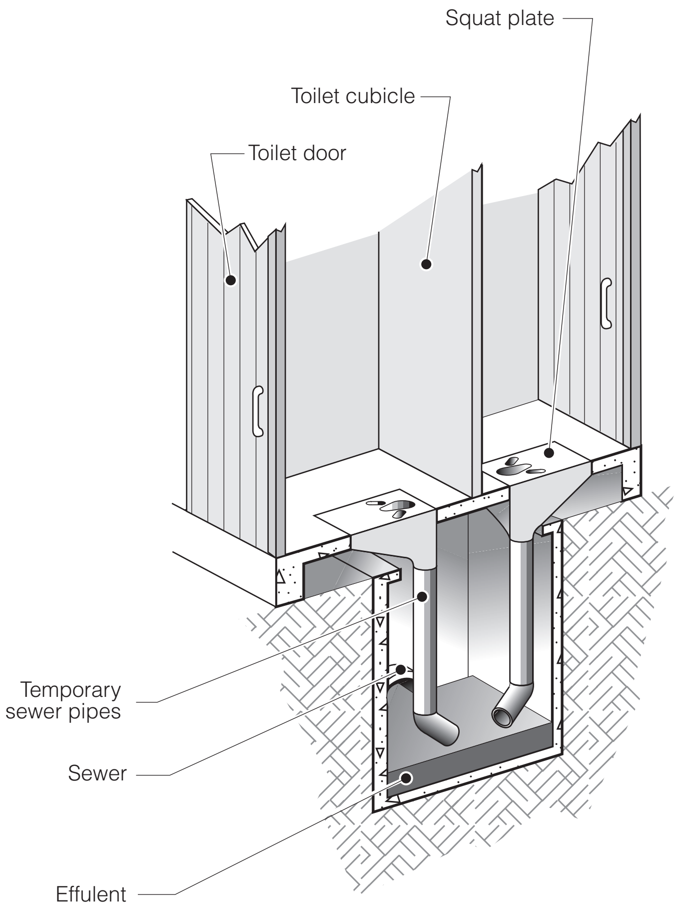

Figure 6.12. Temporary toilet block over existing sewer

6.6 Strategies for difficult conditions

In some situations it may be impossible to use traditional infiltration techniques (such as simple pit latrines) for excreta disposal. This is likely to be the case:

- where the water table is very close to the ground surface, limiting excavation;
- where groundwater sources are likely to be contaminated easily;
- where there is hard rock close to the surface, making excavation very difficult;
- where the ground is so soft that pit walls collapse before an adequate depth can be reached; and
- in flood-affected areas.

Figure 6.13 demonstrates how pollution from a latrine pit travels towards the water table. Generally, the base of the pit must be at least 1.5m above the wet season water table to prevent contamination, but in some geological conditions this may be insufficient. If there is a conflict between latrine provision and water supply it is usually easier and cheaper to develop another water source than provide alternative excreta disposal facilities. This may not always be possible, however, and wherever the groundwater level is high, protective measures should be taken, especially where groundwater is used as a source of drinking water.

If groundwater resources are not exploited for water supply in the area, the prevention of groundwater contamination should be of secondary importance to the provision of adequate excreta disposal facilities.

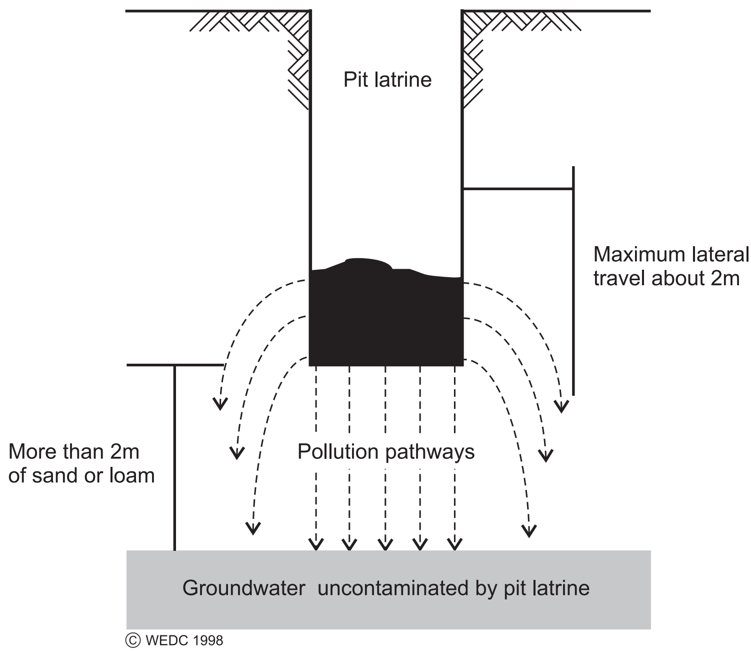

Figure 6.13. Pollution from a pit latrine above the water table

Raised VIP latrines, Tanzania

6.6.1 Raised pit latrines

Where the groundwater table is within a few metres of ground level, or excavation of the ground is extremely difficult, then a raised pit latrine may be a viable solution. This can be in the form of a simple pit latrine or a VIP latrine in which the pit is built upwards above the ground level. This increases cost and construction time considerably and family members may be unable to construct this type of latrine by themselves, but it is a relatively simple measure to minimise groundwater pollution.

6.6.2 Twin pit latrines

Where it is not feasible to dig a deep pit it may be easier and cheaper to dig two shallow pits side by side. This principle can be applied to simple pit latrines, VIP latrines or pour-flush latrines. The superstructure should be built over both pits, each of which has its own drophole. One pit is then used until it is full, at which point it is sealed and the second pit is used. If the contents of the first pit are left to stand for at least two years, virtually all of the pathogenic organisms will have died and the waste will be relatively safe to handle. Unlike a composting latrine (see 6.6.5-6), the pit contents are not a good fertiliser, although they may help to improve the quality of the soil to which they are added. Figure 6.14. illustrates a raised twin-pit VIP latrine.

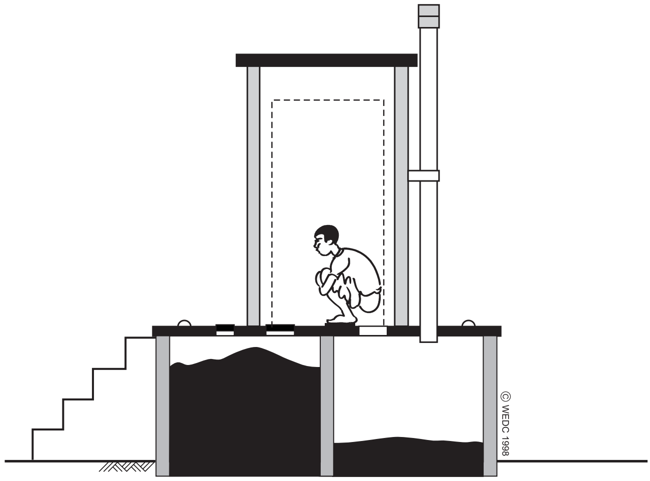

Figure 6.14. Raised twin-pit ventilated latrine

6.6.3 Sand-enveloped pit latrines

Where there is a high risk of groundwater contamination, and it is important to prevent this, a sand envelope can be constructed around a lined latrine pit to reduce pollution (Figure 6.15). This envelope is usually about 0.5m thick and acts as a filter to minimise the transmission of disease-causing micro-organisms. It should not be assumed that this will stop contamination completely. Where the risk of pollution of nearby groundwater sources is especially high, and there is no viable alternative, it may be appropriate to construct sand-enveloped raised pit latrines.

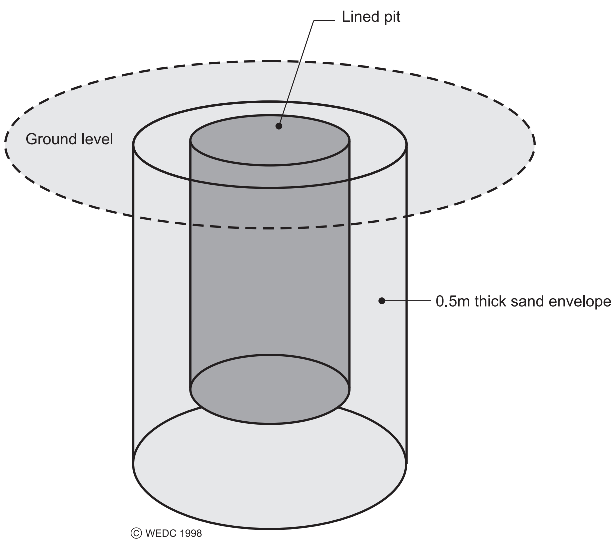

Figure 6.15. Sand-enveloped pit

6.6.4 Sealed pits/tanks

Groundwater contamination can also be prevented if the disposal pit or tank is fully lined and sealed, so that the contents are unable to infiltrate into the surrounding ground. The construction of fully lined pits is expensive and time-consuming, however, and is likely to be impractical where family latrines are desired. The second disadvantage is that such pits will need to be emptied relatively regularly, since no infiltration is able to occur.

6.6.5 Anaerobic composting latrines

Anaerobic composting latrines use a dry disposal system in which urine and faeces are managed separately. The deposited faecal matter is dried by exposure to heat or the sun and the addition of lime, ash, sawdust or earth, which controls the moisture content. Vegetable or other organic waste can also be added to control the chemical balance. The latrine contents are then isolated from human contact for a specified period to reduce the presence of pathogens and make the waste safe for handling. This period should be at least ten months and some practitioners recommend longer periods of two years or more. The longer the waste is stored the more pathogens will be destroyed. The waste may then be re-used as fertiliser or as fuel.

The primary difficulty in using this type of toilet is the separation of urine and faeces. Users have to be made aware of the importance of separation and the addition of ash after defecation. Such a system is unlikely to work where water is used for anal cleansing since this will increase the moisture content. This type of latrine is rarely appropriate in the initial stages of an emergency, unless the population is already accustomed to using similar systems. It requires no water and can be adopted where infiltration techniques are impossible, however, and may be a viable longer term option.

Figure 6.16 illustrates a double-vault latrine where one vault is used initially then sealed when full. The second vault is then used until that is full, at which point the first vault can be emptied and re-used. The vault size must be carefully calculated to ensure that the waste is retained for an appropriate period of time (see 6.8.8).

Heavy usage — as is likely in many emergency situations — may lead to serious problems because of inadequate time for decomposition.

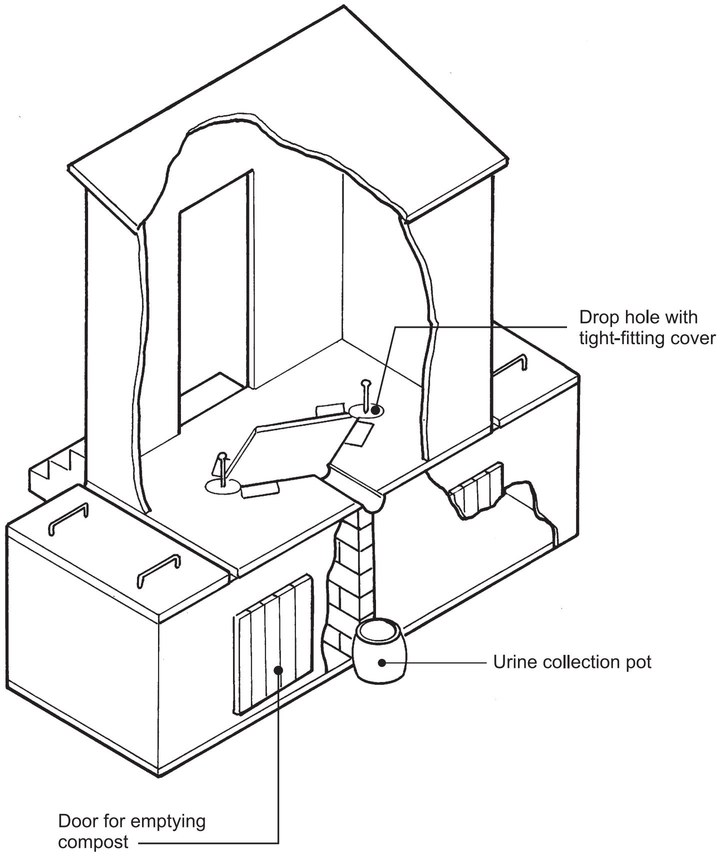

Figure 6.16. Double-vault composting latrine

6.6.6 Aerobic composting latrines

Aerobic composting latrines use a similar method to the anaerobic composting latrine and the intended outcome is the same — to reduce excreta to a safe re-usable state. The main difference is that urine does not need to be separated from faecal matter. New wastes must be separated from old, however, and air must be able to circulate freely. In a composting latrine, bacteria, worms, or other organisms are used to break down organic matter to produce compost. This is encouraged through the addition of organic refuse, such as vegetable waste, to the toilet chamber. The final compost produced can then be used as fertiliser for agricultural purposes.

Continuous composting toilets are expensive to construct and have only proved successful in small communities in industrialised countries. Like all composting latrines, this type of disposal system requires considerable user awareness and understanding, and is most appropriate where the affected population has some experience of this type of technology. In general, it is not an appropriate emergency excreta disposal system.

6.6.7 Septic tanks

A septic tank is designed to collect and treat toilet wastewater and other grey water (Figure 6.17). Its use is likely to be appropriate where the volume of wastewater produced is too large for disposal in pit latrines, and water-borne sewerage is uneconomic or unaffordable. Septic tanks are therefore particularly suited to systems involving high water use, especially where water is used for anal cleansing.

Wastes from toilets, and sometimes kitchens and bathrooms, pass though pipes to a water-tight tank where they are partially treated. After one to three days the liquid wastes leave the tank and are carried to a secondary treatment system. This is usually some form of under-ground disposal system, sewer or secondary treatment facility.

The treatment process in a septic tank occurs in four stages:

Settlement: Heavy solids settle to the base of the tank to form a sludge which must occasionally be removed; about 80 per cent of the suspended solids can be separated from the liquid in a well-designed tank.

Flotation: Grease and oil float to the surface to form a layer of scum; over time this scum layer becomes thick and the surface may be hard.

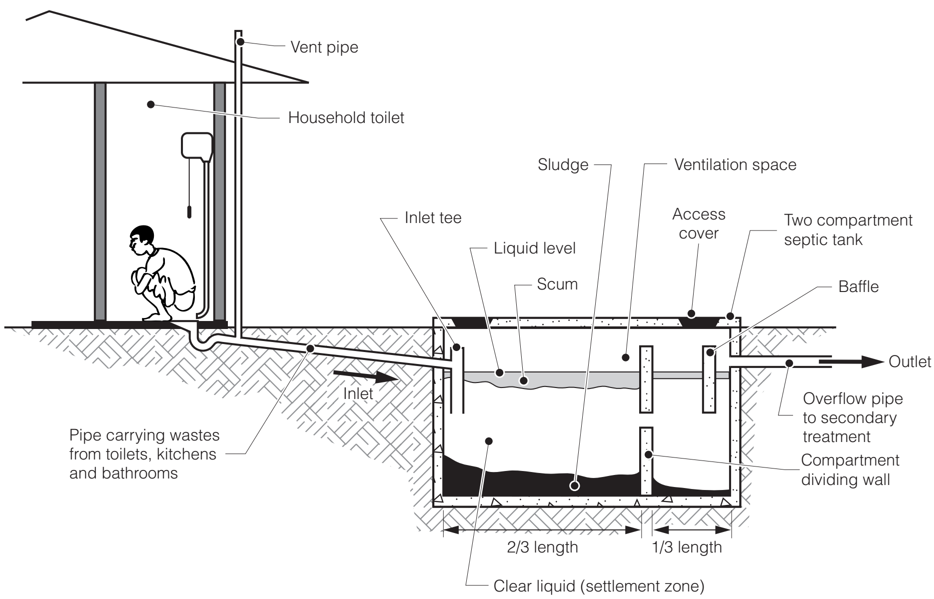

Figure 6.17. Wastewater treatment using a septic tank

Sludge digestion and consolidation: The sludge at the bottom of the tank is compressed by the weight of new material settling on top, increasing its density; and organic matter in the sludge and scum layers is broken down by bacteria which convert it to liquid and gas.

Stabilisation: The liquid in the tank undergoes some natural purification but the process is not complete; the final effluent is anaerobic and will contain pathogenic organisms such as roundworm and hookworm eggs.

The final effluent leaving the septic tank must be disposed of in an appropriate location such as a sealed pit or sewerage system.

6.6.8 Aqua privies

An aqua privy (Figure 6.18) is simply a latrine constructed directly above a septic tank. Aqua privies are appropriate where pit latrines are socially or technically unacceptable but the volume of sullage is small. The amount of water required for flushing is much smaller than for a septic tank because of the location of the tank. The water-seal pan and extension of the drop pipe 75mm below the water surface helps to exclude odours from the superstructure. The tank of the aqua privy must be watertight to maintain a constant liquid level in the tank. The outlet pipe should extend at least 50mm below the water surface to provide an odour seal.

Communal aqua privy, Bangladesh

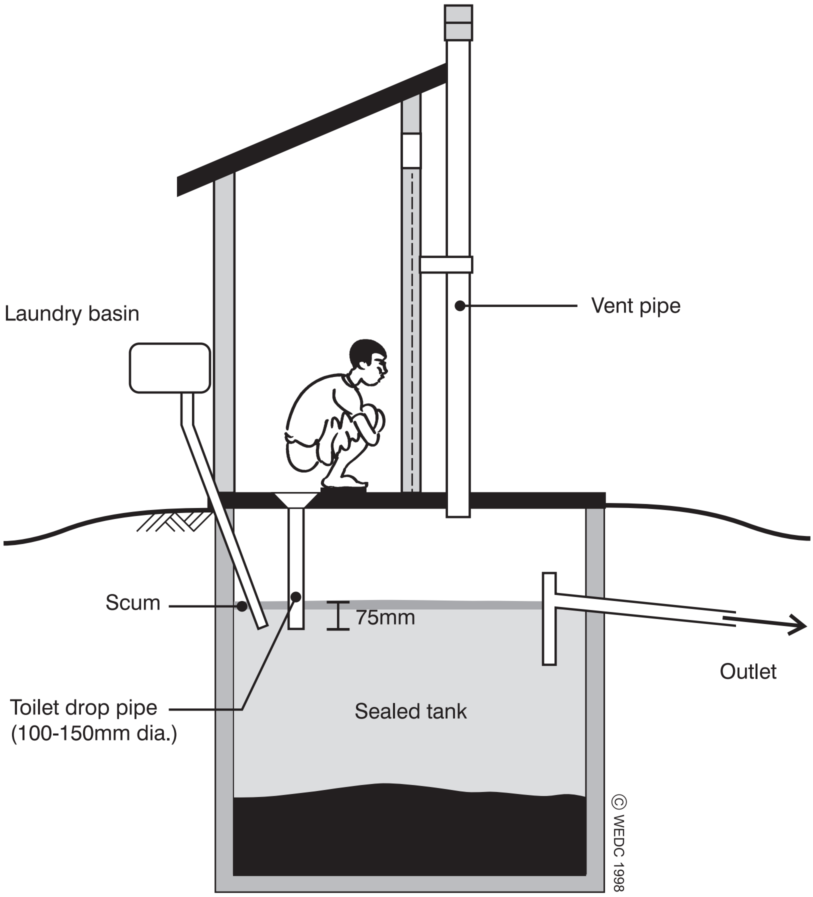

Figure 6.18. Aqua privy

6.6.9 Sewerage systems

Sewerage systems are not common in emergency situations, although they may be used where the affected population remains or relocates in an urban area. Most sewerage systems need at least 20-40 litres of water per user per day to be flushed into the system (Adams, 1999). In addition, pumped sewerage systems and sewage treatment works may require a back-up power supply to keep the system running. This may be a major undertaking.

6.7 Intervention levels

The selection of appropriate actions depends primarily on the actual scenario and the intervention level required. The following tables (6.2-6.4) indicate the most appropriate general options for immediate, short-term and long-term measures for four different scenarios, depending on the amount of space available.

Table 6.2. Recommended interventions for space of more than $30m^{2*}$ per person

Scenarios and recommended interventions	***The affected population go through a transit camp immediately after a disaster***	***The affected population remain in a temporary location for up to six months***	***The affected population stay in the affected area immediately after a disaster***	***The affected population move to a new area and are likely to remain for more than a year***
Immediate action	■ Clearing of scattered faeces ■ Controlled open defecation ■ Shallow trench latrines ■ Repair of existing facilities ■ Temporary communal or family latrines			
Short-term measure	■ Semi-permanent family latrines ■ Semi-permanent shared latrines			
Long-term measure			■ Permanent family latrines ■ Upgrading of existing facilities	

*Total available space (including space for non-dwelling areas)

Table 6.3. Recommended interventions for space of 20-30m² per person

Scenarios and recommended interventions	*The affected population go through a transit camp immediately after a disaster*	*The affected population remain in a temporary location for up to six months*	*The affected population stay in the affected area immediately after a disaster*	*The affected population move to a new area and are likely to remain for more than a year*
Immediate action	The same as Table 6.2			
Short-term measure	■ Semi-permanent communal latrines ■ Semi-permanent shared latrines			
Long-term measure			■ Permanent shared or communal latrines ■ Upgrading of existing facilities	

Table 6.4. Recommended interventions for space of less than 20m² per person

Scenarios and recommended interventions	*The affected population go through a transit camp immediately after a disaster*	*The affected population remain in a temporary location for up to six months*	*The affected population stay in the affected area immediately after a disaster*	*The affected population move to a new area and are likely to remain for more than a year*
Immediate action	The same as Table 6.2			
Medium-term measure	■ Semi-permanent communal latrines			
Long-term measure			■ Permanent communal latrines ■ Upgrading of exciting facilities	

These options are not exhaustive but provide an outline of the main actions to be considered in each scenario.

6.8 Design and construction

In the design and construction of any latrine it is important to consider the following four key factors:

- Safety
- Comfort
- Privacy
- Health

6.8.1 Siting latrines

Perhaps the most important design factor regarding latrine construction is **where** the latrine should be sited. The following factors are important siting selection criteria; each latrine constructed should be:

- not more than 50m away from dwellings to be served;
- at least 30m away from water storage and treatment facilities;
- at least 30m away from surface water sources;
- at least 30m horizontal distance from shallow groundwater sources (more in coarse or fissured ground);
- downhill of settlements and water sources, where possible;
- at least 50m away from communal food storage and preparation areas;
- close to handwashing facilities; and
- easily accessible to all intended users including children, old people, pregnant women and disabled people.

Accessibility is a key issue since this is likely to influence how often latrines are used, and hence whether indiscriminate defecation takes place or not. Security of users, especially women and children, must also be considered, particularly where communal latrines are in place. If necessary, facilities can be lit at night for security and convenience.

6.8.2 Construction materials and tools

The single most important factor in the selection of construction materials and tools is local availability. It is inefficient and inappropriate to import expensive materials if suitable materials are available locally. Possible construction materials include:

- Wood
- Grass
- Mud
- Earth blocks
- Bamboo
- Leaves
- Bricks
- Cement
- Gravel
- Sand
- Corrugated iron sheeting
- Plastic sheeting
- Cloth or sacking

There is often a tendency to focus on the use of typical relief agency materials, such as plastic sheeting, when there may be much better local alternatives available. Tools are often available locally, and although these may sometimes be of lower quality than imported ones, they are likely to be much more cost-effective, and the local population will be more accustomed to their use. Heavy equipment, or specialised equipment, may also be available and this may influence the selected construction method as well as the overall technology choice.

6.8.3 Superstructure design

To the user, the superstructure is likely to be the most important part of the latrine. For this reason alone, due attention must be given to its design. In some cultures people prefer to defecate in the open and a superstructure may not be required. In general, however, the superstructure must provide the necessary privacy for the comfort and dignity of the users. Materials and techniques used for the superstructure should generally be the same as those used for people's shelters, as this will facilitate ease of construction.

In areas of high rainfall, or for VIP latrines, a roof will be essential, although roofing materials may be stolen where shelter is a priority. In other situations roofs may not be necessary. The superstructure may have a door where desired, or a spiral-shaped entrance can be constructed. The superstructure can, more or less, be of any size and shape that the user desires, although a minimum base area of $1m^2$ is recommended.

Although the superstructure has little direct impact on the health benefits of the latrine (with the possible exception of a VIP latrine), its design is likely to influence whether the latrine will be used and looked after. It is therefore essential that the users are involved in the superstructure design, to ensure that it is socio-culturally acceptable and to promote the users' pride in their toilet.

6.8.4 Latrine slabs

An important component of a pit latrine is the latrine slab situated above the pit. The purpose of the latrine slab is to cover the top of the pit and, sometimes, to provide a surface on which the user puts their feet. The slab should be able to support the weight of a person, be easy to clean, and should be sloped slightly towards the squat-hole to allow liquid to drain. Figure 6.19 shows a typical cross-section of a latrine slab.

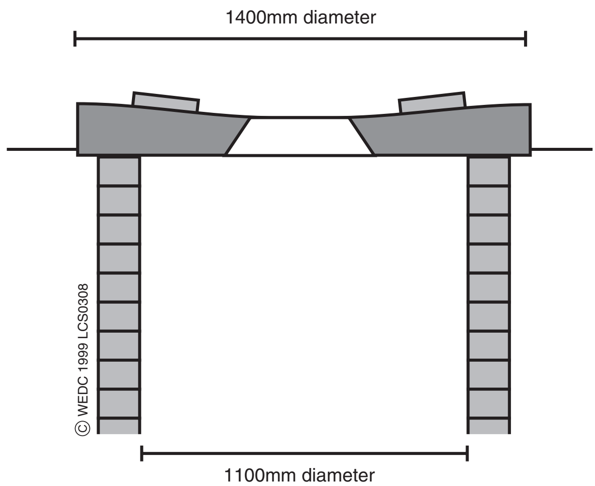

Figure 6.19. Cross-section of latrine slab with footrests

In many cases, the slab is likely to be the most expensive component of a simple pit latrine, since its production may entail skilled labour, cement, gravel and reinforcement.
In the early stages of an emergency, many agencies use pre-moulded plastic squatting plates. These are appropriate for immediate rapid implementation and are often suitable for use in emergency trench latrines, health centres, schools and reception centres. However, for long-term use it is more efficient to use locally manufactured slabs where possible.

The squat-hole in the latrine slab should be large enough to allow defecation and urination without fouling the floor, whilst being small enough for the young and old to span in safety. Ideally, this should be a 'keyhole' shape, about 160mm in diameter and 250mm long.

Slabs can be made of concrete, wood, ferrocement or plastic. Concrete is currently the preferred material since it is cheap, durable, easy to clean and simple to manufacture. Most concrete slabs are reinforced with steel bars to prevent breaking (Figure 6.20), and reinforcing bars should be placed near the base of the slab to carry the tension forces.

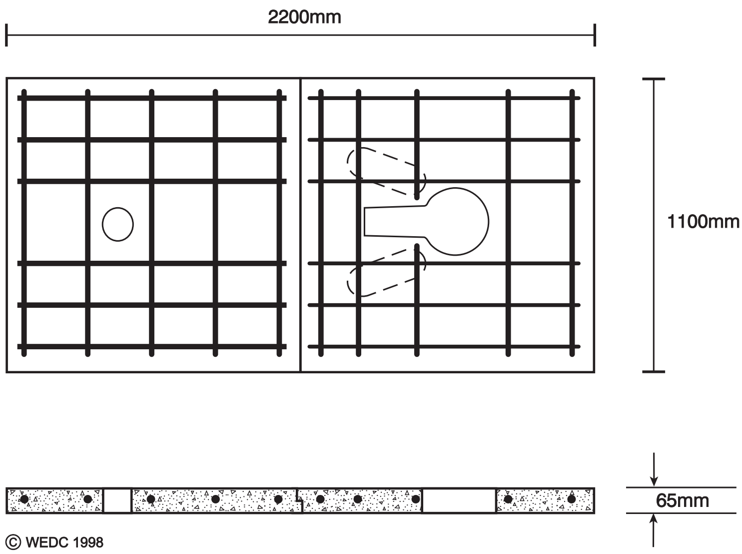

Figure 6.20. Reinforced latrine slab

The amount of reinforcement will depend on the size of the slab and the load to be carried. Table 6.5 gives suggestions for the amount of reinforcement required for different slabs. Slabs may be rectangular or circular.

Table 6.5. Spacing for steel reinforcing bars in pit latrine slabs

Slab thickness (mm)	*Steel bar diameter (mm)*	*Spacing of steel bars (mm) in each direction for minimum spans of:*				
		1m	**1.25m**	**1.5m**	**1.75m**	**2m**
65	6	150	150	125	75	50
65	8	250	250	200	150	125
80	6	150	150	150	125	75
80	8	250	250	250	200	150

Slabs without reinforcement can be made provided the slab is domed (Figure 6.21). The dome shape causes all the forces in the slab (apart from the rim) to be compressed so reinforcement is not needed. Domed slabs are cheaper than reinforced slabs but more care is required in their manufacture and transport. Such slabs have a typical diameter of 1.2-1.5m.

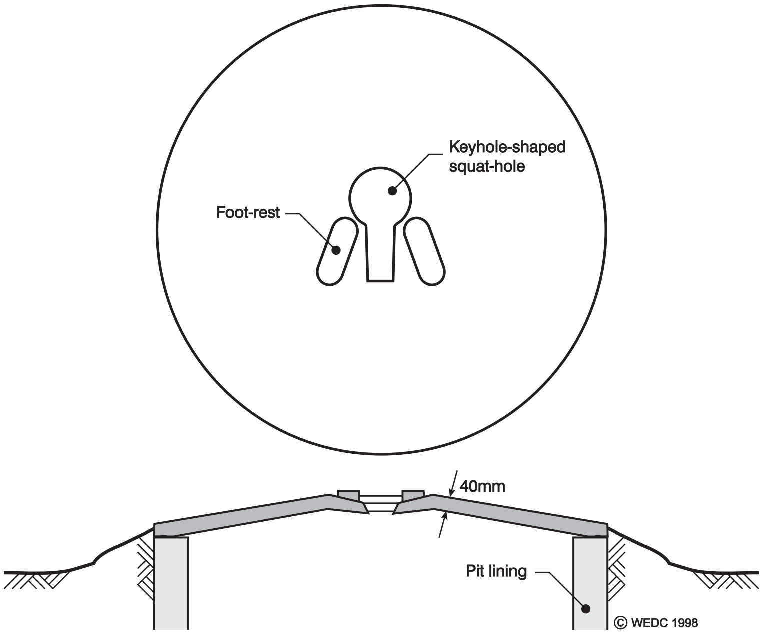

Figure 6.21. Domed latrine slab

Wooden slabs can also be used where concrete is too expensive or is unavailable. Wooden slabs can consist of whole poles covered in mud or soil (Figure 6.22), or can be sawn-timber platforms.

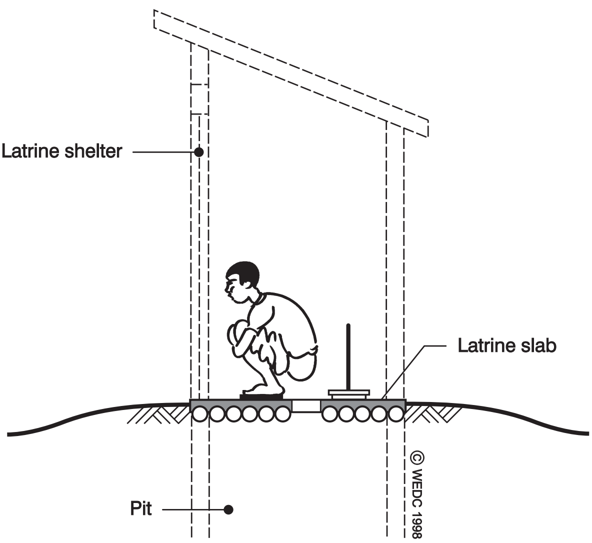

Figure 6.22. Wood and mud latrine slab

Pits with wooden slabs can be improved by placing a small concrete slab (San-plat) on top to cover the area used for defecation. The slab is quite small (typically 400mm x 600mm) but it covers the area of slab most likely to be fouled.

6.8.5 Making concrete

Concrete is a mix of cement, sand, gravel (aggregate) and water. Generally one of the two following design mixes is used:

Cement	Sand	Aggregate	
1	2	4	*Mix 1*
1	3	6	*Mix 2*

Mix 1 will be slightly stronger than Mix 2 due to the increased proportion of cement. In both cases gravel makes up approximately 60 per cent of the volume of concrete. The ratio of water to cement is generally:

Water	Cement	
1	2	*or*
1	3	

Concrete should be mixed on a clean, level mixing area. The following process should be adopted:

1. Measure out appropriate volumes of cement, sand and aggregate (according to the mix ratios above).
2. Shovel half the aggregate onto the mixing area.
3. Add half the sand.
4. Add half the cement.
5. Add the remaining sand.
6. Add the remaining cement.
7. Add the remaining aggregate.
8. Form a 'well' in the middle of the mix and add a small amount of water.
9. Mix the constituents together.
10. Continue adding water and mixing until uniform consistency is obtained.

Once the concrete is poured into the mould it must be **compacted** to eliminate voids (air holes). This can be done manually by using a wooden plank to pound the concrete surface.

The final stage of concrete preparation is **curing**, which simply means keeping the concrete damp while it sets. Concrete can be cured by covering, regular spraying or submerging in water.

The strength and workability of concrete is affected by the:

- concrete mix;
- water/cement ratio; and
- the curing process.

6.8.6 Squat-hole covers

The squat-hole cover for a simple pit latrine is designed to cover the hole when not in use, and to minimise flies and odour. A common problem concerning these covers is that they are often not replaced on the hole after use. This may be due to worries of faecal–hand contamination, or may be because covers are taken away for alternative uses.

In some cases, the cover is designed with a long handle, or is tied with a piece of string to the surrounding superstructure. An alternative design for a squat-hole cover is illustrated in Figure 6.23. Here, a hinged cover is used which can be opened and closed with the use of an attached piece of string, by hand, or even with the user's foot. The hinges can be made from old tyre rubber, which is available in most situations. The rubber hinges can be attached to the reinforcement within a concrete latrine slab, or tied to the wooden poles of a wooden slab.

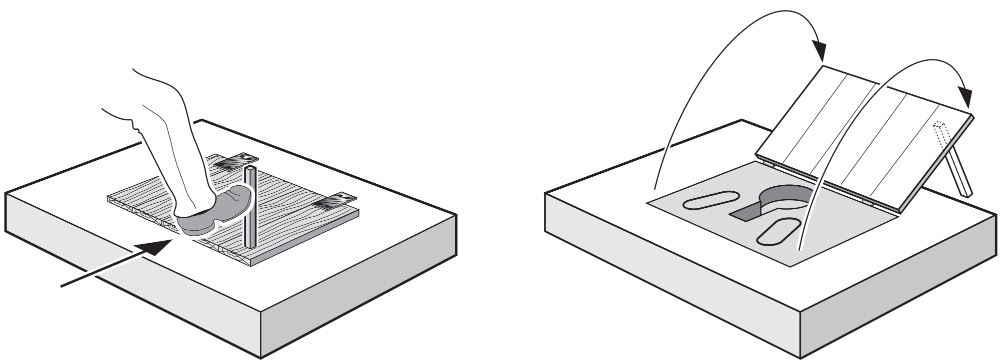

Figure 6.23. Squat-hole cover

6.8.7 Ventilation pipes

For VIP latrines it is important that the ventilation pipe is properly designed. A wide variety of materials can be used, such as uPVC, asbestos cement, fired clay, concrete or even mud covered bamboo or reed. If the pipe is smooth inside (such as plastic or asbestos cement) then an internal diameter of 150mm should be sufficient. Otherwise vent pipes should be at least 200mm diameter or square. The pipe should extend at least 0.5m above the superstructure roof to ensure the air flow is unobstructed.

The fly screen on top of the ventilation pipe should be made of mesh of about 1.2-1.5mm spacing. Mosquito netting is often used. The gases given off by the decomposition of excreta are very corrosive. For this reason, fly mesh made from mild steel will rot very quickly and plastic mesh will last about two years. Aluminium or stainless steel are the best materials to use.

6.8.8 Pit excavation and lining

Most single pits for household or family use are about 1m across and 3m deep. It is difficult to excavate pits less than 0.9m diameter because there is not enough room for the person to work. There is no maximum size for a pit and sizes vary greatly.

The best shape for a pit (in plan view) is circular. Circular pits are more stable because of the natural arching effect of the ground around the hole – there are no sharp corners to concentrate the stresses (Figure 6.24). Pits with flat sides are much more likely to need supporting and require a bigger area of lining than a circular pit of the same internal volume. Many communities prefer to excavate square or rectangular pits, however, as their construction is similar to the process used for building domestic houses.

In general, the top 0.5m of a pit should always be lined, but the decision as to whether to line the rest of the pit will depend on the type of soil in which the pit is dug. When a pit is first excavated it may appear stable, and it may be impossible to tell whether or not the walls will collapse after some time. One way in which this can be assessed is to examine other excavations (such as hand-dug wells) in the area. If existing excavations have not collapsed and are not lined, then it is fairly safe to assume that pit latrine excavations will not need lining. Where there is doubt it is advisable to line the pit. Table 6.6 suggests the types of soil that, in general, do and do not require lining.

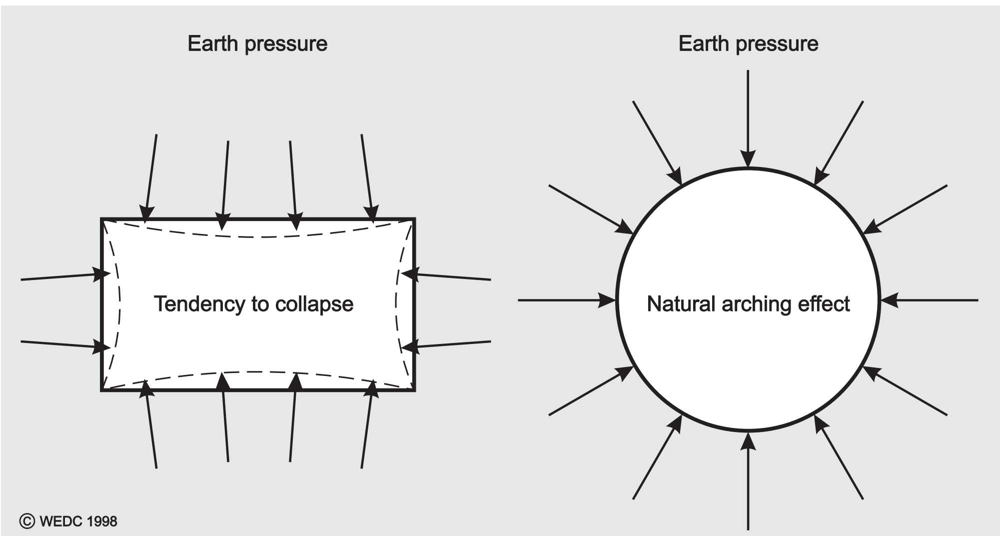

Figure 6.24. Stress concentrations on rectangular and circular pits

Table 6.6. Lining requirements for different soil types	
Soils that require lining	***Soils that do not require lining***
Soft sands and gravels Unconsolidated soils Filled land Compressed mudstones and shales	Soils with significant clay content Most consolidated sedimentary rocks Soils with high proportion of iron oxides (laterites)

Failed unlined trench latrines, Sudan

The following are commonly used pit lining materials:

- Pre-cast concrete rings
- Cast in-situ concrete
- Clay rings
- Oil drums
- Soil/cement blocks
- Local dressed stone
- Burnt bricks
- Concrete blocks
- Termite resistant timber
- Ferrocement

Bamboo and cane can only be used for short-term pits (usually less than two years). Figure 6.25 shows details of the construction of a shallow pit with lining.

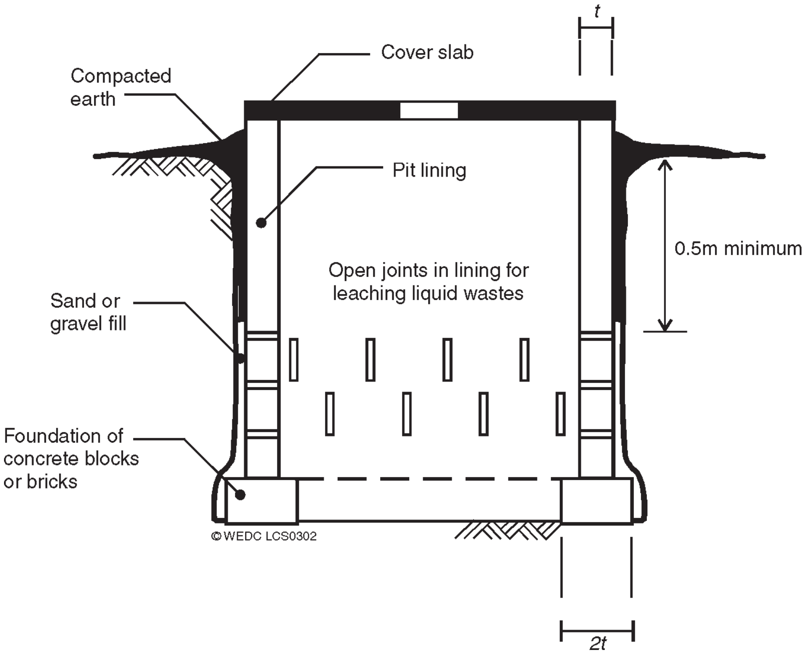

Figure 6.25. Shallow pit with lining

6.8.9 Sizing pits

In order to size pits or tanks it is important to determine the rate at which sludge (including faeces, urine and anal cleansing material) will accumulate, and the rate at which effluent will infiltrate into the surrounding ground. The top 0.5m of a pit should not be filled; this is to allow safe back-filling and to prevent splashing, unpleasant sights and increased incidence of problems with odour and flies.

The approximate size of the pit in m^3 can be calculated from the following equation:

$$\text{Volume of pit, } V = \frac{(N \times S \times D) + 0.5A}{1000} \quad \rightarrow \text{Equation 1}$$

Where: N = number of users
S = sludge accumulation rate (litres/person/year)
D = design life (years)
A = pit base area (m^2)

If the size of the pit is fixed, the time taken to fill it can be calculated by rearranging Equation 1 to find the design life:

$$\text{Design life, } D = \frac{(V - 0.5A) \times 1000}{(N \times S)}$$

Sludge accumulation rates vary greatly and local figures should be obtained if possible. In the absence of local knowledge, Table 6.7 gives guideline sludge accumulation rates for different wastes and conditions.

Table 6.7. Suggested maximum sludge accumulation rates[a]

Wastes deposited and conditions	***Sludge accumulation rate 'S' (litres per person per year)***
Wastes retained in water where degradable anal cleaning materials are used	40
Wastes retained in water where non-degradable anal cleaning materials are used	60
Wastes retained in dry conditions where degradable anal cleaning materials are used	60
Wastes retained in dry conditions where non-degradable anal cleaning materials are used	90

[a] *Source: Franceys et al., 1992*

Notes: The term 'wastes retained in water' when applied to a pit latrine means that wastes are in a section of the pit that is below the water table.

In many emergency situations latrines are subjected to heavy use and exreta and anal cleansing materials are added much faster than the decomposition rate. Where this is the case it is suggested that these sludge rates be increased by 50 per cent.

Worked example: A dry pit latrine is to be used by 20 people for a period of two years, and degradable corncobs are used for anal cleansing. The base of the pit is to be 1m by 1m square.

N = 20
S = 60 l/year (from Table 6.7)
A = 1 x 1 = $1m^2$
D = 2 years

$$V = \frac{N \times S \times D}{1000} + 0.5A$$

$$\Rightarrow V = \frac{20 \times 60 \times 2}{1000} + 0.5 = 2.9\ m^2$$

Since the cross-sectional area is $1m^2$, this pit would therefore need to be 2.9m deep.

The pit is considered full when the sludge reaches 0.5 m below the latrine slab. At this stage the pit should be replaced or emptied.

Important note: This method assumes that liquid wastes are absorbed by the surrounding ground. If liquid remains in the pit it will fill much more quickly. This is likely to happen where large volumes of water are used, where pit walls have a low infiltration capacity, or where the pit is poorly ventilated. It should also be noted that soil pores become clogged with time, reducing or even stopping infiltration. For this reason, pits should be over-sized rather than under-sized, especially where soil infiltration rates are relatively low.

Infiltration rates for different soil types are difficult to determine; for more information refer to Section 4.3.2.

6.8.10 Septic tank design

In designing a septic tank, in general, the length of the first compartment should be twice the length of the second. Guidelines for the sizing of a septic tank are given below.

> Total tank volume (C) = clear liquid retention volume (A) + sludge and scum volume (B) + ventilation space (V)

Clear liquid retention volume is the volume required for storing the liquid wastewater:

$$A = Q \times T/24$$

Where:
- A = retention volume (m^3)
- Q = volume of wastewater treated per day (m^3)
- T = tank retention time (hours)

Table 6.8. Recommended septic tank retention times

Daily wastewater flow	*Retention time 'T' (hours)*
Less than $6m^3$	24
Between 6 and $14m^3$	33 – 1.5Q
Greater than $14m^3$	12

The volume required for storing sludge and scum can be estimated by:

$$B = P \times N \times F \times S$$

Where: B = required sludge and scum volume (m^3)

P = number of people served
N = number of years between desludging (2-5 years)
F = factor for sludge digestion rate (see Table 6.9)
S = rate of annual sludge and scum production (m^3/person/year)
Generally, S = 0.025m^3/person/year for toilet wastes only
S = 0.040m^3/person/year for toilet wastes and sullage

Ventilation space (V) is the volume of air space required between the top of the liquid and the base of the cover. This should be of a depth of 300mm, and is to allow for scum above the liquid and space for gases to escape to the ventilation system.

Total tank volume, $C = A + B + V$

The minimum size required to produce the necessary calm conditions in a septic tank is 1.3m^3. If the value of A + B is less than this then the value 1.3m^3 should be used. This minimum value does not apply to aqua privies however.

Table 6.9. Value of sludge digestion factor 'F'

Years between desludging	***Average air temperature***		
	Greater than 20°C all year	***Between 10°C and 20°C all year***	***Less than 10°C in winter***
1	1.3	1.15	2.5
2	1.0	1.15	1.5
3	1.0	1.0	1.27
4	1.0	1.0	1.15
5	1.0	1.0	1.06
6 or more	1.0	1.0	1.0

6.9 Emptying pits

Many of the technology choices described above involve the construction of a pit or tank which does not rely on infiltration but will need emptying if used in the long term. Where possible, pits should be appropriately sized or replaced to prevent the need for regular emptying. This is not always possible, often due to lack of space, and where this is the case facilities for emptying must be in place. Pit emptying is most difficult where pits fill fast, where hard or plastic anal cleansing materials are used, and where vehicular access is difficult.

6.9.1 Mechanical pumps

The easiest and most hygienic method for emptying latrines is to use a vacuum tanker (sometimes know as a 'sludge-gulper') which is a truck with a large tank fitted with a mechanical pump (Figure 6.26). After pumping out the contents of the pit, the tanker can be driven to a safe disposal site, such as an off-site underground pit or sewage treatment works, where the contents can be emptied.

Vacuum tankers are good at removing liquids but poor at removing solid material. Dry pits or pits containing large quantities of solid materials such as stones, sticks, plastic bags, etc. cannot be emptied. Another problem with vacuum tankers is that they are very large and may be difficult to manoeuvre close to latrines.

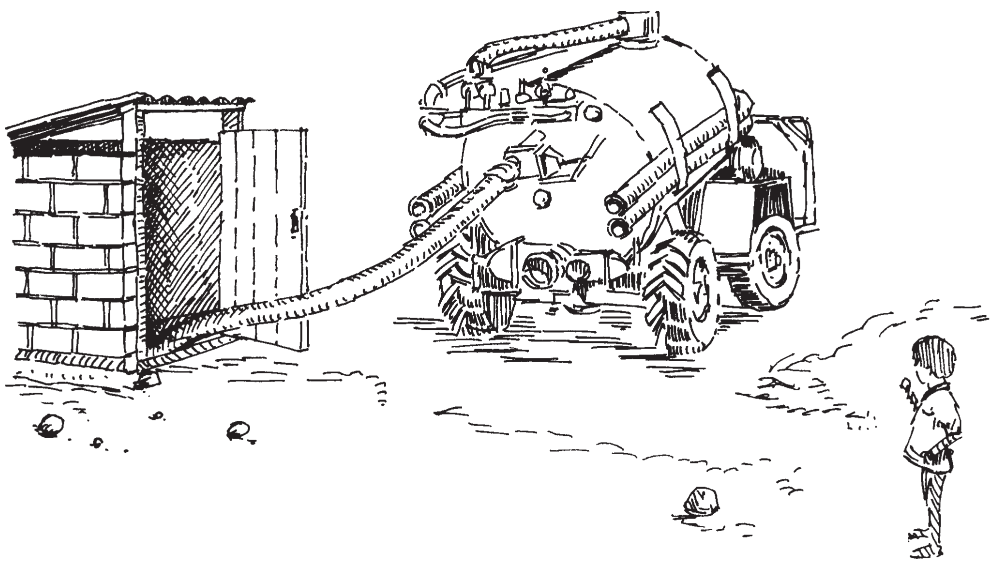

Figure 6.26. Vacuum tanker emptying latrine pit

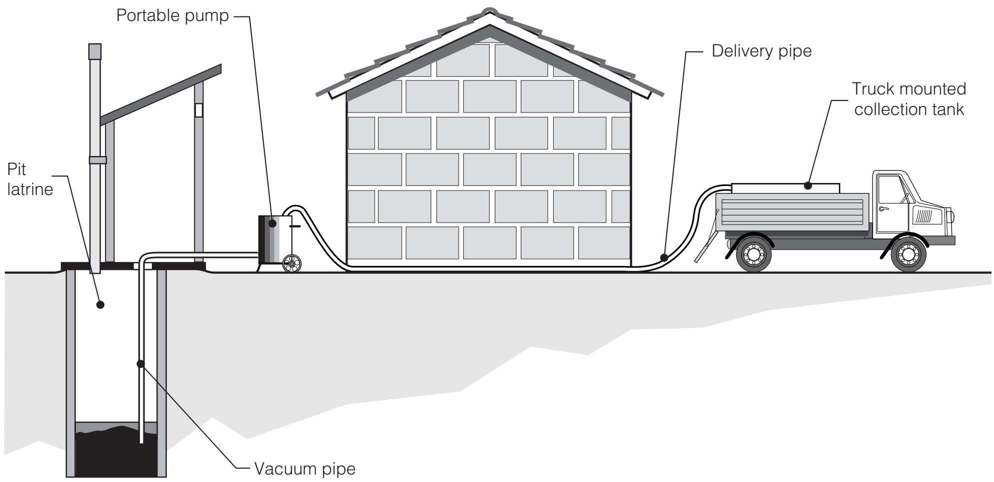

Figure 6.27. Vacuum tanker with remote pumping unit

Where a purpose-built vacuum tanker is unavailable or inappropriate, a collection tank can be mounted on a flat-bed truck, and a portable pump used to pump the waste from the pit to the tank (Figure 6.27). Such pumps must be carefully selected, particularly where hard anal cleansing materials are used, and specialist sewage pumps are recommended. Again, this is most suitable for wet conditions, and if necessary a small volume of water can be pumped into the pit first and stirred into the sludge to help liquify it.

6.9.2 Hand-operated pumps

Hand-operated latrine-emptying pumps are available in some countries. These are usually mounted on a hand-pushed cart which can be wheeled close to the pit to be emptied. These are much slower in operation than a mechanical pump and experience in their use is likely to be necessary. Such pumps are most appropriate if available and used locally, and where pit contents are wet.

6.9.3 Manual emptying

As a last resort, pits can be emptied of waste manually. This generally involves workers climbing into the pit and using shovels and buckets to take the waste out. This can then be placed in a wheelbarrow, or truck, and taken to a safe off-site disposal site. This should only be attempted once a pit has been closed and the contents left to decompose for some time (preferably at least two years).

6.9.4 Sludge reduction

Sludge reducing agents have been developed to speed up the sludge digestion process. These bioadditives are designed to boost one or more of the three basic ingredients of digestion: nutrients, enzymes and bacteria. If successful, such bioadditives could be added to pit latrine contents so that pits will require emptying less frequently. Recent trials have indicated that some bioadditives are successful in reducing sludge volumes and reducing fly infestation (Redhouse, 2001), however there appear to be significant constraints in their application. Due to the generally faster rate of sludge accumulation in emergencies it is not yet known how appropriate such technologies are in emergency sanitation programmes.

6.9.5 Sludge disposal

Sludge that has been left undisturbed for over two years is not a hazard to the environment. It can safely be spread anywhere convenient such as a garden or refuse tip. Its fertiliser value is not good but it will add humus and fibre to the soil which will promote plant growth.

Open disposal of fresh sludge into water or onto land is undesirable as it is an environmental and health hazard. The best solution is to bury sludge in pits where it cannot come into contact with humans or animals, and will not contaminate groundwater sources. Alternatives are to mix it with the influent at a nearby sewage works or compost it with domestic refuse.

References and further reading

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