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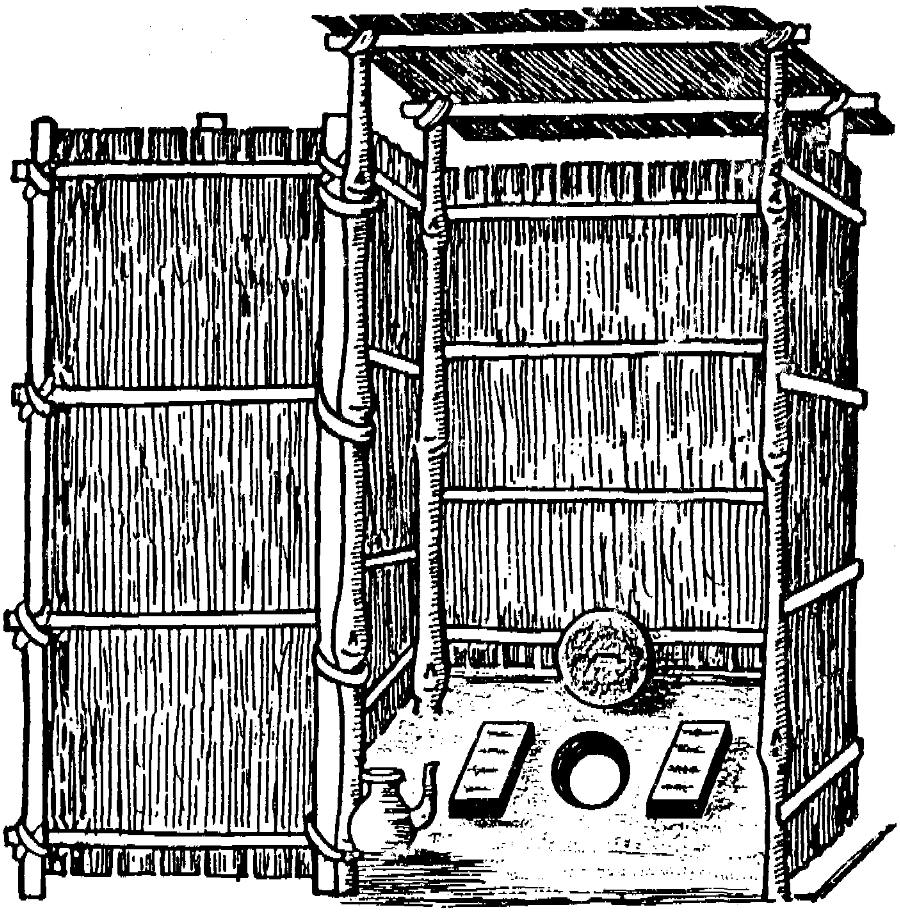
On-Site Sanitation: Building on Local Practice



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For further information:

IRC
P.O. Box 93190
2509 AD The Hague
The Netherlands

Telephone:	+31 - (0)70-33 141 33
Telefax :	+31 - (0)70-38 140 34
Telex	33296 irc nl
Cable	Worldwater, The Hague

On-Site Sanitation: Building on Local Practice

Madeleen Wegelin - Schuringa

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Preface

Despite commendable efforts during the International Drinking Water Supply and Sanitation Decade, the percentage of rural population in developing countries with adequate sanitation facilities has only grown from 14% in 1980 to an estimated 18% in 1990. The coverage for urban sanitation has improved from 56% to 66% over the same period.

It is clear that sanitation developments have to be accelerated to reach the goal of health for all by the year 2000. But it has also become clear, that high coverage levels for sanitation facilities do not guarantee their proper use and maintenance. Unless people have been motivated and involved in planning for sanitation, the chance that improvements are sustainable is small. It is felt that so far, sanitation has been too much of a technical affair, while the cultural and social considerations have not been given enough emphasis.

This manual is written to provide an insight into the cultural and social aspects which influence sanitation developments. It also provides an overview of technical options available for on-site sanitation in rural and peri-urban areas. Because it is often much more effective and acceptable to upgrade existing facilities, emphasis is put on the technical details which can be used in upgrading. Technical aspects of the design of latrines are also included, to use as a guide for carrying out improvements. But for the construction of the more elaborate latrines, existing technical handbooks should be consulted.

The manual is intended primarily for those involved in sanitation programmes for low-income communities in developing countries, not only sanitary engineers, but also social scientists, economists, planners and hygiene educators.

Assistance with the technical sections has been provided by Mr. J. Smet, Mr. J.G. Wilson and Ms. L. Burgers, whilst Mr. J.T. Visscher has provided guidance concerning the conceptual approach adopted in this manual. Many other people at IRC have also assisted with their knowledge on specific aspects of community-based, sustainable sanitation. Mr. R. Schertenleib, Director of IRCWD, has reviewed the document and provided the sections on groundwater pollution and pit emptying requirements. Gratefully acknowledged are also the efforts of Ms. Q. Bakhteari and Mr. S. Hvam in reviewing this document and providing very useful comments. Thanks also to Ms. L. Wolvers of IRC who did the desk top publishing of this manuscript.

1. *Introduction*

One of the major lessons learned during the International Drinking Water Supply and Sanitation Decade, is that the provision of water and sanitation facilities alone does not automatically imply their proper use or maintenance. Quite often, facilities are left unused soon after installation, or they are not repaired when broken down. One of the major reasons for this is that communities have not been consulted about their needs and priorities and have not been sufficiently involved in planning the facilities. They therefore do not feel responsible for them. It is unrealistic to expect people to devote limited resources to something they do not regard as a priority.

One of the problems with sanitation is that it is rarely a strongly felt need, especially in rural areas. Few people realize that many diseases are caused by poor sanitation or understand the way these diseases are transmitted. Although health considerations are rarely a motivating factor for a community to construct sanitation facilities, it is for health reasons that good sanitation is being promoted. For the community, various other factors such as privacy, convenience and status are more important. The key to getting people motivated to improve sanitation, is to understand these factors and to use them as a basis for the development of an intervention strategy together with the community.

This intervention strategy needs to have a two-pronged orientation - individual and community - because sanitation is both a personal and a communal concern. While defaecation itself is a very private function, the positive and negative effects of excreta disposal are of communal importance. For instance, if in a community a number of people have latrines, whilst the rest continue to defaecate in an unsanitary way, the net effect of these latrines on the health condition of the whole community will be minimal. Wider sanitation issues such as drainage and solid waste disposal are even more of a community affair.

This manual discusses key elements of a community-based approach to sanitation improvements and includes a description of:

- methods to involve people from the start in identifying the risks and problems of sanitation conditions in their community as a basis for sanitation improvements;
- cultural and social conditions which influence attitudes towards sanitation;
- methods to upgrade existing sanitation facilities;
- different low-cost sanitation technologies.

The most important excreta-related diseases and their transmission routes are described in Chapter 2. Also discussed are traditional defaecation practices and sanitary facilities. Although these may not be hygienic or safe, they do reflect local, social and cultural preferences. A combination of hygiene education and upgrading of existing latrines may be a much more acceptable form of sanitation improvement than the construction of new facilities, which many people may not be able to afford.

An intervention to improve sanitation always has to begin with what the people already do, what they know and what they want. Because it is unlikely that everybody in the community has the same attitude towards sanitation, it is necessary to make an inventory of the various attitudes and of the main risk factors and problems affecting the different groups making up the community. This can lead to a classification which can serve as a basis for programme development. The steps to be taken to come to this classification are discussed in Chapter 3.

Before planning for improvements with the community can start, an understanding is necessary of several aspects which have a direct bearing on sanitation behaviour and on the choice of possible sanitation improvements. First of all, this concerns the cultural factors which influence sanitation behaviour and the factors which motivate people to have a latrine. Furthermore, options for resource mobilization are discussed as well as ways to organize the community to carry out improvements. Chapter 4 ends with an overview of environmental conditions and preferences in sanitation design, which are the basis for technical options available for improvements.

The possibilities to improve sanitation practices and to upgrade existing sanitation facilities are presented in Chapter 5. If people do not have a latrine and are not willing or able to construct one, it may be possible to reduce health risks by changing existing sanitation practices with the help of hygiene education.
The viability of upgrading is dependent on a number of issues, such as the remaining useful life of the pit and the present structural soundness. If upgrading is viable, there are several options for improvement such as improving the slab, fly and odour control and the superstructure.

If there are no facilities or the existing facilities cannot be upgraded, but people are sufficiently interested, new facilities have to be built. Chapter 6 gives an overview of different systems which do not need water for flushing, while in Chapter 7 low-cost systems which use water for flushing are described.

2. *The Importance of Sanitation*

2.1 Excreta-related diseases

The most important excreta-related diseases are diarrhoea and worm infections. They are excreta-related because they are directly or indirectly transmitted through faecal material. With regard to the transmission of these diseases, there is a distinction between the state of being infected and the state of being ill. Often, the people who transmit the infection show few or no signs of having the disease, while people who are very ill from a disease may be of little or no importance in its transmission (Cairncross and Feachem, 1983).

There are three key factors which affect the probability of transmission of an infective dose of the disease agent from one person to another. These are latency, persistence and multiplication. When choosing an excreta disposal system they will have to be kept in mind as they influence the chance of survival of the different pathogens in the different systems.
Latency is the interval between the excretion of a pathogen and its becoming infective to a new host. All pathogens causing diarrhoea are immediately infective, while a number of worm infections require a distinct latency period because the eggs need to stay outside a host's body to develop into an infective state. The requirements for the safe disposal of excreta containing immediately infective pathogens are far more stringent than for those containing pathogens with a prolonged latency period.
Persistence relates to the amount of time a pathogen can survive after leaving the human body. A persistent germ will create a health risk throughout most treatment processes and during reuse of excreta.
Multiplication of pathogens varies considerably. Most pathogens do not multiply outside the (intermediate) host. But within the (intermediate) host, originally low numbers can multiply to become infective. This is, for instance, the case with bacteria in a human host. Most types of worms will not multiply within a human host, but require another environment (soil, snails, animals) to multiply (Feachem, 1983).

The most important excreta-related diseases can be classified according to their transmission routes:

- Diarrhoeal diseases;
- Worm infections;
  - with no intermediate host
  - with an aquatic intermediate host
  - with an animal intermediate host
- Insect transmitted diseases.
  (Feachem e.a., 1983).

Diarrhoeal diseases

The diseases belonging to this category are caused by viruses, bacteria and protozoa. Examples are rotavirus diarrhoea, pathogenic E.coli diarrhoea and amoebic dysentery. Diarrhoea makes people weak and causes dehydration due to loss of body water. Severe dehydration may cause death, especially for children and people who are poorly nourished.

The infection is transmitted through ingestion of the faeces of infected persons. This is called the faecal-oral route of transmission.
There are many ways in which faeces can become ingested. The most direct way is by drinking contaminated water or eating contaminated food. Another direct, but often less obvious way, is via dirty hands. Children are prone to get infected this way. When hands are not washed properly after defeacating or at regular intervals during the day, tiny bits of faeces may stick to the fingers or under the nails and become ingested when the fingers are put in the mouth. Dirty hands can also contaminate kitchen utensils and food. The most indirect means of transmission is through insects such as flies and cockroaches. These insects feed on faeces and food, spreading pathogens around on their legs.

Worm infections

The health consequences of worm infections are generally underestimated because the clinical effect is rarely acute and the severity of the disease is typically related to the number of worms and not merely to the presence of infection. Moreover, the chronic, debilitating and insidious course a worm infection can have, is rarely revealed in health surveys.
Because most worms do not multiply within a human host, the amount of worms is dependent on the amount of times a person gets infected. Continuous exposure and self-reinfection are therefore determining factors for the total wormload a person may have.
A problem with many kinds of worms is their invisibility to the naked eye. Because they cannot be seen, people are not aware of them. And in many societies worms are anyway not considered a disease.

> A survey in Bhaktapur, Nepal, revealed that people considered themselves to be healthy. After a filmshow on sanitation-related diseases, people were invited to bring their stools for examination. Most people did have worms and they saw them under the microscope. A deworming campaign was then launched, and a prize offered to the person who could show most worms. The prize was won by a seven-year-old girl who produced 63 worms in three sittings. The people then started to realize that something should be done and they were much more motivated to start improving their sanitation practices and facilities (Lohani and Guhr, 1985).

Worm infections with no intermediate host

Several excreted worms which infect people have no obligatory intermediate host. The adult worms live in the human intestine and their eggs or larvae are passed in faeces. The eggs of *Ascaris* (roundworm) and *Trichuris* (whipworm) must remain in a suitable environment (usually warm, moist soil) for 1 1/2 to 6 weeks to become infectious. Infection then takes place through the faecal-oral route of transmission.
The eggs of the *Hookworm* also develop in warm moist soil. After one week or more, infective larvae develop which cause infection by penetrating the unbroken skin, usually of the foot.
The eggs of the *Enterobius vermicularis* (thread- or pinworm) are laid on the perianal skin, especially during the night. This causes itching and consequent scratching. Self-reinfection and infection of others via unclean fingers happens a lot, while infection can also occur when the eggs stick to the faeces after defaecation, and get ingested at a later stage.

Worm infections with an aquatic intermediate host

The most important worm in this category is the *Schistosome* (bilharzia). Schistosome worms live in a host's blood system. The eggs are excreted in faeces or urine, depending on the type of schistosomiasis. When infected faeces or urine reaches water, the eggs develop into larvae. The larvae enter a snail and undergo a series of developmental stages. Later, the larvae emerge from the snail and upon encountering human skin, they rapidly penetrate it, thereby infecting the person. Thus people get infected with schistosomiasis when they bathe, wash clothes, work, walk, fish or play in contaminated water. To a lesser extent people can get infected when they drink this contaminated water.

> Although over 80% of rural households in Tanzania have a latrine, some surface water still gets infested with schistosomiasis. Reported incidence of urinary schistosomiasis in a survey in eight villages was significantly higher for boys of 6 years and older, and for girls and women of 11 years and older. This, and data on water use practices suggests for the former a relationship with swimming, and for the latter with clothes washing, as both activities involve a prolonged stay in the infested water (Kirimbai and Van Wijk, 1983). Combatting the transmission of schistosomiasis thus not only requires installation and use of latrines, but also design, construction and management of communal washing facilities.

Worm infections with an animal intermediate host

The two worms concerned here are *Taenia saginata* (beef tapeworm) and *Taenia solium* (pork tapeworm). The adult tapeworm lives in the intestines of an infected human host. The eggs are passed in the faeces and are then eaten by a cow or a pig. The eggs hatch in the gastro-intestinal tract of the animal and are carried to the muscles. Here the larvae develop into infective cysts. Transmission will occur if a susceptible person eats undercooked meat containing these cysts.

Insect transmitted diseases

The only mosquito-borne infection related to sanitation is *Bancroftian filiarsis.* The infection is mainly transmitted by the Culex pipiens mosquito, which breeds in stagnant polluted water (blocked drains, poorly maintained septic tanks, latrine pits containing water). The infective mosquito injects some infectious larvae into the human host. These larvae find their way to the lymph vessels where they mature into worms in about a year. After this time the female worms give birth to new larvae, which infect a mosquito who sucks blood. The larvae undergo a change in the mosquito and after ten days the mosquito is able to infect the next person. The disease (filariasis, elephantiasis) is caused by a reaction of the human body to the presence of worms in the lymphatic system.

Table 1 lists the most important excreta-related diseases and indicates the relative importance of the different intervention strategies. It shows that both excreta disposal and excreta treatment are very important interventions for all the diseases mentioned. It also shows that for diarrhoeal diseases in particular, an integrated approach combining improvement in water supply and sanitation with hygiene education is necessary to reach the objective of improved health. The hygiene education component is vital in seeking to influence personal and domestic cleanliness and food hygiene. Attention should also be given to Bancroftian filariasis which has the potential of becoming a major problem as a consequence of increased water supply and deficient sanitation if not enough consideration is given to drainage and sullage disposal.

Table 1: The importance of different interventions for excreta-related diseases

Infections	Water quality	Water availability	Excreta disposal	Excreta treatment	Personal and domestic cleanliness	Waste water disposal	Food hygiene
Diarrhoeal diseases							
Viral agents	2	3	2	2	3	0	2
Bacterial agents	3	3	2	2	3	0	3
Protozoal agents	1	3	2	2	3	0	2
Worms with no intermediate host							
Ascaris and *Trichuris*	1	1	3	3	1	1	2
Hookworm	1	1	3	3	1	0	0
Enterobius	1	3	2	2	3	0	1
Worms with an aquatic intermediate host							
Schistosomiasis	1	1	3	2	1	0	0
Worms with an animal intermediate host							
Beef and pork tapeworms	0	1	3	3	1	0	3
Insect transmitted diseases							
Bancroftian filariasis	0	0	3	0	0	3	0

0 = no importance
1 = little importance
2 = moderate importance
3 = great importance

Adapted from: Feachem 1983.

As a conclusion to this section, it must be stressed that any choice of a sanitation system should be based on the type of excreta-related diseases common in a particular area. The chances of transmission and survival of viruses, bacteria, worms and insects are affected differently by the various sanitation systems. This is even more valid for upgrading possibilities where a small improvement such as making a floor slab non-absorbent and smooth, may already reduce the occurrence of hookworm.

2.2 The effects of open field defaecation and traditional latrines

People defaecating in or near rivers, streams or ponds directly pollute the water, which often is a source of drinking water, if not for themselves, then for people downstream. Where defaecation is practised in or close to vegetable gardens or crop fields, it is often argued that the faeces will serve as manure. However, the food crops may get directly contaminated, resulting in a health risk when the crops are consumed raw or slightly cooked.

In many communities where there are few or no latrines, special defaecation areas may be found, often some distance away from where the people live. Because faeces is spread throughout these areas, it is difficult to avoid stepping on it. People walking barefoot will easily get infected with hookworm. Moreover, tiny particles of faeces will stick to either shoesoles or feet and will be carried back to the homes. Children playing on the ground may ingest these tiny particles and become infected. If animals freely roam around, they can spread the human faeces and at the same time risk getting infected with the eggs of beef or pork tapeworm. Flies and other insects also have their share in transporting pathogens from these areas.

Children are often allowed to defaecate wherever the need arises and when others do not immediately clean this up, infections can spread easily. There is a widespread belief that faeces of children is harmless, the contrary is true. Because children play on the ground, they are more often infected with excreta-related diseases. They are, moreover, usually more susceptible for these diseases.

There are many kinds of traditional latrines. They are often made with locally available materials and built on a self help basis. Depending on these materials, the structures may be more or less stable. The building technology depends on the experience within the community and local masons often have developed techniques which are very well suited to the local conditions. A special type of traditional latrine is the hanging latrine, found in many places in Asia. It consists of a platform raised over water, with a superstructure build on top of it for privacy. Faeces drops down, polluting the water in which often also washing and bathing is done. This illustrates that latrines are constructed more for privacy and convenience than for health reasons.

Traditional latrines may be good as they are, but there are also areas where technical or hygienic problems are experienced. Pits may collapse after a relatively short period of time due to instability of the ground. Floors may be made of wood covered with mud to form a flat surface, but this surface may be difficult to clean and become a breeding place for hookworm. Lack of proper cover may create a fly and odour problem and if the pit is used although it is almost full, there is a risk of flooding when the groundwater rises due to rain.

A cholera outbreak in 1980 induced the Ministry of Health in Tanzania to undertake an intensive latrine building campaign. As a result, all or almost all houses have their own traditional latrine. Main problem is the early collapse of wood-and-clay slabs, as the progressive deforestation of the area makes it more and more difficult to obtain the type of logs required for durable latrine slabs (United Republic of Tanzania, Unicef, UNDP and Norconsult, 1987).

Such problems may result in a total disregard for latrines and people may revert back to open field defaecation. This is understandable from the individual point of view, but for the community it is bad, as latrines -even unsanitary ones- at least localize the risks.

2.3 Reasons for an upgrading approach

Improvement of the sanitation situation does not necessarily imply the construction of new facilities. Where traditional sanitation facilities exist, they reflect local social and cultural preferences and are an investment of the people who built them. Although they might not all be good from a hygienic point of view, it may be possible to upgrade them to become both hygienic and safe to use.

One reason for considering upgrading is cost efficiency. For instance, of the total cost of a single pit BOTVIP latrine in Botswana of P558, the cost for the slab, vent pipe, fly screen and squatting pan were respectively, P30, P10, P2, and P35 (Larbi, 1990). Replacing or upgrading part of a latrine is thus much cheaper than building a new one. This is an important policy consideration when taking into account the large number of sanitary facilities and practices to be improved and the limited amount of funds available.
Another factor for consideration is cost-effectiveness. Where problems exist such as caving in of the pit, slab-collapse, bad smell, cleaning problems, lack of privacy or acceptance and ease of use by children, partial solutions to answer these specific problems may be enough to enhance latrine use.
A third consideration is affordability, which is one of the lessons learned during the Decade. Even though there are well proven low-cost sanitation solutions like the Ventilated Improved Pit latrine and the Pour-flush latrine, in some rural areas, the majority of the population might not be able to afford these. Therefore an adequate, yet even lower cost alternative must be promoted. Possibilities must be investigated to improve the existing practices, both with hygiene education and with simple technical solutions. This is cheaper for the people, values the effort they already have made for sanitation, and does not require adaption to a totally new system.

Technical upgrading of existing facilities does not have to be very complicated, but it may not always be worth the effort. For instance, if a pit will be full within a year, it might be better to build a new one. But only when it is not possible to upgrade existing facilities and practices or if people are interested and can afford another (modern) type of sanitation facility, is it advisable to start planning for new facilities.

3. *Steps to Identify the Need for Sanitary Improvements*

3.1 The importance of integrating hygiene education

It should be stressed that technology in itself is not enough to ensure reduction of sanitation-related diseases. Sanitation is dependent on the way people behave and organize themselves towards hygiene. Any intervention should be based on what people already do, what they know and what they want. As people know this best themselves, they have to be involved in all aspects and phases of the project; this can be called a community-based intervention. A way to get this process started is through the integration of hygiene education in the sanitation programme. In every phase of a project, hygiene education can contribute to an understanding of behaviour, practices and needs, so that the local knowledge of the people is fully used and at the same time the knowledge of the external support agency is conveyed to the people in a practical way. The subjects and emphasis of hygiene education can change as the project progresses.

Thus, as a start, it can concentrate on identification of risk factors and problems in sanitation. The joint analysis becomes an educational process in itself and may create an awareness amongst the community about the negative and positive aspects of sanitation and may make them inclined to become involved in sanitation development. Then, cultural factors influencing sanitation behaviour and motivating factors for sanitation can be discussed, as well as possibilities for resource mobilization and the organization of improvements. At the same time local knowledge on environmental conditions can be used to review options for improvements, incorporating local preferences in sanitation design.

During planning, decisions can be made on the different options for improvement and different technologies to be used. This will strengthen local development capacity and responsibility towards the sanitation improvements to be made. It is likely that the results of such an integrated approach will be more permanent than those of a quick latrine construction campaign, while at the same time, it develops institutional capacities for problem analysis and problem solving within the communities themselves.

> A quick latrine campaign in an East African country resulted in many latrines being built. They were sited along the roadside to enable the public health inspectors to monitor construction progress by car. However, the latrines were not used as people disliked entering in the full sight of passers-by (Barrow, 1981). Similar experiences were gained in Thailand were campaigns from 1917 to 1928 resulted in 26% of households owning a latrine. In 1960 less than 1% still owned and used a latrine (MoH and UNICEF, 1988 in GTZ, 1990).

Another advantage of this approach is that it may facilitate the identification of different socio-economic groups and the finding of solutions appropriate to the problems, needs and means as perceived by each of these groups. For instance, if people are not willing or able to construct latrines, it may be possible to change existing practices to become less of a risk. These can be both general hygiene measures, such as washing of hands and safer food handling, as well as site specific, such as making ditches in defaecation grounds.

In a controlled experiment in Bangladesh, families with a confirmed case of shigellosis (dysentery) received health education on the importance of washing hands with soap, together with free soap and pitchers. Spread of infection was only 10% in the educated households as compared to 32% in the control households: a significant difference. Handwashing with only water was found to be ineffective (Uddin Khan, 1982). This experiment is valid to analyze the effect of using soap for handwashing against only using water. But, soap is generally not affordable to low-income households and it is therefore unlikely that people will keep using soap if it is not provided for free. It would have been much better if local soap substitutes such as ash had been promoted.

During implementation of improvements and construction of new latrines and thereafter, user education will be necessary to make sure the system and maintenance requirements are understood well and carried out.

Hygiene education is often undertaken by technical field staff who are given the added responsibility for social and educational activities. A drawback of such an approach is that these people may not be trained for this task, resulting in an emphasis on technical issues, rather than on community perceptions and attitudes. Much better is it to attach promoters, animators or health educators to technical programmes to undertake educational and social services. The organization of hygiene education is discussed at length in 'Key Issues in Hygiene Education Planning and Management' by Marieke Boot, IRC, 1991.

Methods of hygiene education may vary according to circumstances and needs, but have to be adapted to the needs of the community. Instead of giving instructions on what to do and what not to do, material should be presented in such a way that the audience is stimulated to analyze their own behaviour and to find practical solutions to identified problems (Burgers e.a., 1988 and Boot, 1984).

3.2 Methods to approach the community

Many communities are made up of groups with different resources and interests, resulting in factions within the community which may or may not be in conflict with each other. Although the interests may have nothing to do with sanitation, they may interfere in the development process. To reduce the risk of being manipulated by one group or another, it is advisable to get as much insight into local conditions and culture before going there. Most communities will have been involved, one way or another, in development efforts and staff from these projects could possibly be approached about their experience with the community and their opinion about the local social structures. Also government staff, district health workers, etc. with experience in the community may be able to give information about the local structures.

With this background information in mind, the first people to contact in the community are the local authorities and/or local leaders, to inform them about the intended project and to ask for their approval and support. This is not only a matter of good manners, but it will also make work easier. They can give an impression of the community, the various socio-economic groups, their priorities, problems and felt needs, the health situation, possible constraints, and so on. They can give their views on the sanitation conditions and can indicate in what way they would be able and willing to help. Moreover,they will be able to assist in identifying the most appropriate people and groups to get involved with as a start.

The amount or type of informants will differ from community to community, but in general, men and women should be approached who represent a specific group in the community, or who, apart from assisting in identifying risks and problems in sanitation, can give information on other aspects which have a bearing on sanitation. In this way a diverse picture of local conditions can be obtained.

Local health workers should know what kind of diseases are prevailing in the community and their most likely causes. They will also have an idea about the awareness within the community of sanitation-related diseases and the prevailing practices which have a positive or negative impact on the health of the population.

Community development workers or local non-governmental organizations could give an insight in the motivation people have to participate in development efforts and the experience the community has had with previous projects.

School teachers, although often not raised in the community, can give information on the attitude of children towards sanitation and on the educational message they give or are supposed to give their pupils in this field.

Religious leaders can give information on religious beliefs and rules, which have a direct bearing on sanitation.

Masons or sanitary craftsmen will be able to point out the technical problems they are facing in building latrines.

Representatives from social, cultural or religious groups in the community can each give an insight into the specific needs, constraints and perceptions their group has in relation to sanitation.

Besides addressing the above mentioned people, discussions can be started in hygiene education sessions with a more general public to give information on the project and its approach and to also discuss the risks and problems in the field of sanitation.

3.3 Special steps to involve women in the project

Participation of women in sanitation projects is of crucial importance. Not only because usually women are more motivated to have sanitation facilities for reasons of convenience and privacy, but also because they are the ones who keep the facilities clean, who maintain them and who train their children to use them (a detailed discussion on the participation of women in water and sanitation is given in Van Wijk-Sijbesma, 1985). Thus women hold the key to the continued sanitary operation of these units and their benefit to the family's health. For this reason above all, women merit special attention during the planning of sanitation projects, to make sure that the facilities are planned with full awareness of their perceptions and needs (Perrett, 1985). This participation, however, does not happen automatically and special steps may be needed to create favourable conditions.

In some societies the social rules governing women's public and private roles are fairly rigid. For instance, while they may not prohibit women participating in sanitation decisions, they may permit them to do so only in certain situations. Women may be allowed to have a say about what they want and like in the privacy of their home, or in the context of a women's club or informal gathering of female relatives and neighbours, but not in a public meeting or even in their own homes when men are present. Also, women may be able to take part in the construction of a latrine as helpers to their husbands, but be unwilling to do the same task in the company of other women or alone, for fear of social criticism.

In order to avoid unworkable assumptions about women's participation, the social rules and constraints must be known from the outset. It may be safest to assume initially that women can participate best in traditionally approved ways and situations. But once the community begins to see the value of women's contributions within the total community effort, initial restrictions may change. The project can help to build up such awareness gradually, by treating women's activities as an integral and critical component of local development rather than as a separate specialized activity. Especially where women's decision-making is involved, the project will need to find ways to make such decisions known and respected by male community leaders, that is, to create bridges between women's groups or women's views expressed in their homes and the public forum (Perrett, 1985).

Depending on the type of society, different steps will be needed to ensure optimal participation of women. For practical purposes, a distinction can be made between societies where women are relatively integrated, those where women are segregated and those where they live in seclusion. Each of the three types needs a different approach.

In relatively integrated societies, it will be possible to hold community meetings where both men and women are present. But some special steps may be needed to:

- explain to local leaders why women should be involved in meetings and local organizations on sanitation;
- inform the men about the need for women's participation;
- see to it that women are informed and encouraged to attend meetings;
- hold meetings at times and places suitable to women;
- arrange seating in such a way that women sit together, but are still part of the discussion;
- help women to speak up (give time for internal discussion and select a spokeswoman);
- ensure that poor women are also present and speak up;
- ensure that more than one woman is selected in the local sanitation organization.

In segregated societies, it is better to discuss sanitation issues in special meetings with women only. Often, women have their own times and places of gathering (such as for instance saving and loan groups in Indonesia) where it will be easy to introduce the subject of sanitation for discussion. Here the women will feel unrestricted to give their opinions and discuss the best possible sanitation options for local circumstances. They may select some representatives to be present in other meetings where also men are present, but where this is not possible, project staff will have to bring the women's opinions forward. It should be stressed that 'the' local women organization may not be representative for all women living in the community; experience suggests that these groups are often mainly attended by women from higher status households. Women from poorer families often have little time to attend meetings or there may be socio-cultural reasons for their exclusion, varying from not having appropriate clothes to attend meetings to belonging to non-scheduled castes or minority groups. When this is the case, ways have to be found to reach those women as well, for instance within their own groups.

In secluded societies, women are often not able to go outside their houses for meetings with women not belonging to their families. In such circumstances, the only way to have the women participate is by home visits, and by asking permission to the males of the households to organize small meetings on sanitation in the house of one of the women. Once this is accepted, the participation of the women in planning for improved sanitation may lead to a participation in wider development efforts, as was the case in Baldia, Pakistan.

> After construction of the soakpits, the women and children had to be informed on proper use and maintenance. For this purpose, all women who had soakpits formed in groups and regular group meetings were held. Leaflets and booklets were printed on hygiene and sanitation, but when these reading materials were given to the women, it turned out that they were not able to read at all. It was at this point that both men and women realized the need for education for the women and children. Women with high school education were identified in the neighbourhood and trained to give primary education and as a result a whole system of adult literacy classes has been set up, as well as girls classes and a sewing and craft centre. In addition, the women who have learned to read and write, now assist in the motivation in other neighbourhoods to start a sanitation programme (Bakhteari, 1983).

In all types of societies, the best ways and means to involve women in planning for sanitation will be known by the women themselves and for this reason they should be approached from the start. This can be done for example with participatory techniques as described in "Tools for Community Participation" by Lyra Srinivasan, a publication of the UNDP/PROWWESS project. The PROWWESS (Promotion of the Role of Women in Water and Environmental Sanitation Services) programme was started in 1983 with the aim to demonstrate how women can be involved in water and sanitation.

3.4 Inventory of main risk factors and problems in sanitation

After identifying a number of informants, one way of assessing local conditions and problems, is by walking around in the village with these informants. The aim of these walks is to assess the environmental cleanliness of the village, to identify potential risks of contamination, both in and around the facilities and in practice, and to get an insight into the attitude and efforts of the community towards sanitation. These sanitation walks should be done in all areas of the village because there will be differences in sanitary conditions depending on the socio-economic and cultural background of the population or on environmental conditions. Informants from the specific social groups will each show a different, typical, group-related picture of the village. It is also important to walk around at different times of the day, especially at dawn and dusk because in many cultures it is at these times that people go out to defaecate. Men, women and children may have different practices.

While observing latrines, defaecation areas and water sources with the informants, a number of issues related to sanitation behaviour should be raised. For instance, the reasons why people have certain practices and why people have or do not have latrines; the ideas about transmission routes of sanitation-related diseases; what people do about things they experience as a problem and what priorities they may have in improving their living conditions; what is their willingness to participate in finding solutions to identified problems. This will make it possible to get a first impression of the attitude of the people towards sanitation and can contribute towards a rough classification that can serve as a starting point for programme development.

An alternative way to assess local conditions and problems is to ask schools or community groups to carry out a self-inventory of the problems, or to hold small discussion groups with community representatives or neighbourhood groupings making use of adult education tools and techniques. For instance, to stimulate discussions, series of pictures may be used and people requested to tell a story with the pictures. In this way, insight is gained on what people experience as a problem and what kind of solutions are considered feasible in the local situation.

A checklist on the aspects which should be covered in the sanitation walks will serve to identify the potential sources of contamination and to indicate the risk level attributable to the different facilities and practices. The checklist has to be made operational in each different community, and be adapted to local conditions. Especially when looking at latrines, it should be for instance clear what is considered clean, and when a latrine smells too much. This differs by culture and even socio-economic background; the local perception has to be taken as a yardstick. The checklist is not a statistical approach, but a means to get a reliable realistic picture of the sanitation situation. An example of checklists for community efforts towards sanitation, for environmental cleanliness and sanitation facilities is provided here.

Possible checklist on community efforts for sanitation

- Do people have latrines?
- Why do people have a latrine?
- What kind of problems do people experience with their latrines (cleaning, collapse, repair, emptying)?
- Are there seasonal variations in latrine use?
- Who has produced and installed existing latrines?
- Are there any programmes with subsidies or loans for latrine purchase?
- Is there a latrine promotion campaign and what methods are used for this?
- Are sanitation-related subjects included in the school curriculum?
- Are latrine parts produced locally by the private sector?
- What is being done when the pit is full?

Possible checklist on the state of environmental cleanliness

(If the answer to any question is 'yes', this indicates a potential health hazard, requiring some form of action.)

- Is faeces lying around in places where people walk or children play?
- If children defaecate anywhere near their homes, is the faeces left lying around?

- Are water sources polluted directly by faeces?
- Can water sources get polluted indirectly by excreta being washed into it? (due to rain or seepage)
- Are there any specific defaecation areas?
- Are the sources of drinking water unprotected (e.g.rivers, streams, uncovered wells)?
- Are sources of drinking water accessible to animals?
- Is there stagnant water anywhere? (indicating low seepage and lack of drainage)
- Is solid waste left lying around in the compound or the street?

Possible checklist for sanitation facilities

(If the answer to any question is 'no', this indicates a potential health hazard.)

- Is the latrine and area around it clean?
- Is the latrine and area around it free from fly nuisance?
- Is there a cover or other means to keep the flies out?
- Is the latrine and the area around it free from odours?
- Is the area around the latrine free from stagnant water?
- Is the latrine slab smooth and easy to clean?
- Is the latrine slab strong and without any cracks?
- Are possible water sources (spring, well) more than 10 meters away?
- Do all adults of the households who have a latrine always use it when they are around?
- Do the children of the households who have a latrine always use it when they are around?
- Are handwashing facilities available in or near the latrine?

The information gathered during the sanitation walks can later be marked on a map of the whole village, indicating potential sources of contamination and risks, but also the level of interest shown by different groups in the community (this is of course only possible in a situation where groups of people living near each other have the same attitude). The result will provide a basis for later discussions and for the further development of the hygiene education programme and the development of an improvement programme.

3.5 A rough classification

The information gathered on the joint fact-finding sanitation walks and talks may indicate differences within the community, both in facilities and practices used as in the attitudes of the people. Although assessment of the situation can only be global at this stage, it is useful to come to a rough classification of the community for the purpose of follow-up planning in consultation with the different groups. The most common situations which could be identified include:

1. Many people in the community show interest in sanitation development. The existing facilities and practices are bad from a hygienic point of view, but it is clear how they could be improved.

2. Many people in the community show interest in sanitation development. The existing facilities are bad from a hygienic point of view, and their technical improvement does not seem feasible.

3. Only a small part of the community seems to be interested in sanitation development. The existing facilities are partly improvable, partly not.

4. The community as a whole does not seem to be interested as they have other priorities for development. There are hardly any existing facilities.

Each of these situations require a different approach to ensure optimal results for the intervention.

- Where people are interested in sanitation development and the improvement options are clear, upgrading of the existing facilities and practices can be carried out and new facilities can be constructed where necessary.
- Where people are interested, but solutions are not clear, a pilot approach is required to establish the most suitable system, both from a technical and a social point of view, before going into large scale construction.
- Where only part of the community is interested and only part of the facilities are improvable, a two-pronged approach is needed. On the one hand upgrading of existing facilities, on the other a pilot approach combining hygiene education to change defaecation practices and an identification of the most suitable types of low-cost latrines.
- Where the community is not interested, it is important to establish the extent to which existing sanitary conditions pose a risk for the health of the community. If this risk is low, it may be better not to interfere in the community at present. If there is a risk, some intervention is necessary. This should aimed at finding ways to motivate the community, maybe through a combination of hygiene education and a few demonstration latrines.

It should be kept in mind that the classification is only a tool in the planning process, it is only a first step to bring some order in the information gathered. The classification is to a large extent based on the level of 'interest shown by the people', but a real assessment of interest can only be based on more detailed information. Interest may for instance only be expressed as a form of politeness and an easy way to avoid further discussion. It is impossible to expect people to make a commitment when the financial consequences are not known.

Because sanitation is to a large extent a social phenomenon, rather than a technical one, it is essential that background information on cultural, social, economic and environmental factors influencing sanitation is acquired before actual planning can start. This is especially true when new facilities need to be built, but the information is also needed to adapt hygiene education to local circumstances. The classification will help to identify what information is further needed.

4. *Information Needed for Programme Development*

Planning for improvements is done with the community, but before the external agent can fulfil the role of advisor well, an understanding is necessary of several aspects which have direct implication on sanitation behaviour and on the choice of possible sanitation improvements. First of all, this concerns the cultural background of sanitation behaviour and the factors which motivate people to have a latrine. Then, discussions are needed on the options for resource mobilization and on the best way to organize the improvements. Furthermore, information is needed on environmental conditions and on local design preferences.

Although the approach used in this manual is focussed on sanitation in an individual community project, it is also useful as a guide for larger-scale programmes. For these programmes, a community study can be carried out first to come to a classification of the different communities on the basis of the physical, socio-economic and cultural conditions. In Appendix 1 an overview is given of useful socio-cultural data to be gathered for this purpose. The classification can serve to group the communities together and for further programme development, the individual community approach can be used. Thus it can result for instance in communities of type 'A', having programme intervention 1, type 'B' communities having programme intervention 2, or a possible combination of intervention strategies.

4.1 Methods to collect background information

Collecting information on cultural aspects of sanitation behaviour and on factors which motivate people for sanitation, is not easily done through a survey. The sensitivity of the subject requires a less formal approach. It is likely that, at least with some of the people who have assisted in identifying the risks and problems in sanitation, it is possible to build up a somewhat informal relationship where asking sensitive questions is not a problem. But it should always be kept in mind that also these informants have their own interests to consider and that they are likely to push proposals which suit them best, even though for other people different solutions would be better.

By being in the community, it is possible to make observations on the behaviour of the people and it may be possible to discuss motivational factors for having a latrine with the households who have one. To find out where people defaecate, it may be possible to express to have to go for defaecation. By asking this question 'naturally', people will come up with an answer. Thereafter it may be possible to ask more questions about the place visited. Another approach is through 'indirect' questioning, that is asking about the behaviour and attitudes of others.

Discussions with small groups of people, such as neighbourhood groups, in or outside hygiene education sessions, will also elicit information on the subject and can substantiate the information given by the 'key' informants. It is important to approach all different groups identified and to try to have discussions with all of them, even if people do not seem to be interested in sanitation or do not want to talk about sanitation as such. The reasons why they are not interested can be very important for the programme development.

> In a village in Maharashtra in India a survey was done to assess interest in sanitation among the women. Part of the women were interested and part of them not; analysis showed that the women who were interested all lived in the centre of the village, whereas the ones not interested lived at the edges. With the increase of population densities, the distance the women living in the centre had to walk to the traditional defaecation areas was increasing as well, while those living on the edge did not have to go far. Moreover, the women living in the centre all belonged to higher status families, whereas those on the edge were poor. Thus each of the two groups of women had perfectly valid reasons for their interest or lack of it (Sundararaman, 1986).

Because building up a degree of informality is necessary, the collection of information is facilitated by working through or with someone who is already known and respected in the community. Whether this person should be a man or a woman depends on the local situation. For a woman it will be easier to have access to other women and the sensitivity of the subject will be less of a problem, but in situations where it is mainly the men who make major decisions such as sanitation improvements, a male project person will have more influence on the male 'clients'. However, given women's informal role as 'influencers' of male decisions within the family, their role needs to be acknowledged and properly reinforced. In some communities having a male and a female project 'facilitator' may be a solution, but both should be accepted in the community to play this role.

If the project area is too large for an informal approach, it may be necessary to use other data-gathering techniques such as open-ended interviewing and surveys. A very comprehensive overview of these different techniques is given in 'Methods for Gathering Socio-cultural Data for Water Supply and Sanitation Projects' by Mayling Simpson-Hebert. But whether open-ended interviewing or a survey is used, it is important that the questionnaire is designed well, with a very clear idea what information is needed, what the survey is measuring and how it will be tabulated. The questionnaire, of course, needs to be pretested before carrying out the study.

4.2 Cultural aspects of sanitation behaviour

Sanitation behaviour is based on ideas and taboos associated with defaecation and on traditional habits originated in local environmental circumstances. Probably most common in different cultures is the sense of shame associated with defaecation, which is often expressed in a taboo on talking about the subject. But it is precisely this taboo which may have prevented people from changing age old practices although the need for sanitation facilities may be high, like in cultures where women are not supposed to be seen outside their houses.

> In rural Bangladesh women have to defaecate before dawn or after sunset, because they are not supposed to be seen by men outside the direct family circle. They have trained themselves to do this from when they were young. In order to be able to hold out, they sometimes have to skip lunch to delay the urge. If they fail, they have to hastily go in the backyard (Agarwal, 1985).

These circumstances most probably make women interested in having a latrine, but bringing up the subject with the men in their house may be difficult because of the sensitivity. At the same time, it is often the men who decide on having a latrine or not, although they do not experience the same inconveniences as women.

Some of the local practices and beliefs are harmful for the health of the people, but others are neutral or helpful. It may be possible to promote the helpful and neutral ones at the expense of the harmful ones.

> In some parts of Africa where schistosomiasis is widespread, urinating blood is viewed by men as a sign of maturity comparable to menstruation for women. Therefore young adolescents are rather proud to show the symptoms of this disease and there is no sense of it being harmful (personal communication).

Rules and regulations affecting sanitation behaviour are often prescribed by religion, as is notably the case with Hinduism. For people practising this religion, daily life is ruled by notions of ritual purity and pollution; these sometimes coincide with scientific notions of hygiene and cleanliness (bathing after defaecation) but are not synonymous. Also Islam has many rules affecting sanitation.

> The first two water seal latrines were constructed at government expense for the use of the primary school, in an open area in the middle of the school's playground. They were built in such a way though, that the potential user would have to squat with his back towards Mecca - the direction sacralized by the official religion. When this serious shortcoming was noted by the religious leaders, the latrines had to be rebuilt (Kotalova, 1984).

This failure could have been prevented by planning the facilities together with the people and especially in consultation with the religious leaders.

Apart from religious rules, there are traditional habits which directly affect the options for improved sanitation, for instance frequency of defaecation. In many cultures frequent defaecation is the norm; it may be considered healthy to clean out the intestines regularly with laxatives or enema; loose stools may be endemic in certain places and the incidence of diarrhoea is of course high in many developing countries. This directly affects the number of latrines needed in a community, if sharing arrangements are considered. Habit is also the main determinant in the choice of materials for anal cleansing. In most of South East Asia using anything else than water for anal cleansing is considered dirty, while in other parts of the world dry materials such as paper, corncobs or stones are normally used. It is obvious that the selection of sanitation techniques has to take these habits into account: you cannot throw corncobs into a water sealed latrine.

The following table gives an indication of cultural variations in defaecation practices. The left column gives the different aspects of defaecation practices, while the right column indicates the two extremes of the cultural variation.

Table 2: Cultural variations in defaecation practices

	Aspects	*Extent of Cultural variation*	
1.	Choice of preferred site		
	a) location	Open field	Sheltered
		Near or in water	No water contact
		Within the house	Away from the house
		Socially prescribed	Individually selected
	b) visibility of (intention of) use	Allowed	Not allowed
	c) direction of latrine	Prescribed	Not prescribed
2.	Preferred posture	Squatting	Sitting
		Ritually prescribed	Individually preferred
3.	Preferred times of defaecation	Sunrise or sunset	Whenever the need arises
4.	Daily frequency of defaecation per day	Once or less	More than four times
5.	Anal cleansing materials	Only water used	Paper, leaves, sticks, corncobs, stones etc. used
6.	Cleansing after defaecation	No cleansing	(Ritual) bathing
7.	Social organization of defaecation	Strict male/female separation	Less strict
		Communal defaecation accepted	Not tolerated
		Avoidance rules within family	No avoidance rules
8.	Attitude to human feaces	Cannot be handled	Seen as useful resource: used in composting or feeding animals
		Children's faeces considered harmless	Children's faeces considered harmful

Adapted from: Piers Cross, 1982.

4.3 Factors which motivate people to have a latrine

The aim of most sanitation programmes is to improve health conditions in a given area. In a situation where people are aware of the link between sanitation and health, improvement of health conditions may be a motivating factor for the adoption of sanitation improvements. On the other hand, sanitation related diseases may be considered unavoidable and not requiring any change of practice, but for many people, the relationship between health and sanitation is not clear. Diarrhoea or worms may not be viewed as an illness, but as part of a normal pattern, not related to water or sanitation behaviour. As a consequence, people will not consider health improvement a reason to adopt sanitation facilities, unless a course of action is taken such as in the Bhaktapur project (see 2.1) where the community was shown the result (in this case worms) of not having sanitation facilities. This may at least elicit interest in thinking about sanitation. There may, however, be other reasons why people are interested in sanitation. It is essential to find out these reasons, as they may be the key for motivating people to participate in sanitation improvements.

Three main reasons why people are interested in sanitation facilities are convenience, privacy and status. It is of course more *convenient* to go to a latrine near or in the house than to have to walk to a defaecation area or hide somewhere in the bushes, which maybe quite some distance away. This may be less of a burden during the day and when it is dry, but when it is raining it becomes more so, and besides, there may be a problem of accessibility of the designated defaecation areas in the rainy season. When people have to go out at night for defaecation they are an easy target for abuse, and fears of spirits and ghosts, who may be believed to freely roam around at night, may exist, not to mention fear of snakes and wild animals. People are therefore likely to defaecate very near the house after dark.

> Fear of the dark interior and falling into the hole have prevented young children from using latrines in rural communities in Sri Lanka. On the insistence of the villagers, an improved design was developed and installed near the kitchens so that mothers could train and supervise their children more easily (Fernando, 1982).

The most common need with respect to defaecation is probably the desire for *privacy*, although the level of privacy needed may vary. This may be the case even within one community, according to sex or social status. Generally, women have more need for privacy than men and often it is this aspect that motivates them for having a latrine.

> In West Asia it is quite common to see a group of men walk together at dawn to the defaecation grounds for their morning ablutions and squatting next to each other, but it would be only men and male children. The women also go to a defaecation area (probably a different one) as a group, but when it is still dark; they should not even be seen walking there.

In other cultures communal defaecation would be inconceivable. The desire for privacy has even led to rejection or non-use of latrines, when the user was visible through the ventilation space under the door or when the latrines were located in such a way that the user could be seen entering (Burgers e.a., 1988). The privacy offered by a latrine may even be used for bathing purposes. The popularity of VIP latrines in Zimbabwe is not only due to the fact that they are odourless and free of insects, but also because it provides a private place for bathing (Morgan, 1990).

Another important factor influencing interest in sanitation is connected with *status* and *prestige*. Usually the people who already have a latrine constitute the better off segment of society and this status aspect may well be a stimulance for interest, especially for males. Besides, having a latrine is also a sign of being 'modern' and as such it is an attractive facility to have. Status and prestige is to a great extent linked to the design of the superstructure, which very often is neglected by programme planners. The principle that the beneficiaries themselves are responsible for the superstructure is sound, but in some cases may backfire if the facility is viewed as a status symbol. In such cases latrines may be promoted more successfully if different low-cost but prestigious designs are included within the project.

> Ownership and use of latrines is invariably associated with enlightenment and respectability. Defaecating in the bush is considered 'backward' and has influenced ownership and use of latrines. Remarks like 'it is embarrassing', 'it is not enlightened' and 'it is not respectable' indicate the high social status associated with latrine ownership in Kibwezi in rural Kenya (Oendo, 1983).

Similarly, keeping up with the rest of the community may become a driving force behind interest in latrines, especially when there is a strong value on community cohesiveness and solidarity. It may then be that the cost of not participating in the improvement effort may be higher in terms of loss of goodwill and deterioration of solidarity than that of participating.

It should be noted however, that if status, prestige or solidarity are the motivating factors behind having a latrine, this does not imply that the people also use the latrine. There are many examples of latrines which are used as storage rooms, or reserved only for visitors or certain members of the family. In such cases, hygiene education should be directed to make people aware of the need to actually use their new facilities.

Interest in sanitation may be influenced by the condition of existing latrines. If they function well, they are viewed as a positive facility. But if the condition of existing latrines is bad, this may become a negative influence on the interest people might have for sanitation. If the only type of latrine people have seen is a dirty, fly infested, foul smelling, dark place, where a broken slab poses a risk of falling in the pit when it collapses, it is not surprising that they are not interested in having such a facility.

> In the Philippines an investigation was carried out to see why acceptance of latrines was low. One farmer said; "We like the toilet because we know it is good for our health, but you see we have something better than the odorous thing you are offering. Our latrine is a five hectare area behind my house, where the faecal matter is automatically dried by the sunshine and does not smell. It is even good fertilizer for my plants" (Feliciano and Flavier, 1967).

If in the past a sanitation programme has already taken place, it will have an effect on interest for sanitation in the community, either positive or negative. It is very important to get as much information as possible from the people about the past programme, to avoid making the same mistakes and to use the positive aspects of the programme. The construction of demonstration latrines can be a way to help people overcome disinterest in latrines as a result of a former bad experience with latrines.
A positive consequence of a sanitation programme previously carried out, be it a good or a bad one, is that people may have a better idea of their priorities in sanitation.

The different factors, which motivate people to have a latrine are often not the same for the whole community. That doesn't matter as long as this is taken into account in deciding the intervention strategy to be followed with the different target groups. For instance for some people (women) in the community the interest in sanitation can be influenced by stressing the privacy aspect of a latrine, while for others (men) who put great value on 'being modern',the status aspect of having a latrine may be stressed. A different motivation may also imply the preference for a certain sanitation system (for instance a shiny ceramic toilet bowl for the prestigious value connected with it).

4.4 Options for resource mobilization

The cost of a sanitation programme can be divided into three categories. These are institutional and project delivery costs, material and labour costs, and operation and maintenance costs.

The first category is often omitted in cost analysis. It includes the cost of such activities as community mobilization and development, information dissemination, training and financial delivery; it also includes monitoring and evaluation and technology delivery activities such as logistic support and engineering supervision. In the absence of adequate information, the institutional and delivery costs may be assumed to be 30% of the costs of a project, or about 45% of the sum of material and labour costs (Mara, 1984). The costs belonging to this category are always borne by the government or external support agencies.

Material and labour costs have to be paid by the community, at least to some extent. This may be partly in *cash* and partly in *kind*, depending on the provision of appropriate financing and credit facilities and the total costs of the proposed sanitation improvements. Because the choice of technology will greatly affect total costs, the implications of different options and what each user should contribute have to be discussed with the community during the early planning stage. The community needs to be aware of the various components that make up the total costs. It also has to be clear which part of the total costs are going to be covered by grants or subsidies and do not need to be paid back by the community. Generally, however, most government supported sanitation programmes will not be able to include substantial grants or subsidies, and even the provision of credit facilities may pose a problem.

Contributions in cash

Willingness to pay in cash is directly related to the level of interest for sanitation improvements, but also to the financial capacity of the people in the community. A credit system may be needed because usually people living in low-income areas will not have enough savings to directly pay the total costs required. Yet a down payment should be required to substantiate commitment. The terms and conditions for repayments of the credit/loan have to be clear and acceptable to the users beforehand, i.e. the rate of interest, period and arrangements for repayments, incentives for early repayment and penalties that could be applied in case of default. And even then, chances are high that repayment is bad, if the obligation to pay back loans is not ingrained in a culture. It is usually the extent of social control which is the deciding factor in loan recovery. The involvement of local NGOs, who are experienced with systems of loan recovery, could help to facilitate setting up an appropriate system.

In a way organizing the financial aspects of sanitation is easier than that of water supply because on-site sanitation is usually a private affair and it is thus easier to identify who has to pay what. Yet it also means that the need for differentiation within the community may be larger. This is both valid for subsidies and for repayment terms. For instance, offering subsidies to the first applicants for a latrine as an incentive often has the result that the subsidies go to the wrong people. Those who realize the advantages of early application, are often those who least need the incentive of a subsidy to either become interested or for financial reasons. Repayment terms have to be adjusted to the specific characteristics of the different target groups in the community because payment capacity is dependent on the amount of cash income. This may be fixed for some people, but for most this income will be fluctuating. Not only daily - for people working in the informal sector - but also seasonally, for agricultural labourers.

If the financial capacity of the different target groups within the community differs a lot, it might be necessary to give additional subsidies to those occupying the lower end of the income scale. This requires investigation into the financial resources, physical possessions and other assets (such as labour) of the households applying for extra subsidies. In communities with a certain extent of cohesiveness, often mechanisms exist to help the poorer households acquire facilities. It is therefore important to explore together with the community what kind of financing mechanisms already exist, such as for instance community revolving funds where initial capital may come from a government donation, an NGO or the issue of shares to individual households. Using the initial capital, loans are given to individual households for sanitation. Upon repayment, new loans are given to other members, according to the decisions of the group. Another mechanism is the savings club. Each member of the club (often a women's group) makes a small regular contribution to a communal fund. The group's savings are paid out in turn to each member to finance a major acquisition. In Indonesia and Africa, this is a very widespread mechanism for saving. Usually the groups are quite small, consisting of women living in the same neighbourhood. Because of the extent of social control, default is very low.

Some of the common problems that affect the ability and willingness of the community to invest in sanitation facilities are:

- level of income;
- costs of technology adopted;
- financial arrangements for implementation;
- beliefs and expectations about sanitation project implementation;
- caution in investing scarce funds;
- opposition from local leaders;
- limited interest in improvements;
- inadequate administrative procedures
- lack of understanding of project content resulting from inadequate communications support;
- unfulfilled expectations;
- delays in project execution;
- lack of agency support in providing services for maintenance and latrine emptying;
- lack of agency involvement in training and promotion.
(Larbi, 1990).

Contributions in kind

Because latrine construction is relatively simple, a considerable degree of self-help is possible, reducing the total costs for the user. In sanitation projects where people are expected to carry out the work themselves, care should be taken that sufficient assistance and supervision from technical staff is given. People have to be properly instructed on how to locate the pits and to dig them to the required dimension.

> In Malawi two people were killed when the pit they dug collapsed. Upon checking, it was found that they had dug to a depth of 20 meters, without supporting the sides. The pit was dug to this depth to last for three generations (personal communication).

Female headed households and older couples often do not have the ability or financial capacity to carry out latrine construction. In such cases special arrangements are needed such as assistance from other households, or help to hire labour. This is also valid for those groups who cannot be involved in the actual digging because of religious restrictions (for instance certain higher castes in India). In each community solutions to these kinds of problems have to be found through discussions within the community, thereby stressing that the highest possible coverage of sanitation improvements is of communal importance.

It is also important that the labour inputs of the people themselves are co-ordinated with the arrival of latrine components required from outside (such as pre-cast floor slabs) to avoid situations where adverse weather conditions could, for example, cause the pit to cave in before the required materials arrive.

Apart from reducing the cost, there are other positive aspects in involving the people in implementation. These are a sense of being involved, proudness of being able to carry out these tasks, a better understanding of the technology and hence a better perspective for future maintenance.

To minimize the organizational aspect of individual implementation, a community might opt for a local labour team, who digs the pits for all and/or locally manufactures building materials, thereby reducing the cost and at the same time providing local employment and expertise. This system also reduces the problem of social acceptability of participating in manual labour.

> In Tanzania villagers were allowed to work out their own system of inducement for the masons who carried out latrine construction. In three of the four villages the masons were paid in cash, but in the fourth village it was decided that the masons would be exempted from their normal village tasks as consideration for latrine construction. A similar approach was adopted elsewhere with a minor modification which provided that beneficiaries would work on the farms of the masons during the period that the masons were constructing their latrines (Wright, 1982).

It should be mentioned that both willingness to pay and willingness to participate in implementation may be adversely affected by other sanitation projects carried out either in the community or near it. A lot of governments and external support agencies initiate sanitation projects by constructing free demonstration latrines or giving large subsidies and expect that once the idea has caught on, people will start building latrines by themselves. But if people know that others have received latrines at no or minimal cost and without much effort, they will expect to get latrines under the same conditions.

The last component in the cost of a sanitation programme is the cost of operation and maintenance of the sanitation facilities. This has to be discussed with the community early in the planning phase, as the choice of technology will have implications for these costs. In most cases operation and maintenance will have to be carried out and paid for by the users (see also Chapters 5 and 6). Cash would be mainly required for repairs and possibly for contracting labour to empty or desludge the pits or to rebuild the latrine at a new location when it is full.

4.5 Social organization for improvements

The feasibility of a community-based approach is to a large extent dependent on the capacity within the community to organize themselves. Although the decision of a household to adopt on-site sanitation is an individual one, the wider implications of sanitation are a communal concern. Improved sanitation only has an impact on health if large scale coverage is achieved and the environmental aspects of sanitation, such as drainage of waste- and rainwater, are mainly a community concern.

In order to effectively organize the sanitary improvements, an adequate organizational framework has to be available or established. This means that at local level a particular group of people (for instance under the name of 'the sanitation committee') has to take the responsibility for the programme. This committee may take many different forms: it can be part of the local government authority responsible for water and sanitation; it may be part of an existing community development committee or existing water committee; it may be carried out by the village health committee; it may be the traditional leadership, the local women organization or any other existing community level organization. Each of these possibilities has its own positive and negative aspects. A drawback can be for instance concentration of power and influence in only a small group. And in cases where the sanitation tasks are an addition to other tasks already carried out by the committee, there may not be enough time available to do the job well. Moreover, these committees are usually not without internal problems. They are not insulated from local politics, nor are they necessarily representing the views of the whole community. An advantage of these committees often is their considerable authority and the respect they carry in the whole village. This is especially the case in smaller communities, where the leadership consist of people who are really part of the community, who have a similar standard of living and who therefore represent the views of the people in general. Thus, here again, the best organizational form depends on the local conditions and has to be worked out in consultation with the community.

Whether an existing committee is used, a subcommittee set up under the aegis of an existing committee, or a new committee established, it should have a balanced representation of the community, including for instance:

- both men (for authority) and women (for direct interest and strong motivation);
- both old people (for authority and respect) and young people (for initiative and drive);
- persons with relevant modern and indigenous knowledge (e.g. a schoolteacher, modern and traditional health worker);
- representatives from all factions and socio-cultural groups.
  (White, 1981).

Care should be taken that the members of this sanitation committee themselves either already have a good sanitation facility or are willing to improve their facility. In case they do not have one, they should be willing to build one. This is necessary to avoid a situation where these people do not practice what they preach, and in the long run loose credibility.

In some societies it may be difficult for women to become part of the sanitation committee, but in view of the importance of their participation, some organizational form has to be found where this is possible. Consultation with local women is needed to find this form. For instance, it may help to have two or more women on the committee for mutual support. The women themselves have to choose who will represent them in the committee, considering aspects such as availability of time, respect, sense of responsibility, social feeling and acceptability to all. Alternatively, women could form their own committee, with a different task than the male committee, but supplementary to it and as a control mechanism.

Tasks of the sanitation committee will have to include:

- to take stock of the needs and priorities of the community with respect to sanitation;
- to act as a sounding board for observations and information gathered during the sanitation walks and discussions in the community;
- to develop design options for improvements or new facilities, together with the project engineer;
- to develop an appropriate programme for health education and motivation together with the responsible project official;
- to liaise between project officials and the community;
- to hold discussions with the community on design options and implementation;
- to develop appropriate financing mechanisms together with the project officials and assist in their implementation;
- to develop appropriate cost recovery mechanisms together with the project officials
- to motivate the community for participation;
- to co-ordinate construction activities together with project officials.

The sanitation committee will have to be trained in preparation for their task. This training not only has to include factual information about sanitation related diseases, improvement options and design criteria, but has to concentrate on methods to convey messages, on ways to induce people to participate in discussions and on the basic principles of a community-based approach.
The sanitation committee has to form the link between the community and the project, and has to make sure that planning for improvements is based on what the community wants. For this purpose they have to discuss the following planning subjects with the community, which can be done in hygiene education sessions:

- types of latrines;
- design preferences and adaptations;
- siting options;
- traditional hygiene and improvement techniques;

- financing and repayment system;
- organization of labour and cash contributions;
- targeted coverage;
- assistance to poor households;
- monitoring of installation, function and use (self-evaluation);
- local hygiene education activities and follow-up.

The functions of a sanitation committee could also be carried out very well by a local non-governmental organization (NGO), if available. Although there are different types of NGOs, most are development oriented and experienced in working with the community towards the goal of sustainable self-improvement. Their strength is the ability to reach the poor, to optimize local resources and arrive at creative solutions with the people, because of their awareness of local dynamics and structures. Moreover, they are usually met with far less suspicion than government field workers. In the past, governments and international organizations were not much inclined to work with or through NGOs, but at present more and more realize that they themselves may not be able to effectively reach the poorer sections of society, and that they need the NGOs to do this.

Private latrine producers also can be involved in latrine promotion. They could be given training in manufacturing different types of latrines and in marketing and provided with soft loans for molds and other equipment necessary for latrine production. Private latrine producers may be much more effective than government staff, because they are more geared towards producing what people want and more responsive to changing designs to adapt to local needs and priorities.

4.6 Environmental conditions

Environmental factors such as water availability, soil conditions, groundwater depth, risks of groundwater pollution, and population densities directly influence the selection of an appropriate technology. Most information on these factors can be obtained through technical surveys, but lifelong experience of the community with these factors has built up intrinsic knowledge. People will for instance know from experience if water sources dry up in the dry season, or if places are liable to flooding in the rainy season. Similarly, people will probably know from experience if the soil is stable enough to have unlined pits. They will also know how much water they approximately need, if they use water for cleansing purposes.

Water availability

Water availability is one of the key deciding factors in opting for a system which requires water to function or one which does not need water. The feasibility of a system which requires water for flushing, either by pouring (by hand) or from a cistern, depends on the reliability and service level of the water supply. In systems which do not require water, the excreta drop through a hole into a pit, vault or other receptacle. An overview of different sanitation systems and water requirements for the systems is given in Table 4, Chapter 6.

Past availability or non-availability of water has probably influenced existing anal cleansing habits. Thus, in traditionally dry areas, people are likely to use solid matter for anal cleansing. But, where changes in water supply have occurred, anal cleansing with water and water seal latrines becomes an option. It will depend on local preferences and attitudes, however, whether a water seal latrine can be introduced or not.

Soil condition

Soil permeability is an important factor in assessing on-site sanitation options. Soils with low permeability such as expansive clays are unsuitable for pit latrines as the liquid fraction of the excreta is unable to infiltrate the soil. This would necessitate frequent emptying of the pit, which is expensive and can lead to unnecessary health hazards, if not properly carried out. In that case, off-site technologies such as small-bore sewerage must be considered. Soil tests to assess the leaching capacity of the soil are given in Appendix 2.

The occurrence of rock or unpickable soil within 2m of the ground surface generally makes latrine construction difficult. Where possible, assistance with mechanical diggers may facilitate the digging of the pits. Alternatively, shallow alternating pit latrines or raised pit latrines may be considered.

For the purpose of pit design, soils can be considered as either stable or unstable. Stability is defined as resistance to collapse and should be assessed (for soil stability criteria, see Appendix 2). The stability of the soil directly affects the stability of a pit. Pits dug in loose and unconsolidated soils are liable to collapse, especially when there is stagnant water in the pit. In such cases proper pit lining is needed, but care should be taken that the lining does not prevent seepage out of the pit into the surrounding soil (Mara, 1984).

Groundwater

Where the groundwater level is high, construction of pit latrines becomes difficult. During construction, a pump may be needed to pump the water out, while the pit will have to be lined to avoid collapsing. Because the pit will always be filled with some water, it may become a breeding spot for culex pipiens mosquitoes, which transmit filariasis. Nevertheless, wet pits have the advantage of lasting longer, as their rate of solids accumulation is lower than in dry pits. Alternatively, it may be possible to build the latrine on a mound to have a greater volume without having to dig below the groundwater.

The higher the groundwater level, the greater the risk of groundwater pollution. The extent of pollution of groundwater arising from pit latrines depends also significantly on the hydraulic loading, the characteristics of the soil and the temperature and flow velocity of the groundwater (which determine the survival and residence time of pathogens in the ground). Therefore, there can be no general or universal rule for a 'safe distance' between latrines and sources of water supply (Lewis et al., 1982). Based on the data available from pollution studies in many countries and particularly in India and the United States, the following rules of thumb can be given (Schertenleib, personal communication):

In *dry pits* and/or unsaturated soil conditions where the distance between the bottom of the pit and the maximum groundwater level throughout the year is two or more meters, the pits can be located at a minimum distance of about 8m from the well used as water supply if the effective size (E.S.) of the soil is 0.2mm or less. (Effective size is the size of the sieve opening through which 10% of the sand grains will just pass by weight). For coarser soils (with E.S. greater than 0.2mm), the same safe distance can be maintained if the pit is sealed off at the bottom by an impervious material such as puddle clay or plastic sheet, and if a 500mm thick envelope of fine sand of 0.2mm E.S. is provided around the pit.

In *wet pits* or saturated soil conditions where the distance between the bottom of the pit and the maximum groundwater level during any part of the year is less than 2m, the pits can be located at a minimum distance of 15m if the E.S. of the soil is 0.2mm or less. For coarser soils, a minimum distance of 15m can be maintained if the bottom of the pit is sealed off and if a 500mm thick envelope of fine sand of 0.2mm E.S. is provided around the pit.

Latrines inevitably pose a pollution hazard to the groundwater resources if unfavourable hydrological conditions prevail, such as coarse sand, chalk formations, high groundwater velocity and/or high groundwater table, and where no envelope of fine sand can be provided. In such instances, advice from a specialist on alternative water supply arrangements should be sought.

Wherever groundwater is used for any purpose and soil conditions vary within the area, on-site sanitation programmes should be monitored with regard to their effects on the quality of the underlying groundwater. Otherwise inadvertent contamination of groundwater supplies and a consequent worsening of community health may be experienced (Ward, 1989).

Population densities

Population densities have an influence both on the technical and on the practical sanitation possibilities. The denser an area is built up the less space is available for latrines to be constructed. There might not be enough space between houses for a latrine, or the proximity of a water well may make latrine construction undesirable. Lack of space may exclude the option for temporary latrines (which are covered when full) so that permanent latrines have to be built, which require emptying services. This situation is found in many low-income urban areas, but might also occur in urban fringe areas or rural areas where densities have increased over time or where small congested pockets may be found within a built-up area.

Communal latrines could be proposed in such areas, but communal latrines need a very specific kind of organization in view of operation and maintenance. Experience suggests that they only function when there is an attendant who gets paid by the users for operation and maintenance; not a government worker who receives a salary anyway, because that doesn't give enough incentive to keep the place well maintained. Privatization may be an option to overcome most problems, as has been done widely in India by Sulabh Shauchalaya International. In any case the location of public latrines has to be carefully chosen together with the community, so as to make ultimate use of available space.

In a practical sense, people in higher density areas will be confronted with lack of secluded space for defaecation, where traditionally defaecation could be practised in the open field. This means either having to go a longer distance to find a secluded spot, to get less privacy, or to resort to the 'wrap and throw' method of faeces disposal. Where these kinds of conditions occur, the community may well be interested in sanitation as the solution of a problem caused by changed circumstances.

4.7 Preferences in sanitation design

Preferences in sanitation design are to a large extent based on cultural and socio-economic factors. Although the choice of technology used for the substructure also depends on environmental and technical conditions, most people will base their choice on the cultural acceptability of a certain system.

Location

Because ease of access, comfort and privacy are often the main considerations to have a latrine, it is essential that all new latrines are easier to reach and more comfortable than what the people use at present. Although a latrine inside the house would be optimal from a perspective of ease of access, for most low-cost latrines this is technically not possible (see Chapters 6 and 7). But even if it would be possible, it is in many cultures not acceptable to defaecate inside the house. It is best to have the prospective users decide where to locate the latrine, given technical constraints, as they know best what is culturally acceptable.

> Privacy in the sense that one cannot be seen entering the latrine is in some cultures a very important consideration; visibility and direction (in view of cardinal points, such as Mecca), not distance from a dwelling area, are considered when a site for a latrine is chosen. A latrine is viewed as a place to provide privacy rather than as a sanitary measure (Kotalova, 1984).

Where people live in a walled compound, the latrine is often built adjacent to the wall. Socially prescribed norms such as access to water for cleansing or the designation of certain sites for defaecation are also factors affecting choice of location.

Substructure

Preferences for the substructure system will be mainly based on whether people use water for anal cleansing or not. Acceptability of handling human waste will influence a decision on whether a pit can be emptied after it is full (either immediately through desludging services or after a period of at least one year when the contents are pathogen free), or whether a new pit will have to be dug. Other considerations in opting for a certain system are environmental conditions, technical requirements and cost.

Floor slab

The design of the floor slab is a technical matter (see Chapters 5, 6 and 7), but the choice between a squatting hole or a raised seat is a social and cultural matter. Although the squatting hole is most widely accepted, people in some parts of Africa and the Caribbean are increasingly expressing a preference for a raised seat.

Advantages claimed for it are that it is easier for pregnant women and old people who find squatting difficult, and that it is less often fouled. A seat is also considered to be more 'modern'. Squatting remains, however, a strong preference in highly pollution-conscious societies (Pacey, 1980).

Superstructure

The superstructure of the latrine presents few technical problems, but its design is an essential component for the ultimate acceptability and use of the latrine.
Locally available building materials and local building techniques should be used and generally it is best to propose materials which are similar to those used for the houses. This sounds logical, but many sanitation projects have latrine huts which are substantially better built than the houses and consequently often not used as latrine but as a store room (especially when the latrine is the only place which can be locked).

In some projects the building of the superstructure is not considered to be the project's concern; emphasis is placed on the pit stability and the strength and cleanliness of the floor slab. It is left to the people to build a superstructure which at that moment is affordable for them, to be improved when more money is available. In a way this is a sound principle, because it reduces initial costs. People may use temporary building materials such as banana leaves, palm leaves, jute sacks, and corrugated iron for the superstructure, and this may make a quite acceptable superstructure, as long as privacy is guaranteed. When these temporary materials are used, the sanitation committee should continue to promote more permanent superstructures, maybe through demonstration models, to avoid situations where the temporary materials dilapidate to such an extent that the latrine is not used anymore. Furthermore, care should be taken that use of local materials does not impede adequate cleaning of the latrines.

> In Bangladesh an evaluation survey was carried out to assess user opinion and use of different types of latrines. Most of the latrines had been provided for free with the condition that the people had to put up a suitable superstructure for it.
> It was found that not the type of technology used was the deciding factor for the use of the latrine, but the quality of the superstructure. There was a high correlation between the quality of the superstructure and frequency of use of the latrine by women. The better the quality, the higher the privacy, the higher its use by adult women. But the privacy apparently valued by the women was not at all valued by the children. Here the correlation was reversed. Children do not value privacy and are generally quite happy to defaecate in the open. They may well regard the dark interior of a smelly latrine as frightening, especially if they fear falling through the hole. In Sri Lanka similar findings were reported (Gibbs, 1984).

For children a superstructure is usually not essential. To educate them in latrine use and at the same time avoid their fear for darkness, in some places (Tanzania, Sri Lanka) special children's latrines are dug without a superstructure.

In communities where water is used for anal cleansing, it might be recommendable to include some form of a water basin in the design; or depending on local preferences and financial possibilities, to enlarge the superstructure to include a bathing area, like in Zimbabwe (Morgan, 1990). The expected life length of the pit will be of influence on the possible elaborateness of the design.

It is not very difficult to incorporate the local preferences of sanitation design for the superstructure. As long as there is community participation in planning, the people will make sure that the options are acceptable to them. It is especially needed here to have women participate in working out sanitation improvements which are most suited to their preferences. It might be advantageous to use scale models in showing people different design possibilities, this is often more understandable than a sketch.

4.8 Requirements for pit emptying

Permanent latrines with a single pit have to be emptied on a regular basis with the use of mechanical devices (engine or manual driven). If the pit content is not left to rest for at least one year prior to handling, pit emptying carried out by hand is very risky and hygienically dangerous and should therefore be relinquished. The requirements of pit emptying technology and services depend mainly on the physical characteristics of the pit content and on the accesibility of the pit (Bösch and Schertenleib, 1985).
Dry pits usually contain heavy sludge which can be lifted only by using powerful tankers. From an emptying point of view, wet pits have the advantage of containing more liquid and requiring less powerful pumping equipment. Even in wet pits, however, a heavy sludge is stored and the more water is allowed to leach out of the pit, the more stiff and resistant to flow it becomes. The decrease of organic content due to digestion also reduces fluidity of the pit content. Difficult access to the pits in densely populated areas with narrow streets aggravates the problem even further. Therefore, standard vacuum tankers are often not powerful and manoeuvrable enough to empty pits in urban fringe areas. Although more powerful and also more manoeuvrable vacuum tankers are now available on the market, adopting twin-pit latrines and desludging them manually is often much more appropriate, especially in high density low income areas. The more powerful and sophisticated the equipment, the more expensive it becomes and the more difficult it is to operate and maintain.
In rural areas availability of powerful tankers is even more unlikely than in the urban areas. Thus, it is usually advisable to either construct non-permanent single pits or to adopt the twin-pit latrines.

5. *Upgrading: the Very First Option*

The philosophy of upgrading is based on the understanding that existing sanitation practices and facilities are a reflection of local social and cultural preferences and local economic and environmental conditions. If the existing facilities are not good in terms of hygiene, or changed circumstances, such as increased densities necessitate an adaption, the possibility of upgrading should be considered before anything else. This means that an assessment has to be made on the viability and options for improvement.

Where motivation to build or upgrade sanitation facilities is low in either the whole community or part of it, it may be possible to at least reduce the risk for excreta-related diseases by discussing traditional defaecation practices and finding options for improvement of practices together with the community.

5.1 Improvement of open field defaecation in low density areas

When the community or part of it will continue to defaecate in the open field, measures should be promoted to minimize the risk of contamination of water sources or the transmission of faecal material to other places. This could be done as a follow-up of the identification of risk factors and problems in hygiene education sessions.

The first item to be addressed is the selection of places for defaecation. These have to be away from open water. If people defaecate in or near water, for instance because they use water for anal cleansing, they will pollute the water (directly or indirectly by the faeces being washed into the water by the rain) and make it unsafe for drinking or bathing. The same applies to the practice of defaecating in the wet paddy field, where the water eventually also reaches open water. If defaecation is practised in banana groves or plantation fields, where the ground is furrowed, people could be encouraged to use the high furrows to walk on and the low furrows to deposit the faeces, to avoid stepping on it and getting infected by hookworm.

People also may be stimulated to bury their excreta. This is a simple and aesthetic solution to prevent odours and any immediate direct contact with faecal material. The disadvantage is that it requires time to dig even a small hole, and equipment may be needed for burying, while the risk of, for instance, hookworm is not reduced because the shallow burying does not prevent worms from penetrating top cover soil. Furthermore it is doubtful if people who cannot be motivated to construct a low cost latrine, could be motivated to go through the process of burying their excreta every time. The same is applicable for encouraging the use of footwear to prevent hookworm from penetrating the soles of the feet.
Where farmers and/or agricultural labourers live in larger concentrations away from home for certain periods, it may be possible to stimulate the building of a temporary facility. For instance, a hole of half a meter deep can be dug and the faeces covered with ashes. When it is full, it should be covered again with earth (enough that larvae and worms cannot come out) and a new hole made.

The attitude of the people towards communal responsibility for the sanitary environment is crucial. This attitude will vary in different cultures, depending on belief systems and to a large extent on the level of social control. For instance, in a society where all adults are expected and able to exert influence on all children - be it their own or others - it will be easier to control indiscriminate defaecation by children than in a society where everybody is expected to mind his own business. A different way of operating is therefore needed in these societies. It again shows the importance of the hygiene education component being adapted every time to local circumstances, and jointly planned with the people.

5.2 Improvement of traditional latrines

The most widely used facility for excreta disposal in developing countries is - and probably will remain - the traditional pit latrine, having the drop hole directly over a pit (Figure 1). Although many traditional latrines are quite good as they are, a large number needs improvements to become more hygienic, aesthetic and safer to use. Sometimes, the substructure and the floor represent health and safety hazards. Due to lack of technical knowledge, not enough consideration is given to unstable ground conditions, with the result that many traditional latrines collapse after a relatively short period of time. This is not only dangerous for the user but also means a loss of investment.

Floors are often made from logs, planks or wood, sometimes covered with earth or mud to form a flat surface. Such surfaces can easily be fouled and become a breeding place for hookworm. Dampness and termites can erode the structure of the wooden floors causing their collapse into the pit.

Lack of a drop hole cover or screened ventilation pipe creates fly nuisance and thereby the potential spreading of disease.

With simple improvements and upgrading methods many of these traditional latrines can be converted into being not only sanitary and safe but a worthwhile long term investment, which does not require replacement every few years.

5.3 Criteria for upgrading

When considering the potential to upgrade an existing traditional latrine the following criteria should be taken into account in order to make the decision to upgrade or not:

- relative costs of upgrading or constructing a new facility;
- the remaining useful life of the latrine pit;
- the present structural soundness (stability of the pit and condition of the floor slab);
- acceptance in the community;
- pollution potential.

Relative cost of upgrading or constructing a new facility

If the cost of upgrading is not much less than constructing a new facility, it would usually be better to build a new one. But it may be possible that the owner prefers upgrading, for instance because it values the effort taken in constructing the existing latrine or because alternative space to construct a new one is lacking.

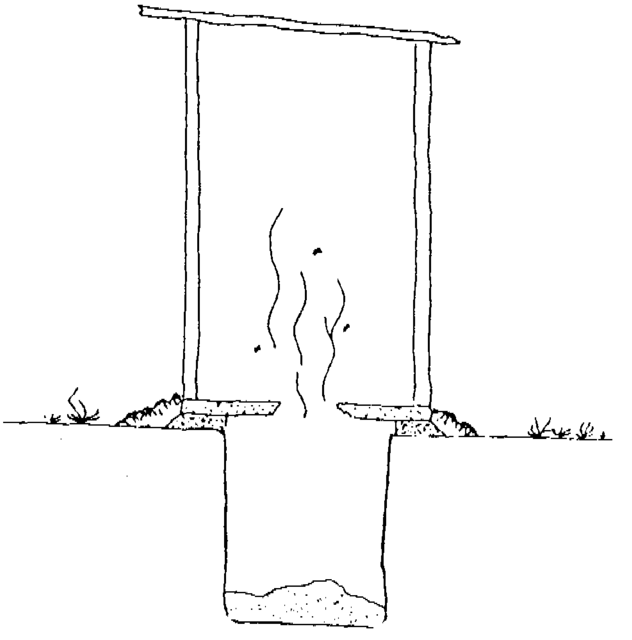


Figure 1: A traditional latrine (World Bank, 1986).

Remaining useful life of the pit

The majority of rural traditional pit latrines are non-emptiable and most urban and peri-urban latrines are usually not emptied, although in theory they could be. If the pit cannot be emptied or is not likely to be emptied, an assessment must be made for the length of its remaining useful life. This is calculated as the time that it will take for the pit contents to fill to within half a meter of the floor slab. As a general rule upgrading of a single pit latrine is considered being worthwhile when the pit has at least some three years of its lifetime left.
The easiest way to assess the remaining useful life of the pit is to ask the users how long the pit is in use, how many people regularly use it and what depth it has. If the remaining space in the pit is measured, an indication of the filling rate and leaching rate can be obtained. A more technical calculation is given in Appendix 2.
At least half a meter should be reserved for soil coverage when the pit is abandoned, to prevent larvae and worms penetrating the top soil.

Structural soundness

The two major aspects of the present structural soundness of an existing latrine are:

- the stability of the pit;
- the condition of the floor slab.

The majority of traditional latrine pits are unlined and it would be unsound practice to upgrade a latrine whose pit shows signs of erosion either at the surface where rainwater has entered or at the interface with the pit contents, especially if the pit is wet. Both situations create potential instability of the latrine and it is doubtful whether any form of remedial action can be justified.

The majority of traditional pit latrines have wooden or bamboo floors either in log or plank form. In some areas specific woods are selected for use which are known to be resistant to both rot and termite attack. Such floors have potential for upgrading. And this is certainly valid for latrine floors constructed from reinforced concrete.
In some cases specific adaptations to the design of slabs must be made to make these safe and acceptable for children and/or elderly people. Well constructed slabs, for example, may be too wide for young children to squat over.

Acceptance in the community

If the type of existing latrine is not really acceptable in the community, but only built because of lack of knowledge about other options or because people were forced to build them, upgrading should not be considered. For instance, if people use water for anal cleansing and water is readily available, they might be much more interested in the provision of pour-flush latrines. Similarly, once the people get to know the system of the VIP latrine, they might prefer that to the traditional latrine.
Only if lack of acceptance is caused by bad construction technology or bad use, may it be possible to demonstrate that the type of latrine can function well if constructed and used properly.

Pollution potential

If a latrine is located very near to a drinking water source, it would be best to recommend to stop using it. This is even more valid if the pit reaches the groundwater table (see also section 4.6).

5.4 Options for improvements

If an existing latrine is considered to be worth upgrading, there are several options for improvement. These improvements can be carried out along the lines suggested below, but it should be kept in mind that also traditional local upgrading techniques should be investigated. Some of these techniques may be well known in the community, but others may be practised only by some families, carried over from father to son or mother to daughter. Especially in cultures where there is a taboo on the topic of sanitation, it may well be that very sensible traditional knowledge is underutilized. It could be a very good task of the project to spread these traditional techniques. Some of these techniques are added below as an example.
The most effective options for improvement are:

- to make the floor slab as hygienic as possible;
- to improve insect and odour control;
- to improve the superstructure.

Hygienic improvement of floor slabs

Usually existing floor slabs do not have a slope to allow proper drainage. Moreover, often the construction material of the slab is not hard enough to prevent cracks or seepage. A good hygienic floor slab not only has to be non-absorbent and smooth, it also has to be able to freely drain any surface liquid into the drop hole.

If an existing floor slab is already made of concrete, an effective way to improve this is to lay a cement mortar screen (1 : 3 cement/sand) on top of the existing floor slab, first ensuring that the slab is sufficiently rough to key the screen on it. Foot rests can also be added which not only ensure that the feet are kept away from any fouling of the floor, but if carefully positioned ensure that the body, when squatting, takes up the ideal position over the drop hole so that excreta will fall into it.

One particular effective development is the small pre-cast un-reinforced concrete "San Plat" (Figure 2). It has been developed in Mozambique at the National Institute of Physical Planning and subsequently implemented in Malawi by the Ministry of Local Government. The "San Plat" has the following features:

- a hard and smooth surface sloping towards the drop hole, which will make daily cleaning easier;
- elevated foot rests, which help the user to find the right position when using the toilet;
- a key-hole-shaped drop hole which makes the latrine safe also for the smallest children;
- a tight-fitting lid which stops not only flies and cockroaches, but also smell. (Brandberg, 1985).

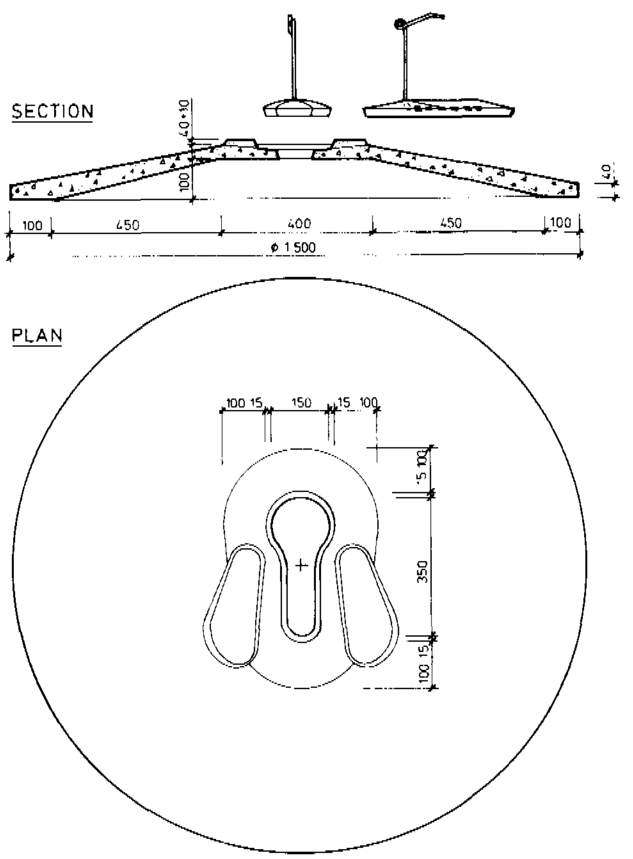


Figure 2: The San Plat (Brandberg, 1985).

The slab can be fitted on existing slabs or can be incorporated in new latrine construction. The advantage of it being pre-cast is that a well proven design can be replicated easily, accurately and with a high degree of quality control. Its relative small size and weight means that its distribution, especially in rural areas, is made easier. The introduction of the "San Plat" should be especially considered in areas where other upgrading options like the construction of vent pipes, are very expensive or impossible. Alternatively, it might be possible to improve the slab with traditional methods and materials. Earthen floors can easily become infected with hookworm and are difficult to clean, but the earthen floor can for instance be plastered with thin wet cement to make the surface harder. In parts of Africa techniques exist for combining clay with other materials (such as cow-dung) to make plaster that will form a very hard and impermeable floor. In Zaire cassava flour is mixed with soil and water to make plaster for floors, which is said to have qualities such as cement. In the Philippines green bamboo is used to reinforce floorslabs and in Nepal large flatstones are used as floor slabs (Pacey, 1980). When looking at possibilities for improvements of the floor slabs, the specific excreta-related diseases of the location should be taken into account.
As part of the upgrading exercise, the people will have to be shown how to keep the slab clean and to be aware of the necessity to always place the tight-fitting lid back.

Insect and odour control

Fly control is important, not only because flies are a nuisance if present in large numbers in a latrine, but because they breed in latrines. Moreover, they form a health risk as they spread infected faeces. Some tiny bits of faeces will stick to their legs and later may come into contact with food, cups, plates, utensils and eyes, transferring faeces and pathogens. This infected faeces is then ingested by people and the faecal - oral route of transmission via the fly as vector, is complete. Fly and odour control can be carried out by the provision of a tight-fitting lid, as is mentioned in the above section. Another option for control is the fitting of a screened vent pipe (for a description of the vent pipe see section 6.3).

The fitting of an internal vent pipe to an existing latrine or making an existing one more effective, is quite feasible and will improve both odour and fly control, provided that the pipe has the right dimensions (at least 110mm in diameter if made from uPVC), extends at least to the height of the highest point of the latrine roof and has a screen through which flies cannot pass. A suitable hole has to be made in the slab and possibly in the roof to accommodate the vent pipe. It is not recommended to fit a vent pipe on a latrine with a wooden floor as this can seriously weaken the structure. Local materials for vent pipes include bricks, blockwork, cement-rendered reeds, anthill soil mixed with plaster, plastered split bamboo pipes or bamboo pipes. The diameter of a vent pipe made with these materials needs to be larger because the inner surface is rougher, which hinders the flow of air.

The vent pipe has to be covered with a fly screen, which preferably should be made of non-corrosive material such as stainless steel or plastic coated glass-fibre mesh. If this is not available, metal wire screen can be used, but in that case a very intensive user education programme is called for to make people aware of the need to regularly check the screens and replacing them when there are holes. Because the superstructures of traditional pit latrines almost always are situated directly over the pit, there is very little possibility to fit an external vent pipe on an existing latrine.

In the case of multiple latrines over one common pit with no individual dividing walls (often found in communal or school latrines), the installation of a vent pipe also poses problems. Multiple compartment latrines will create severe cross-ventilation, which the installation of a vent pipe will not overcome. In such cases the best solution would be to upgrade the floor slab and supply tight-fitting drop-hole covers.

> The potential of the concept of improving existing latrines has for instance been realized by the Ministry of Health in Kenya where a pilot upgrading project has been initiated. At an affordable price uPVC piping is readily available, and the Health Authority has imported stainless steel fly screen material. The primary objective of the project has been to improve the hygiene of the latrines in licensed trading premises. To achieve this it is now necessary for such premises to have either upgraded their existing latrines or to have built new ventilated improved pit latrines (VIPs) before their trading license is renewed. Out of necessity this is a top-down approach to improve facilities used by the public. It is hoped that in the long term the advantages, assisted with a suitable hygiene education programme, will be perceived and acted upon by individuals (personal communication).

The vent pipe is not effective against the culex pipiens mosquitoes which breed in wet pit latrines and which cause filariasis. The mosquitoes are less attracted by the light on top of the vent pipe because they emerge at dusk and seem more able to find alternative escape routes via the squatting slab or any small opening. A device effective against both flies and mosquitoes is a fly trap placed over the drop hole instead of a cover. A simple fly trap can be made from an old (paint) tin with a cone of mosquito mesh at the bottom side and covered with mesh at the top side (Cairncross and Feachem, 1983).

Apart from the tight-fitting lid and the vent pipe, there are many traditional methods for fly and odour control. These include the throwing of hot ashes from the cooking fire into the pit, which makes the gasses pop, but also cold ash works to reduce the smell. For fly control earth, ash, horse manure or kerosene are used, but it is very likely that each community has its own techniques for fly and odour control, which may be more or less effective. These should be discussed in the hygiene education sessions, so that local methods which are effective are at least known to everybody.

Improvement of the superstructure

If an inadequate superstructure prevents the use of local latrines, while the substructure and slab are in good condition, an assessment needs to be made with the community on how the superstructure can be improved with locally available materials. Some of the problems which may play a role in acceptance of design of the superstructure are mentioned in section 4.7. The crucial point is that the design is adapted to local conditions and preferences.

Leaving the building of the superstructure to the people at a price which is at that moment affordable to them, is a sound principle. But, where it is essential that the inside of the latrine is kept dark, upgrading of the superstructure may be necessary. If latrine use is low because of non-availability of water nearby, it might be possible to extent the superstructure to include a small water basin. Similarly, small additions like a board on which to put an oil lamp or enlargement of the door to prevent visibility of use, may be enough to enhance the use of the latrine.

6. *Introducing New Facilities: Dry Systems*

If upgrading of existing latrines is not feasible and people are interested in improving sanitation conditions, new latrines must be constructed. The choice of a new excreta disposal system must be based on local current practices and take into account the cultural and social preferences, as well as environmental conditions and technical factors, as discussed in Chapter 3. It is always necessary to start with a pilot phase where different kinds of latrines (either different types, substructures or superstructures) are constructed and evaluated with the community before implementation on a larger scale can be carried out.

An overview of the different types of sanitation systems is given in Table 3.

Table 3: Types of sanitation systems

	On-site disposal	Off-site disposal
Dry	1. Pit latrine 2. Bored hole latrine 3. VIP latrine 4. Twin pit latrine 5. Compost toilet	10. Bucket latrine 11. Vault toilet
Wet	6. Pour-flush toilet with direct leaching pit 7. Pour-flush with offset leaching pit (single or double) 8. Septic tank and soakaway 9. Aqua privy	12. Sewerage: - small bore - conventional

Adapted from: Cairncross, 1988.

A first distinction between types of systems is based on the disposal of the excreta and liquids. This can be on-site in the nearby ground or off-site, by draining excreta and liquids away via a system of pipes or sewers. An interim option is to collect and store the excreta temporarily on-site in a receptacle or latrine and to have them removed with a cart or truck periodically. Off-site disposal include the bucket latrine (emptied by hand by a collector) and the vault toilet (emptied by a vacuum truck) and sewerage systems, both small bore and conventional.

The off-site disposal systems are not included in this manual for a variety of reasons:

- the bucket latrine is very unhygienic and can only work well in situations of tight institutional control;
- the vault system has high operating costs and is only advisable in high density urban areas where access by truck is possible and maintenance facilities for the trucks exist;
- small-bore sewers are suitable for liquid wastes only. They can be used with latrines using water for flushing, where on-site disposal is not possible due to limited leaching capacity of the soil or high population densities. Especially in (peri)urban

areas small-bore sewers may provide a good solution, provided the sewerage is treated properly. In rural areas, other systems are cheaper and more suitable;
- conventional sewerage is very expensive and requires large quantities of water.

Of the different on-site disposal systems, the compost toilet is also not described in the manual, because it is found to be unsuitable in many developing countries (cultural reasons) and even when culturally acceptable, requires an enormous amount of user education to ensure proper use. The other on-site systems are described in this and the following chapter.

A second distinction between systems is between 'wet' and 'dry'. In dry systems, the excreta drop through a hole into a pit, vault or other receptacle. In wet systems, water is used to flush the excreta away while some of the flushing water remains in a U-pipe to seal off the pit, or the drop pipe is extended below the water level of the pit. In short, the distinction is based on the necessity to use water for flushing or not.
It should be noted, however, that the term 'dry' does not necessarily imply that the contents of the pit are dry as well. If a 'dry' pit extends below groundwater level, the content will always be wet, even if no water is used for flushing. Similarly, in cases where water is used for anal cleansing and leaching capacity of the soil is limited, the pit may be very wet. The result will be that the decomposition of the excreta will be quicker than in a really dry pit, hence the filling rate will be lower and the calculation of the effective pit volume needed (see Appendix 2), has to be adapted. The wet on-site systems are described in Chapter 7.

Apart from social and cultural factors, technical factors which influence the choice of a particular type of latrine for a community are: cost (both of construction and operation), ease of construction and operation, and environmental factors. An overview of the technical factors which are of influence in the choice of a system is given in Table 4.

Table 4: Choice of sanitation system

Sanitation system	*Suitable for rural areas*	*Pop. density where suitable*	*Construction cost*	*Operation cost*	*Water requirement*	*Permeable soil required?*	*Off-site facilities required?*
Pit latrine	Yes	L	VL	L	None	Yes	None
VIP latrine	Yes	L	L	L	None	Yes	None
Twin pit latrine	Yes	L/M	M	L	None	Yes	None
Pour-flush toilet	Yes	L/M	L	L	Water nearby	Yes	None
Septic tank and soakaway	Yes	L	H	H	Multipe tap	Yes	Sludge disposal
Small bore sewerage	No	H	H	M/H	Yard tap	No	Sludge disposal, sewers, treatment
Sewerage	No	H	H	M	Multiple tap	No	Sewers, treatment

H = high M = medium, L = Low, VL = very low

Adapted from: Cairncross, 1988.

6.1 Basic improved traditional latrine

6.1.1 Description

The basic improved traditional latrine is a traditional latrine with two essential features:

- hygienic self-draining floor with tight-fitting lid for the drop hole to reduce smell and control insect movement;
- adequate foundation, natural or man-made, to prevent collapse of slab and superstructure.

6.1.2 Application and experiences

This type of latrine can be used in all rural areas and peri-urban areas where little water is available. It is appropriate for single households but not recommended for public places and institutions, as the risk of inappropriate use of the lid is high. Minimum distance to a well must be such that water contamination is avoided. The distance in meters, usually put at between 10m and 30m, therefore depends completely on the soil and groundwater conditions. The distance to the house depends on the choice of the users, but possible fly and smell nuisance (if the users do not replace the lid every time), make a distance of 5 to 10m preferable.

6.1.3 Design and construction

pit dimensions

To avoid the slab having to span too great a distance, the maximum width of a rectangular pit should be 0.9m and for a circular pit a diameter of 1.2m. Depending on soil conditions single pits are usually dug between 3 and 4m deep. Of course, the larger the pit, the longer it will last, but excavation below 3 to 4 meters will cause a safety hazard for the builders, as deep pits are more likely to collapse during construction. In places where mechanical desludging equipment is not available, pit latrines need not be designed to be emptied, because manual emptying is unsafe before the waste is pathogen free. The pit preferably should have a pit volume sufficiently large to function for about 5-10 years (for calculation of the effective pit volume see Appendix 2). The deeper the pit, the longer the interval between relocations and hence the lower the cost on an annual basis. Deep pits need more effort to dig and are thus more expensive. It may make latrines more affordable for low-income groups if the size of the pit is reduced and hence the initial cost.

For pits which are designed to be emptied, the volume can be less, but these pits have to be lined, to avoid damage to the pit during emptying. A balance needs to be found between the cost of constructing a deeper pit and the cost of desludging, as desludging is needed less frequently in a deep pit, but might require more powerful equipment (see section 4.8).

soil stability and pit lining

The condition and stability of the soil is important to determine the risk of collapse of the pit sides (for soil stability criteria see Appendix 2). Often, the stability of the soil in any particular area is also known by the community from previous experience with latrines, although poor design and construction may contribute to failures. If there have been latrine collapses in the area due to unstable soils, pits should be fully or partly lined. If pits are designed to be emptied, which has to be done mechanically in the case of single pits, the pits have to be fully lined.

A wide variety of materials can be used for lining, such as concrete blocks, cement or clay rings, natural stone, rocks, brick or rubble masonry; old oil drums; cement mortar; or timber (Figure 3). Where a masonry lining is used the top half meter must be fully mortared. Below this, the vertical joints should be left unmortared to allow liquids to soak away. Where possible, any gaps between the lining and the surrounding soils should be filled with gravel or permeable soil. Round pits are most resistant to collapse and are preferable where there is any doubt about the stability of the soil.

foundation

The foundation has two extremely important functions:

- to provide a firm base for the cover slab and superstructure;
- to raise the slab so that the latrine floor is at least 150mm above ground level.

The latter is to ensure that the latrine will not flood too easily. Moreover, if the surrounding area is sloping, the rainwater can easily drain away from the latrine. If this is not done, water soaking into the ground could weaken the foundation, possibly leading to collapse. To make the slope impervious, it is advisable to mix soil and cement.

The foundation may consist of a lightly reinforced concrete ring beam with one or two courses of concrete, stone or brick masonry on top. In stable soils the ring beam can often be omitted and the masonry laid directly on the soil surface. Where there is a layer of unstable soil at the surface, the foundation needs to be extended below until it rests on a stable formation, at the same time providing a partial lining to the pit. Where there is no lining to the pit the foundation should be set 150mm from the pit wall to avoid collapse of the pit edges under the pressure of the foundation and superstructure.

cover slab

The cover or squatting slab must be strong enough to ensure the safety of the users and the soundness of the structure, and should be durable enough to continue to be safe throughout the life of the latrine. Usually this will mean a slab made of concrete or ferrocement, although when sufficiently durable timber is available, cement screen supported by timber can be used. The dimensions and characteristics of a typical concrete slab are as follows:

- maximum span of 1.2m and maximum thickness of 70mm;
- precasting of slabs under supervision to be encouraged;
- light reinforcement is recommended, or alternatively barbed wire placed at 100mm centres can be used;
- where reinforcement material is not available or is too expensive, non-reinforced and slightly conical self supporting round concrete slabs may be used;
- all slabs must have a tight-fitting lid which preferably has been cast in the very hole of the slab to which it is to be fitted (Figure 3);

- floor surface must be self-draining towards the drop hole. For non-reinforced slabs this is limited to the immediate area around the hole (see Figure 3);
- a concrete mix of 1 part cement, 2 parts sand and 4 parts aggregate is recommended and the amount of water should be kept to a minimum. A dry mix makes stronger concrete than a wet one.

drop hole

The drop hole should have a minimum length of 300mm and a maximum width of 200mm (if oval shaped). It should be located at a comfortable distance of 200-300mm of the rear wall and at least 500mm should be left in front. It is essential that the tight-fitting lid is replaced over the drop hole every time the latrine is used.
Where a seat is preferred above a squatting plate, it is possible to install a seat over the drop hole. But the seat needs to have a tight-fitting cover and care should be taken that faeces does not stick to the sides of the seat.

superstructure

For the construction of the superstructure, the use of materials similar to those locally used for houses is advised, to avoid unnecessary cost and a latrine looking much better than the house. The minimum internal dimensions should be 1m x 0.9m. A roof on the superstructure is not essential, a privacy screen is often quite sufficient. But, if funds are available or it is culturally preferable, a roof can be added. This has advantages, especially in areas where rain is abundant, but sufficient light must be allowed to enter the superstructure to avoid fear for darkness or fouling of the slab.

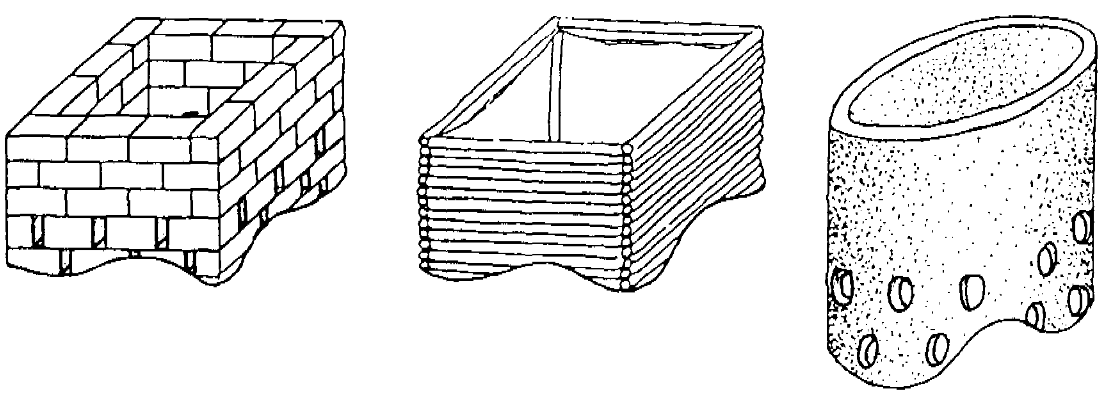


Figure 3: Types of Pit Linings (World Bank, 1986).

raised pit latrines

In areas with hard rock near the ground surface or with a high water table, construction of latrines is only possible by raising or extending the pit above ground level (see Figure 4). The pit should be fully lined with stone, brick or concrete block masonry, the lining continued up to an appropriate level above the ground and the outside walls plastered with mortar. The soil excavated from the latrine pit should be placed in a mount around the pit walls to provide support and to prevent any leakage from the extended latrine pit.

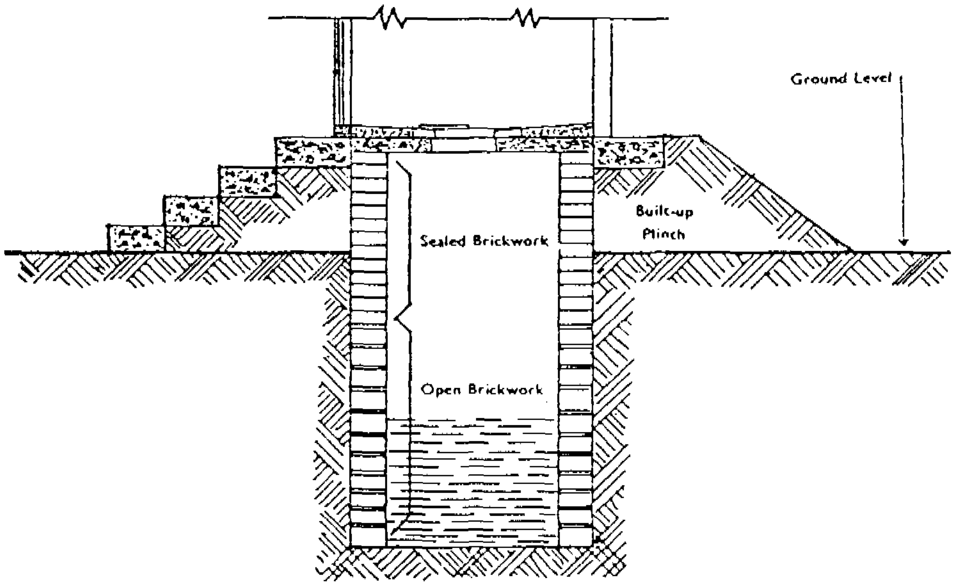


Figure 4: Raised pit latrine (Cairncross, 1988).

6.1.4 Operation and maintenance

Basic operation and maintenance requirements are the same for all types of dry latrines. A suitable brush is needed inside the latrine superstructure for cleaning of the slab. The latrine slab or seat has to be cleaned regularly with a little water to remove any excreta or urine. Preferably, a container with ashes, powdered soil or sawdust is also placed there for sprinkling over the excreta in order to reduce odour and insect breeding. The appropriate anal cleansing materials should be provided in the latrine or at least be available in the direct environment.
For the improved traditional latrine and bored hole latrine, daily maintenance procedures aside from regular cleaning of the slab and ensuring that the tight-fitting lid is always replaced after defeacation, are not required.

Periodic maintenance on a monthly basis includes checking the slab for cracks, checking the superstructure for structural damage, ensuring that the lid remains tight-fitting and ensuring that surface water continues to drain away from the latrine. Anticipation of the latrine becoming full is essential as a decision has to be made in advance where to relocate it, to dig another pit in time and then transfer the slab and superstructure to the new pit (substructure). The contents of the old pit must then be covered with at least 0.5m of top soil to hygienically seal it off.

For all types of dry latrines is valid, that non-biodegradable material such as bottles, plastic bags, rags and tin cans should not be deposited into the pit as they rapidly reduce the effective volume of the latrine. This is even more applicable where mechanical emptying methods are used as they soon block suction hoses and can damage equipment.

6.2 Ventilated Improved Pit latrines

6.2.1 Description

The Ventilated Improved Pit (VIP) latrines are designed to reduce two of the problems frequently encountered by traditional latrine systems, namely their smell and their insect production. A VIP latrine differs from a traditional latrine by a vent pipe covered with a fly screen. Wind blowing across the top of the vent pipe creates a flow of air which sucks out the foul smelling gases from the pit. As a result fresh air is drawn into the pit through the drop hole and the superstructure is kept free from smells. The vent pipe also has an important role to play in fly control. Flies are attracted to light and if the latrine is suitably dark inside they will fly up the vent pipe to the light. They cannot escape because of the fly screen, so they are trapped at the top of the vent pipe until they dehydrate and die. Female flies, searching for an egg-laying site, are attracted by the odours from the vent pipe but are prevented from flying down the pipe by the fly screen at its top (Figure 5) (Mara, 1984).

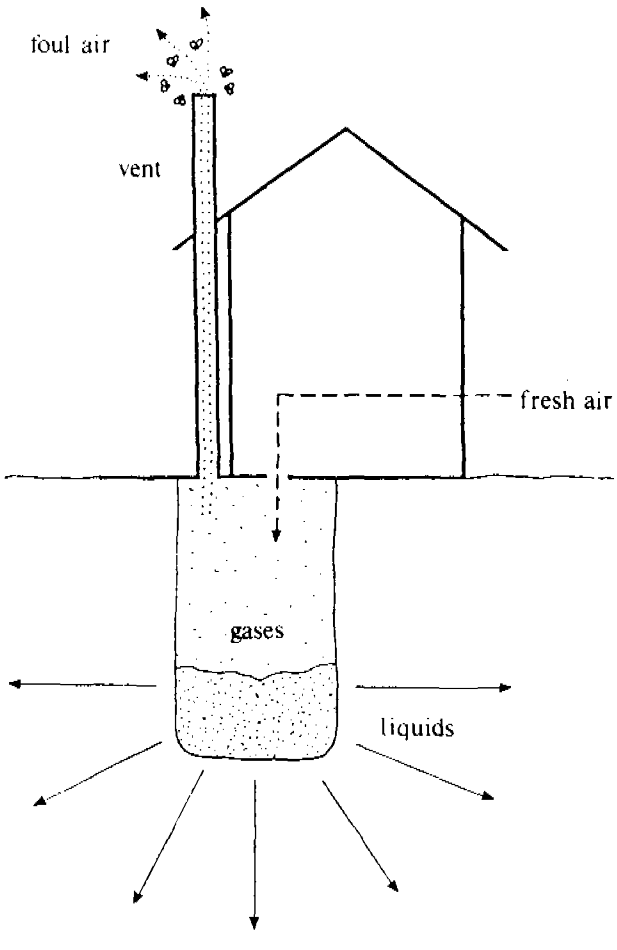


Figure 5: Ventilated Improved Pit Latrine. (World Bank, 1986).

6.2.2 Application and experiences

VIP latrines can be used for individual households, institutions and other public places in all rural and peri-urban areas with densities less than 300 people per ha. where water use is low and water has to be hand-carried. Like the improved traditional latrine, the distance to a well should be no closer than 10 to 30m, depending on soil and groundwater conditions. Distance to a house depends on local preferences, there are even examples of in-house VIP latrines. The direction of the prevailing wind should be taken into account to avoid smells from the vent pipe being carried into the house and to avoid the latrine being too sheltered from the wind which will reduce the efficiency of the vent pipe. In densely populated areas, it may be necessary to extent the vent pipe to prevent the smell being carried into the neighbouring house.

6.2.3 Design and construction

pit dimensions, lining and foundation

The guidelines given for pit dimensions, soil stability, lining and foundation for the improved traditional latrine are all valid for the VIP latrine. The effective pit volume is also applicable (see Appendix 2). VIP latrines can be designed to be emptiable. This is often preferred if there is very limited space to relocate the latrine once it is full, or when the VIP latrine is located in-house. If there is a well-functioning emptying system (see also section 4.8), the effective pit volume can be considerably reduced, compared with the volume calculated for an improved traditional latrine designed for 10 years usage. The minimum depth is usually about 2 meters. A shallow pit also reduces problems caused by a high groundwater level. However, if a pit is to be emptied mechanically (which is the case with single pit latrines), the pit has to be lined (Mara, 1985).
The leaching capacity of the surrounding soil may decrease over the years as the pores between the soil particles get clogged with organic material. This may imply shorter cycles for filling up of the pits, but the ultimate minimum cycle is 18 months. The degree of decomposition and the consistency of the decomposed material may also vary after several cycles of use.

cover slab, drop hole and seat unit

The requirements for the cover slab are the same as those for the slab of the improved traditional latrine with the addition of a suitable hole for the vent pipe. Often VIP latrines have reinforced concrete slabs with an additional cement screen applied to ensure that the floor surface drains towards the drop hole. However, in the VIP latrine, it is important that the drop hole is not covered when not in use, because this would interfere with the essential circulation of air needed for fly and odour control. Where filariasis is a problem, a mosquitoe trap may be placed on the drop hole, but this would not prevent air circulation. Drop hole configurations are the same as for the traditional latrines.

In cultures where a seat is preferred above a squatting plate, the VIP latrine can be easily adapted to build in a seat unit. In some countries hygienic low cost fibre glass seat inserts have been designed for this purpose.

superstructure

Where for most types of latrines the design of the superstructure is not essential as long as it provides the user with privacy and protection from rain, the superstructure of a VIP latrine has two important functions. First of all, the inside has to be relatively dark, to ensure that the brightest light visible to the (newly hatched) flies in the pit is from the top of the vent pipe, and not from the drop hole. This does not mean it has to

be pitch dark, but if there is a door it must be kept closed when the latrine is not in use. This can be ensured by constructing a self-closing door, by fixing the door frame 50mm out of plumb, leaning outward if the door opens inward and vice versa if it opens outwards.
A second requirement for the superstructure is to allow ventilation (usually above the door) to maintain the draught down the drop hole and up the vent pipe. The ventilation process can be helped if the entrance of the latrine faces into the prevailing wind.
In some areas it may be acceptable to build a spiral superstructure, which avoid the need for a door while still giving privacy. This has some advantages because doors are not always left closed and are sometimes stolen. Furthermore wood is expensive and hinges may rust.

vent pipe

The vent pipe can be made of any material that is durable and cannot easily be damaged. The preferred material is either uPVC or asbestos cement pipe with a minimum internal diameter of 110mm. Brick can also be appropriate when available and affordable. It can be built as a chimney either internally or externally as part of the superstructure. Because the roughness of the internal surface of a brick chimney is considerably greater than that of either a uPVC or asbestos cement pipe the flow of gasses and air may be impeded, therefore, the internal diameter of a brick chimney must be between 180 and 230mm. Other materials that have been successfully used include cement plastered hessian over chicken wire frame and cement plastered split bamboo or reed. The recommended internal diameters for these types of pipes vary between 200 and 250mm. The major problem with this type of pipes is that they are prone to damage, with cracking or falling off of the cement plaster. This immediately reduces the effectiveness of the venting effect.

Regardless of which type of vent pipe is used, they all must be properly sealed into the cover slab, securely attached to the latrine superstructure and extend to at least 0.5m above the highest point of the roof in order to be fully effective. To obtain the best results each pit should have only one vent pipe and one drop hole.

fly screen

The purpose of the fly screen is to prevent the passage of flies. The mesh aperture must therefore not be larger than 1.5mm x 1.5mm, but should not be much smaller either because that would impede the air flow. The screen must be made of material that is corrosion resistant, since it must withstand strong sunlight, high temperatures, intense rainfall and the corrosive environment of the vented gasses. The best - but also the most expensive - material for the screen is stainless steel. Also effective is uPVC-coated glass fibre, but it only lasts for five years. Other materials like synthetic fibres or wire may be used, but have to be replaced regularly, which implies intensive user education (Ryan and Mara,1983).

It is important to ensure that the fly screen is tightly fixed to the top of the vent pipe in such a way that it forms a sharp horizontal edge, thus creating the optimum wind shear conditions producing the best circulation. It has been found that mesh globes or cones (as often seen on design drawings) fixed to the top of vent pipes seriously impair the efficiency of the vent pipes by creating wind turbulence.

6.2.4 Operation and maintenance

Apart from the maintenance requirements for all dry latrines, as described in section 6.1.4, the VIP latrine requires periodic checking of the fly screen and vent pipe to ensure that they are not corroded or damage. If the VIP latrine is designed to be emptied, the joint between the removable slab and the foundation must be checked as well to ensure that it remains air-tight.

6.3 Alternating twin-pit VIP latrine

6.3.1 Description

An alternating twin-pit VIP latrine has two shallow pits, each with their own vent pipe, but only one superstructure. The cover slab has two drop holes, one over each pit (see Figure 6). Only one pit is used at a time. When this one is full, its drop hole is covered up and the second pit is used. After a period of at least one year, the contents of the first pit can be removed safely and used as a soil conditioner. The pit can be used again when the second pit has filled up. This alternating cycle can be repeated indefinitely (Mara, 1984).

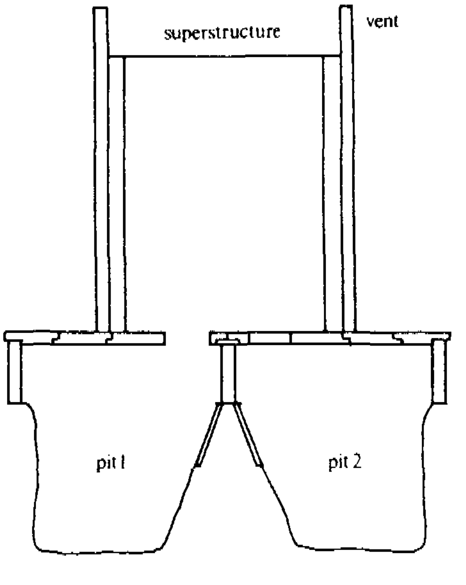


Figure 6: Alternating twin-pit VIP latrine (World Bank, 1986).

6.3.2 Application and experiences

The system is applicable in rural and peri-urban areas particularly where soil conditions are adverse or the groundwater level is high and construction of deep single pits difficult. Where densities prevent the use of space for more single pit latrines, the alternating system also offers a solution. In urban areas where the service for mechanical emptying is not reliable, the twin-pit system makes dependence on these services far less acute. First of all, the pits can be emptied manually and the contents reused, thus eliminating the need for mechanical emptying. But if this is culturally not acceptable, mechanical emptying can be planned a long time ahead, while the emptying of single pit latrines is always an urgent matter (see 4.8). Although construction costs are higher than those of a single pit, the alternating pit is a permanent sanitation facility lasting much longer than a single pit.

6.3.3 Design and construction

The basic principles for the design and construction of a single pit VIP latrine also apply to the alternating twin-pit latrines.

pit dimensions

Each of the two pits must have a volume that takes at least one year, but preferably four years to fill. The application of an extra 0.5m of depth to the calculated minimum depth for final soil coverage when the pit is full is not necessary, because the pits are designed to be permanent and emptiable. However this is often done to appease user concern that the pit is too shallow; users are reluctant to be close to the excreta even though there is no possibility of direct contact (for calculation of the effective pit volume and minimum depth see Appendix 2).

As this type of latrine is designed to be a permanent system adequate, access must be provided so that both pits can be easily emptied. The minimum size of opening for pits that will be either manually or mechanically emptied is 600mm and extends the full width of the pit. This gives sufficient opening to be able to manoeuvre to all corners of the pit as the contents to be emptied will usually be free standing and will not flow to the centre.

soil stability and pit lining

Pits in unstable soils have to be fully lined, just like the single pit latrines. If the soil is stable and the emptying done manually, lining is not necessary. In all cases where the pit is to be emptied mechanically, lining is needed because of the high probability of damage to the sides of an unlined pit during emptying. Materials for lining are the same as those for the improved traditional pits.

cover slab

The cover slab is usually made of reinforced concrete in three or more sections: a central section with the two drop holes and holes for the two vent pipes and at least two removable covers (one for each pit) to allow access for emptying. The joints between each of the removable slabs and also between the slab and the substructure must be completely sealed either by using a weak mortar or a mastic compound. This will prevent the movement of insects, the escape of odorous gasses and ensure effective ventilation of the latrine. In peri-urban situations where the municipality is responsible for latrine emptying it would be preferable for them also to have the responsibility of ensuring that all the seals are intact by carrying out this work themselves when they empty the latrine.

superstructure and vent pipes

The requirements for the superstructure and the vent pipes are essentially the same as for the single pit VIP latrine. Each pit has to be provided with a separate vent pipe and fly screen to ensure proper ventilation and fly control.

6.3.4 Operation and maintenance

Operation and maintenance requirements are largely the same as for the single pit VIP latrine. But it is most important that only one pit is used until it is full. In order to minimize misuse, it is preferable to seal the pit not in use by cementing a small cover over the drop hole with a weak cement mortar. Only after a minimum of two years can the first pit be emptied and put back into service while the second pit is sealed off. After the pit contents have been sealed for at least two years they present no health risk and can even be emptied manually without creating a health hazard for the emptier. Unfamiliarity with this type of system may lead to improper and ineffective use.

> In Botswana, for example, users requested the municipal council service to empty their first pit immediately after it was full, instead of sealing it of and using the second pit. The council service employees did so without questioning the need for this urgent emptying; also they were not adequately informed on the system. Also examples are known that people use both pits at the same time (personal communication).

If the latrine is to be emptied mechanically, advantage can be taken of the extra storage period between year two and year four (when the second pit will also be full), to decide for the most convenient time to empty the pit. Planned emptying in areas with many latrines leads to more efficient use of manpower and machinery than ad hoc emptying of pits on a crisis basis.

When introducing this type of latrine it is essential to initiate an intensive user education campaign. This campaign should also extend, if applicable, to the municipal institutions which will be responsible for servicing them.

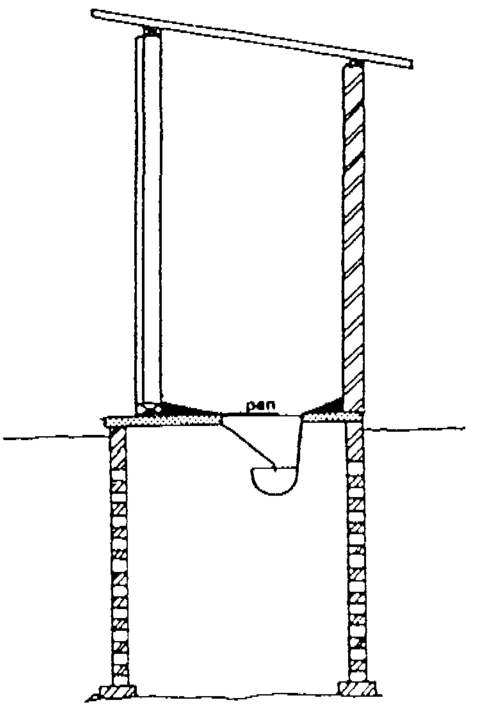
6.4 Bored hole latrine

The bored hole latrine is in principle similar to the improved basic traditional latrine, and differs mainly in its method of construction. The pit is not dug by hand but with an earth-auger or borer of at least 400mm in diameter, to a depth of at least 4m or up to the auger's maximum boring depth (approximately 10m), although a depth of 6 to 8m is usual. The latrine slab and superstructure have the same requirements as the basic improved traditional latrine, but because the cross section is smaller, it requires only a small slab which does not need to be reinforced.
The bored hole latrine can be constructed in soils free of stones, permeable and stable and with a relatively low groundwater level. The comparatively small volume of the borehole means that the useful life of the latrine is short, the small diameter of the hole increases the likelihood of blockage, and the depth of the bored hole increases the danger of groundwater contamination. Even if the hole does not become blocked, the sides of the hole become soiled near the top, making fly infestation probable.

Although bored hole latrines are not considered a good alternative for the traditional improved pit latrine, they are useful for the provision of emergency sanitation because they can be constructed rapidly in great numbers, and light portable slabs can be used. Their capacity, however, is not very large: used by a family of five to six persons, the latrine usually fills up in 1 1/2 - 2 years and even faster when bulky cleansing materials are used.

Preparedness for emergency situation using bored hole latrines is illustrated by a contingency plan in West Bengal, India. The plan is designed to cater to 100,000 people in an area where the subsoil is suited for bored hole latrines. The aim is that everyone should have access to a latrine after 20 days. With an estimated 50 users per latrine (rather a high number), this means that 2,000 latrines have to be constructed in 20 days, 100 every day. With each hole about 5m deep, this rate of construction can be achieved with 100 earth-augers even in difficult soil conditions. One steel mould can turn out concrete floor slabs with squat holes at the rate of 15 slabs per day. To speed up production the concrete must be vibrated mechanically in the mould, the slabs must be turned out of the mould before initial setting is complete, and 3% calcium chloride is added to the cement to speed up setting and curing time for the concrete. With this production technique moulds with ancillary equipment can produce 105 concrete slabs per day. Therefore the equipment needed to provide for 100,000 people in 20 days would include 100 earth-augers, 7 mild steel moulds for latrine squatting plates, and 7 form vibrators for use with moulds. It is also necessary to ensure the adequate supplies of the basic materials such as cement, calcium chloride, steel reinforcing bars, sand, aggregate, and water (Office of UN Disaster Relief Co-ordinator, 1982).

Figure 7: Pour-flush latrine with discharge directly into the leaching pit



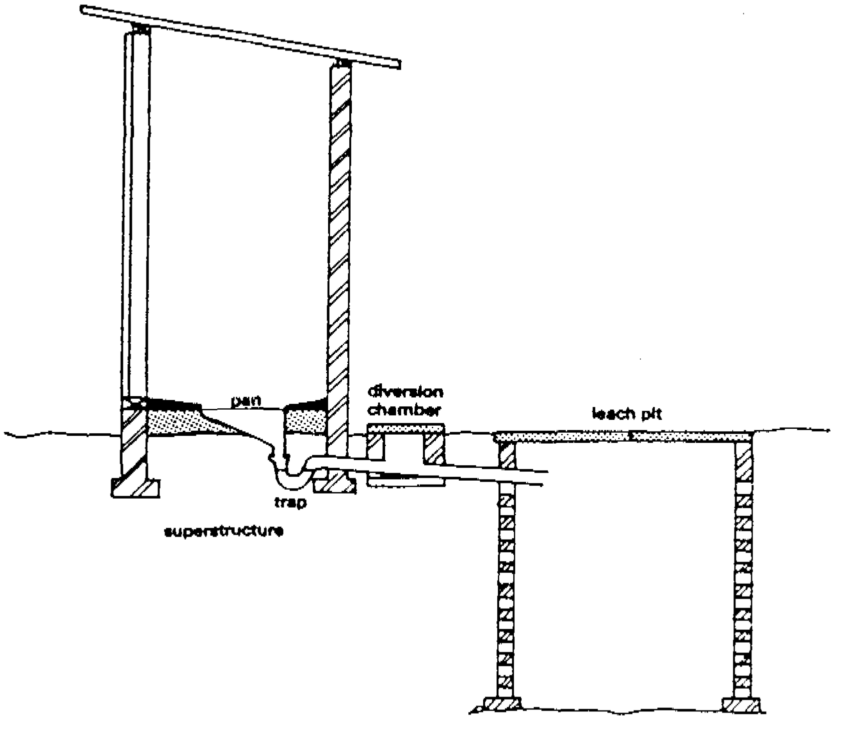
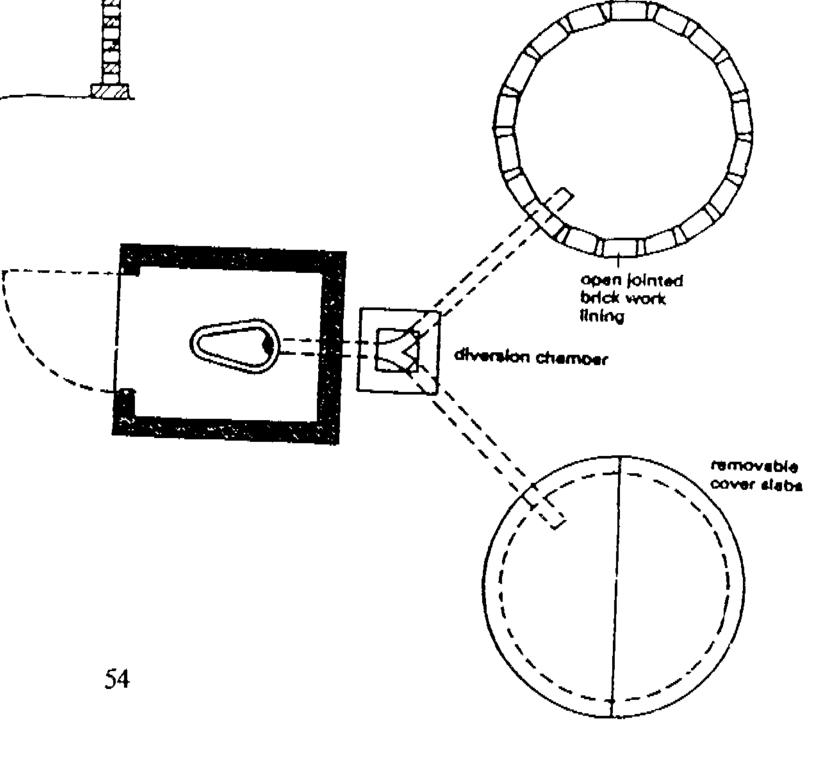


Figure 8: Pour-flush latrine with discharge in single offset leaching pit

Figure 9: Twin offset leaching pits



7. *Introducing New Facilities: Wet Systems*

Wet systems need water for flushing and are therefore dependent on perennial water sources. Given the level of water availability, generally only a few of the possible sanitation options will be appropriate. All wet systems use water to seal off the latrine pit, eliminating odour, flies and mosquitos. Usually this water seal is located in a U-trap attached to the seat or squatting pan. If this pan is well designed and holds only 1.5 liters of water, it can be flushed by hand, requiring 2-3 liters per flush.

Another possibility is a cistern flushing toilet, but this requires a house level water connection to provide at least 8-10 liters per flush. This system is not recommended because apart from a house connection, it requires a considerable infrastructure to get rid of the water, ranging from a minimum of a septic tank to a full sewerage system. In most circumstances, it is better to avoid such a system, because even when connected to a septic tank, it can easily lead to pollution of the environment.

Another type of water seal not having a U-trap can be found in the aquaprivies, in which the liquid level of the tank below functions as a crude waterseal.

The receptacles of the wet latrines can vary from simple leaching pits to extensive septic tanks, or small bore sewer systems.
The leaching pit is a traditional pit but with specific requirements to allow for optimal leaching. Three systems with leaching pits can be distinguished:

- discharge directly into the leaching pit (Figure 7)
- discharge into a single offset leaching pit (Figure 8)
- discharge into twin offset leaching pits (Figure 9).

Septic tanks and aquaprivies are water-tight tanks filled with water for digestion of the excreta in water; they have a soakaway for the effluent. Small bore sewerage is a simple form of sewerage which only transports liquid wastes such as the effluent from a septic tank.

This chapter focusses on on-site systems applicable for low-cost communities: the pour-flush system with discharge either directly or indirectly into a leaching pit. The more expensive on-site systems like septic tank and aquaprivy are only briefly described.

7.1 Pour-flush latrines with leaching pit

7.1.1 Description

The pour-flush latrine is essentially an improved pit latrine and consists of a concrete floor slab with a squatting pan or seat. A water seal is fitted below the seat or squatting pan, consisting of a U-trap (Figure 10). The design of this U-trap is very important because it determines the amount of water necessary for flushing. The excreta are flushed through the U-trap either directly into the leaching pit, or indirectly through a connecting pipe intc an offset leaching pit. The pan is thereby cleaned after each use, while the water-seal is maintained to provide a barrier against odours and insects.

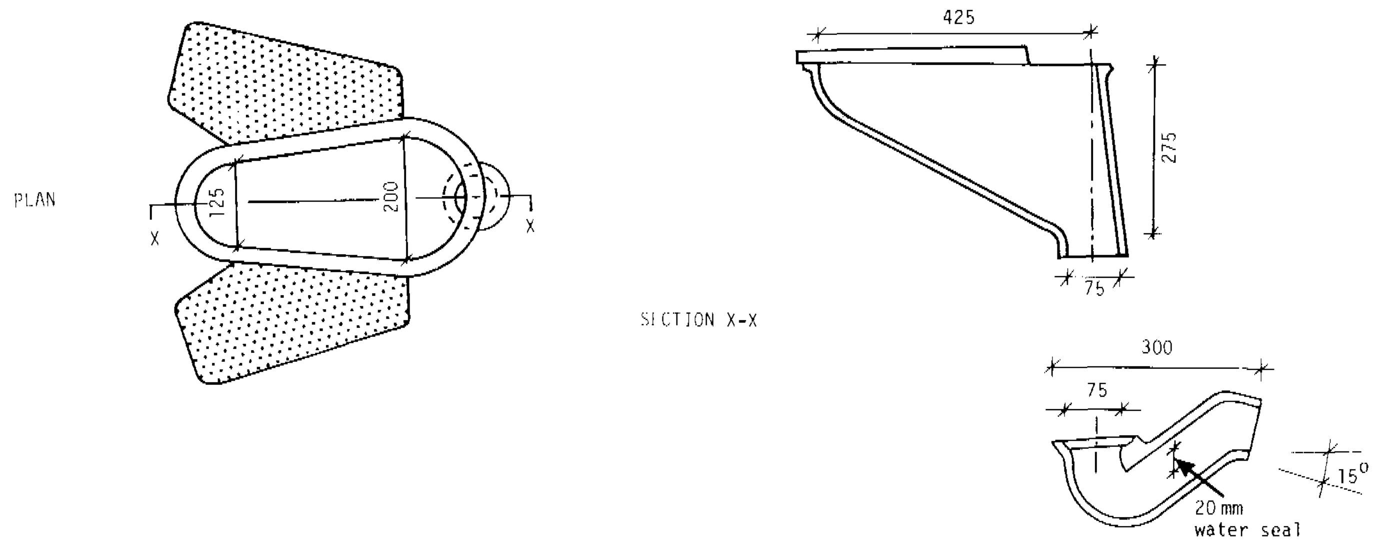


Figure 10: Pour-flush squatting pan and U-trap (Roy et al., 1984).

7.1.2 Application and experiences

This system can be used in rural and peri-urban areas provided there is a nearby reliable water source. It is particularly suitable wherever water is used for anal cleansing. Since flushing is done manually, a multiple-tap, in-house level of water supply is not required. The system is most suitable where a pond or well is near the house or in connection with a yard-tap level of water supply. But the flushing water can also be carried from a public standpipe or public well.

The latrine can be located inside the house as the water seal prevents any smell or insects from entering; it can even be located above the groundfloor.

A pour-flush latrine with direct discharge into a pit requires the least amount of water for flushing, usually about 1.5-2.0 liter per flush. Latrines which discharge into an off-set pit require a little more water per flush, depending upon the length and gradient of the connecting pipe, but usually no more than 3 liters.

One problem which may be encountered is blockage of the U-trap, due to inappropriate design, a surface which is too rough or inappropriate use. Often suitable cleaning tools which are flexible enough to make the bend in the U-trap are not available, thus people use a wooden stick or metal pole to unblock the U-trap, with the result that the trap breaks. Especially in a pit with direct discharge, where the U-trap is not supported by a connecting pipe, the trap can be expected to break with rough treatment.

> Both in Bangladesh and Pakistan, several cases have been noted where people who were in the process of installing the pan with waterseal were advised by their neighbours to smash the U-trap before installing it, to prevent blockage. The fact that there would, as a consequence, not be a waterseal to protect against smell and insects apparently was of minor importance (personal communication).

If well designed, however, the system is easy to clean and not difficult to maintain. An additional advantage of the system is the fact that it is suitable both for adults and children, who do not need to fear falling into the drop hole, as the U-trap is small in diameter and always filled with water.

The leaching pit must be located in such a way, that contamination of the water supply is avoided. The soil must be sufficiently permeable for the estimated quantity of effluent discharge into the pit to be able to leach away.
Thus, the system is not suitable for areas where percolation is extremely poor, e.g. heavy clay soil. It is also not advisable for use in cultures where it is common practice to use bulky materials for anal cleansing such as corncobs or stones which cannot be flushed through the U-trap.
Pour-flush latrines are common in the Indian subcontinent and South East Asia and are becoming widespread in Latin America.

7.1.3 Design and construction

Pit dimensions

Leaching pits serve for storage and digestion of excreta and for infiltration of waste water liquids. The dimensions of the pits are therefore dependent on a number of external parameters (see Appendix 2):

- the solid accumulation rate, which is dependent on a number of variables;
- the soil leaching capacity (long-term infiltration rate), which is the amount of water that is capable of seeping into the soil over a given period of time;
- the hydraulic loading on the pit, which is the total volume of liquids entering the pit from all sources, expressed in liters/day (Mara, 1985).

In general, leaching pits which penetrate the groundwater table are wetter than those above it, and their solid accumulation rate is consequently also lower than for a dryer pit. The shape of the pit can be circular or rectangular, or a combination of the two. However, circular pits should be constructed wherever feasible as these are more stable and cost less.

direct leaching pit

The pit must be sealed off when it is filled to within 0.5m of the top, the last half meter is to be filled with earth. This has to be taken into account when calculating the number of years the pit has to last. Like with the dry pits, the deeper the pit, the longer it lasts, but also the higher the excavation cost. Because the waterseal pan is directly over the pit, the pit cover has to be strong and should not have to span more than 0.9m m for a rectangular pit or 1.2m for a circular pit.

single off-set leaching pit

For this type of pit a balance has to be found between desludging costs and construction costs. If mechanical desludging services are easily available and do not cost much, there is no need for a deep pit. However, it is likely that in most cases, it will be better to dig a deep pit as the organization of desludging services is generally not very adequate (see also section 4.8).

twin off-set leaching pit

In principle the dimension of twin-pits can be much smaller than that of a single pit, which is an advantage where soil conditions are adverse or the groundwater level is high. Minimal pit dimension should be such, that the pits can be used for at least two years, the period required for effective pathogen destruction. After this period, the contents of the pit not in use can be removed safely by hand.

Location

direct leaching pit

This latrine cannot be situated inside the house as the pit will be closed off when full and a new pit has to be dug. The pit should not be located too near to a building foundation as the leaching may weaken the foundation.

single off-set leaching pit

The latrine can be located inside the house and connected to the pit outside. The pit outside should be accessible for mechanical desludging equipment. Preferably, the pit should be located within the premises it serves, but in case of insufficient space, it can be located outside in a public alley or under a sidewalk. In this case, the cover should be strong enough to withstand the load it has to carry. However, it may not always be acceptable or permissible to have a private pit in a public space.

twin off-set leaching pit

The same conditions are valid as for the single off-set leaching pit, but in principle they do not have to be accessible for mechanical desludging equipment. The pits have to be separated by at least one meter for structural stability and to prevent liquids from the pit in use to enter the other pit. There are different geometric configurations of latrine unit and leach pits possible. If space does not allow two separate pits, it is possible to construct one pit with a dividing wall in the middle. This wall should extent for half a meter outwards to minimize cross-contamination due to water infiltration from the pit in use entering the other pit (Mara, 1985).

Pit lining

direct leaching pit

The upper part of the pit has to be lined for stability, but the need for full lining is determined by the stability of the soil (see section 6.1.3) The materials suitable for lining are the same as for the traditional improved pit latrines (see section 6.1.3). The free space at the top of the pit should be fully mortared, but below, the vertical joints must be left open to permit infiltration of liquids into the soil. In loose, sandy soils a layer of gravel or similar material should be provided outside the lining to prevent sand from entering the pit (Mara, 1985).

The national sanitation programme in Bangladesh used to promote pour-flush latrines which discharge directly into the leaching pit. Each latrine consisted of five cement rings and a slab. The depth was about 1.5 meters. Partly because the majority of the rural population could not afford this option, it was decided to promote a 'one slab - one ring' option whenever this was technically possible. The ring served as foundation for the slab and to prevent top-soil from entering the pit, particularly during floods. Below the ring, the lining could be made with locally available materials if necessary, or the pit could remain unlined. When the pit is filled, another pit has to be dug, a new ring purchased and the slab and superstructure shifted from the first pit. In practice, it worked differently as users would pay somebody to empty the pit manually. The contents are buried in another hole or just dumped somewhere, resulting in a health hazard not only for the emptiers but also for others. A new approach is now being promoted where the ring is placed on the ground and a hole dug inside the ring. If unlined, the hole is seldom deeper than one meter. The slab is placed on the ring and when the pit is filled, the ring, slab and superstructure are shifted. In this way, the ring is not 'lost'. An additional advantage is that the slab is elevated, which is of importance during floods.

single off-set leaching pit

Unless the pit is closed when full, these pits will always have to be lined as they have to be emptied mechanically.

twin off-set leaching pit

The upper part of the pit has to be lined until below the connecting pipe. The need for lining of the rest depends on soil conditions, taking into account that the pit will be emptied by hand.

Cover slab

For the off-set pits, the strength of the cover slab is dependent on the load it is expected to carry. Thus, a cover for a pit located outside the premises, may have to be stronger than one which is not expected to support people or vehicles. The covers are usually made of reinforced concrete or ferrocement, a thickness of 50mm is generally adequate for pits located within the premises. It may be cast in two or more pieces and lifting handles should be cast in it to facilitate handling when emptying the pit. Where a heavy load is not anticipated, the covers may also be made from other material.

Squatting plate, pan and U-trap

A distance of 200mm is required between the rear of the pour-flush pan and the rear wall of the superstructure. The squatting plate should have a smooth, hard and self-draining surface with a minimum gradient of 1 in 20 towards the pan. The plate must be bedded and sealed with a weak cement mortar of 1 part cement to 6 to 10 parts of sand. It should be raised at least 150mm above the ground to prevent surface water flooding the pit.
Connected to the pan is the waterseal (U-trap), which keeps odours and insects in the pit. The most satisfactory depth for the water seal trap has been found to be 20mm, and the internal diameter of the trap should be approximately 75mm. The trap can be made from cement mortar, glazed ceramic, plastic or glass fibre according to preference and availability of funds and materials. It is very important that the pan and water seal units are levelled and correctly aligned during construction so that the correct depth of the water seal is obtained. This may be achieved by designing the pan and the trap to fit together as an integral unit (Mara, 1985). The inside of the U-trap should be smooth to prevent faeces from sticking to the sides, eventually resulting in blockage. The trap must be strong enough to withstand rodding in the event of a blockage.

If a seat is preferred above a squatting plate, a pedestal unit can be installed instead of the squatting pan. The same requirements for levelling and aligning of the U-trap are valid as for the pan. Also pedestal units with an integral water seal may be available.

direct leaching pit

As the squatting plate is located directly over the pit, it functions as cover slab as well and thus a foundation is needed to provide a firm base (see section 6.1.3). It should have a smooth, hard and self-draining surface with a minimum gradient of 1 in 20 towards the pan. The pan has to be cast into the slab in such a way that maximum strength is provided. The U-trap should preferably be cast as an integral part of the pan to be as strong as possible as the trap is not supported by a connecting pipe. The U-trap can be directed forward (underneath the pan) or backward to the rear of the superstrucure. A disadvantage with the forward trap is that it is more difficult to clean or unblock as the bend is more difficult to reach. A disadvantage with the backward trap is that the flushing water may weaken the foundation.

Interconnecting pipe work

The pipe work connecting the pan and U-trap to the leaching pit needs a minimum gradient of 1 in 30 and a diameter similar to that of the trap, approximately 75mm. If asbestos cement or uPVC is not available, a covered brick drainage channel may be used, but this should be less than 5m and may need a steeper gradient. This pipe work must allow a smooth and unrestricted flow of flushed excreta and urine to the leaching pit, with a maximum distance of 15m.

The twin offset leaching pit needs to have a small chamber or Y-piece to divert the flow of each leaching pit in turn. This can be a 250mm square chamber with smooth cement mortar benching or a solid concrete block having an Y-shaped opening connecting the pipes. The branch to the leaching pit not in use should be sealed with weak cement mortar or clay. It is important that the temporary seal maintains the smooth channel for the excreta flow, otherwise blockages might easily occur in the flow diverter. The flow diverter must be covered with a concrete or stone slab, sealed in place with weak mortar so that it can be easily removed to divert the flow from one pit to the other or for rodding to remove blockage. The diversion chamber or Y-piece could also be installed with single pits to allow for the later addition of another pit, if initial costs for a twin-pit are too high for the user.

Superstructure

The requirements for the superstructure are the same as those for the traditional improved pit latrine if the latrine is to be built outside the house (see section 6.1.3)

7.1.4 Operation and maintenance

Near or preferably inside every latrine, a suitable water container should be placed. This container should always be kept full of water. A small container of between 2 and 3 liters capacity must be provided to draw water from the large container for anal cleansing and flushing. A brush will be needed to scrub the slab and clean the squat pan. A bendable brush, or other bendable material would be advisable to clean the U-trap in case of blockage. From a daily maintenance point of view the most important aspect is to ensure that the slab and pan are washed clean.

Generally sullage from laundry, bathing or the kitchen should not be disposed into the latrine unless the pit has been designed to receive such wastewater. Likewise no solid waste, such as rags or any solid anal cleansing material, should be put into the pan as this will quickly block either the water seal or the connecting pipe to the pit. If the water seal is broken, a new pan has to be installed if the pan is made in one piece, or a new U-trap has to be connected to the old pan.

The first indication that the pit is full is usually the inability to flush the squat pan. After it has been established that this is not being caused by a blockage of the water seal or pipe, an arrangement has to be made to seal off the pit, if it is not designed to be emptied. In case of a single offset leaching pit, an emptying service has to be called. This indication is rather a late sign, as the outlet of the waterseal is normally less than 50 cm below ground, thus eliminating the possibility of hygienically sealing the pit with the 50 cm of earth. Furthermore the desludging service may not be available in time to prevent overflowing. Therefore, it is preferable to have some other means to indicate the level of the pit contents, such as a marked stick which has to be designed to fit in the cover slab.
For the twin offset leaching pit, the flow diverter in the splitting chamber is removed from the pipe leading to the empty pit and then used to seal off the pipe to the pit in use. As the discharge has now been diverted into the second leaching pit, the latrine can continue to be used. After about one to two years, the pit can be emptied manually and earlier if this is done mechanically.

A general problem in all cases where the pit is emptied before the contents are pathogen free, is how to empty the pit without causing a health hazard to the persons emptying it and how to dispose of the pit contents in an environmentally acceptable way. This issue should not be overlooked when planning for the construction of single pits (see also section 4.8).

7.2 Septic tanks

A septic tank is a water-tight settling tank to which wastes are carried by water flushing down a pipe connected to the squat pan or seat (Figure 11). A septic tank usually has one or two compartments; the total volume of the tank should be at least three times the average volume of water used daily. A septic tank does not dispose of wastes: it only helps to separate the solid matter from the liquid. Some of the solids float on the surface, where they are known as scum, while others sink to the bottom where they are broken down by bacteria to form a deposit called sludge. The liquid effluent flowing out of the tank is, from a health point of view, as dangerous as raw sewage and remains to be disposed of, normally by soaking into the ground through a soakaway. The sludge accumulating in the tank must be removed regularly, usually once every one to five years.
A soakaway is usually a pit or trench filled with stones, broken bricks or other rubble. It allows the wastewater to filter through the sides into the ground and disperse. Sometimes it is in the form of a pit lined with open-jointed masonry. The size of a soakaway and the area of land it requires will be determined mainly by the volume of wastewater produced and the local soil conditions.

soak away!

Septic tanks can receive waste household washing water or sullage as well as the wastes from toilets, but then a larger amount of space is required for the soakaway system to cope with the greater quantities of water involved. This means that in relatively high density areas (more than 100 persons/ha) there may not be sufficient space for adequate soakaways and discharge into a small-bore sewer may be necessary.

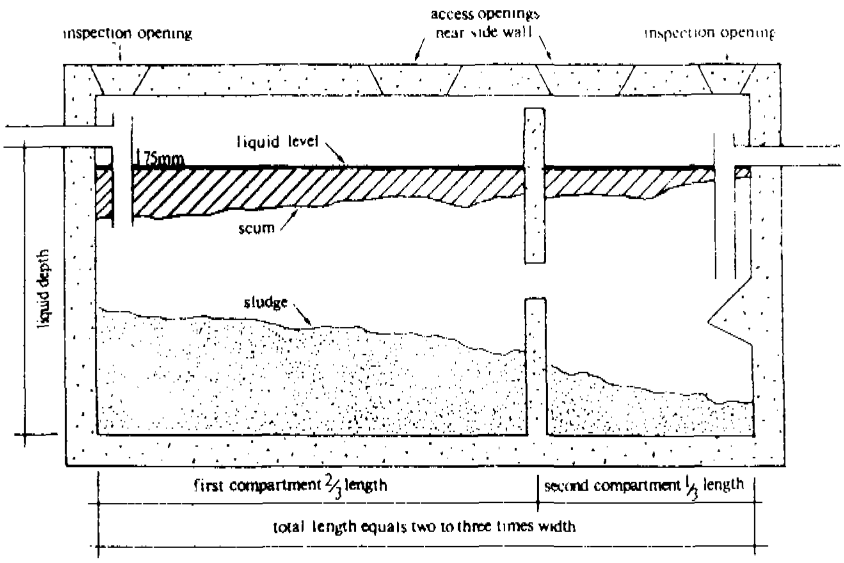


Figure 11: Septic tank (World Bank, 1986).

7.3 Aquaprivies

The aquaprivy latrine consists essentially of a squatting plate situated immediately above a small septic tank that discharges its effluent to an adjacent soakaway. The squatting pipe has an integral drop pipe of 100-150mm diameter, the bottom of which is 10-15cm below the liquid level of the tank. In this manner a simple water seal is formed between the squatting plate and the tank contents (Figure 12).

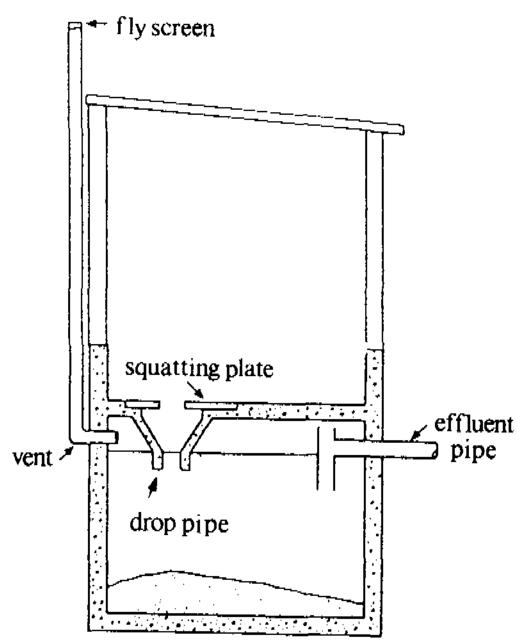


Figure 12: Aquaprivy.

A couple of buckets of water should be poured down it each day to clear scum (in which flies may breed) from the bottom of the drop pipe and to maintain the water seal necessary to prevent mosquito and odour nuisance. In practice, the water level tends to fall due to a low inflow of water or to leaks in the tank, so that the water seal is not maintained. Discharging sullage into the tank (by connecting the waste pipes from basins, showers, etc.) has not proved capable of solving this problem. When the flow of sullage is relatively large and especially in high-density areas, soakaways cannot dispose of the effluent, so that it has to be discharged into a small-bore sewer, in which case a second compartment is needed to settle out the solid matter (Cairncross and Feachem,1983).

If the aquaprivy has to dispose of only a small amount of sullage, it is essentially equivalent either to a VIP latrine with a separate soakaway for sullage, or to a pour-flush toilet whose offset leaching pit can also receive the sullage. These systems are less expensive than aquaprivies and less likely to give trouble. The pour-flush latrine has a water seal which is much superior to that of the aquaprivy, and it does not require a water-tight tank and can be located inside the house.

Appendix 1

Useful socio-cultural data — Tools suitable for collecting data

1. *Demography - S* *
   - Population size, growth rate, mobility;
   - Household size and composition (special features such as women heads of households, sharing, individual or family renters).

2. *Health - KI*
   - Major health problems in the community and relative importance of water/sanitation-related diseases;
   - Seasonal variations.

3. *Occupation - KI, S*
   - Major occupations and approximate distribution;
   - Seasonality of employment.

4. *Organization and participation - KI*
   - Major local organizations and type of membership;
   - Community and family level leadership in decision making;
   - Major local political or social factions which might affect participation;
   - Extent of previous interest and participation in water/sanitation or other development activities;
   - Important characteristics that would determine the acceptability and influence of outsiders working on projects in the area.

5. *Level of interest - KI, OE*
   - Evidence of popular interest in improving water supply/latrines, compare to other potential improvements in the community;
   - Evidence of leadership to improvements.

6. *Physical structures - P, KI, S*
   - Types of dwellings, their physical condition and layout;
   - Types of building materials used;
   - Existing water supply and sanitation facilities;
   - Space availability inside and outside dwellings.

7. *Water use patterns and practices - P, KI*
   - Preferred sources of water (by purpose);
   - Quantity and uses;
   - Water-source-related activities (e.g. laundry, animal watering);
   - Possibilities for contamination of drinking water.

*	Key -	Usual means of obtaining data
	P	Participant - Observation
	KI	Key informant interviewing
	OE	Open-ended interviewing
	S	Survey

8. *Defecation habits and associated practices, underlying beliefs and attitudes - P, OE, KI*

- Existing practices (noting important differences between: castes; religions; men, women and children; different age groups);
- Cleansing and ablution materials and practices (e.g. anal cleansing materials; prevalence of bathing in latrines);
- Underlying causes of the above;
- Important taboos, beliefs related to locations, sharing etc.;
- General household cleanliness;

9. *Level of technology and resource availability - P, KI*

- Local availability of building materials;
- Availability of skilled and unskilled labour (noting seasonal variations);
- Availability of technology-related inputs (such as water for pour-flush toilets);

10. *Education activities and potential - KI, S*

- Literacy level;
- Mass media access in the area;
- Coverage by field workers, volunteers;
- Ongoing formal or non-formal health education activities.

11. *Health and disease - KI, OE*

- Indigenous understanding of principal excreta-related diseases (especially diarrhoea and worms) including local disease categories and local ideas of transmission, cure and prevention;
- Local ideas of needs, desires and realistic activities which they could carry out to improve living standards;
- How important is sanitation amongst these needs.

12. *Defecation practices and latrine usage - P, OE, KI*

- Defecation sites for those without latrines;
- Preferred times and frequency of defecation;
- Values, beliefs, rites and taboos associated with defecation;
- The disposal of children's excreta and toilet training methods;
- Social organization of defecation (who may share a latrine with who).

13. *Social soundness of sanitation technology*

- Number and types of existing latrines (case studies);
- Proportion of population with access to latrines;
- Social characteristics for households with latrines;
- Locally perceived attractive structures of latrines;
- Factors affecting preferred siting of existing latrines;
- Maintenance requirements and health benefits.

From: TAG Technical Note no.1, Methods of gathering socio-cultural data by Mayling Simpson-Hebert, World Bank, 1983.

Appendix 2

Tools for determination of technical options

Soil test 1: Soil colour

The colour and patterns in the soil indicate levels the groundwater can reach.

Select a soil sample, and, without crushing it, observe the colour. It is important to have good sunlight. If its surface is dry, sprinkle some water over the samples.

A uniform red, yellow or brown colour indicates soils that are well aerated and rarely or never saturated with water.

A grey or blue colour indicates soils that are saturated for extended periods or all the time. A uniform grey or blue colour indicates the constant groundwater level.

Spots or streaks of different colours, called mottles, indicate seasonally saturated soils. This indicates the groundwater level during the wet season.

If you find spots or streaks or soils of a grey/blue colour, the pit will reach the groundwater level. If that does not correspond with the assumed groundwater level, choose another pit location if possible.

This soil colour test is simply a first indicator of the groundwater level. When the pit has been excavated to its full depth, a second soil colour test will give more definite information.

Soil test 2: "Feel and Appearance" test

Take another soil sample, about 2cm in diameter, from the hole and do a "feel and appearance" test.

Sprinkle the sample with water till the consistency is like putty. Too much moisture results in a sticky material, which is hard to work.

Try to form a cast:
If a cast cannot be formed or the cast crumbles when touched, it is sand.

If the cast can be handled freely without breaking it could be either loam or clay. In that case:
Press and squeeze the cast between thumb and forefinger and try to form a ribbon.

If it is difficult to form a ribbon, it is loam.

If it forms a thin, flexible ribbon, which retains its plasticity when elongated, it is clay; clay is sticky and puddles easily.

To double-check the results, take another sample of soil and, without moistening it, do a second feel and appearance test.

Sand has a large percentage of single grains which can easily be seen. It feels gritty. Squeezed, it will not hold its shape.

Loam has a fairly smooth or slightly gritty feel, and clods are crumbled easily. Squeezed it forms a cast.

Clay is fine texture, clods are hard to very hard and strongly resist crushing by hand. When pulverized, it has a grit-like feeling due to the harshness of the very small aggregates which persist.

Soil stability criteria

Three alternative, simple field tests for soil stability are designed. On the basis of these tests, it can be decided whether a pit needs to be fully lined.

Test A

This is the simplest test. Soil samples are taken by hand auguring; one sample should be taken every 50cm to a depth of 3m. Each sample is then hand-rolled to form a rough cylinder of approximately 2cm diameter and 5cm long. After sun-drying for two days or, preferably, oven-drying for two hours at 100° C, the sample is gently crushed between one's thumb and fingers.
Unstable (cohesionless) soils crush easily, whereas stable (cohesive) soils do not. This test requires some experience, and it is therefore a good idea to practise the test on soils of known particle size distribution and undrained shear strength.

Test B

This is the standard soil mechanics measurement of particle size distribution*. A soil can be considered stable if it contains more than 30% clay (0.002mm). It is simpler to measure the combined sand and silt fraction (0.002mm), which should not therefore exceed 70%.

Test C

This test is the measurement of the undrained shear strength of soil samples and is thus applicable only to cohesive soils. It is done in the field by the standard soil mechanics vane test procedure . Soils with an undrained shear strength of less than $15kN/m^2$ are likely to be able to support normal superstructure and cover slab loads (which may exceed 20kN). As a reasonable precaution, pits excavated in soils with and undrained shear strength of less than $20kN/m^2$ should be fully lined.

From Mara, D.D. (1985). Ventilated Improved Pit Latrines: Guidelines for the Selection of Design Options.

Effective pit volume

The required pit volume depends on the solids accumulation rate, the number of users and the desired life of the pit. In practice the pit must not be allowed to fill up completely (right to the underside of the cover slab), so a small free space at the top of the pit must be allowed for in the design; usually 0.5m is sufficient for this. The effective pit volume m^3, which is the total volume less the free space volume, is calculated as the product:

solids accumulation rate, m^3/person/year	x	number of users	x	design life, years

The solids accumulation rate may for design purposes be taken as 0.04 and $0.06m^3$ per person per year in wet and dry pits respectively, a lower value may be used if known to be locally more appropriate. These design values should be increased by 50% if bulky anal cleansing materials (for example, corn cobs, cement bags) are used, as these degrade only very slowly. The design life should be as long as possible; 10 years should be considered desirable. The longer the design life, the longer the interval between relocating or emptying the latrine, and so the cost of the latrine (when calculated in annual terms) is generally lower**.

From Mara, D.D. (1984). The design of Ventilated Improved Pit Latrines.

* This is described in, for example, British Standard BS 200411972.

** This assumes that the cost of extra depth in the pit is less than the present value of more frequent emptying or relocation. This may not always be true, especially in very deep pits in difficult soils.

Calculation of remaining useful life of the pit

The majority of rural traditional pit latrines are non emptiable and most urban and peri-urban latrines, although they can in theory be emptied, are usually not in practice. In the context of upgrading it is assumed that the pit cannot be emptied and an assessment must be made for the length of its remaining useful life. This calculated as the time that it will take for the pit contents to fill to within half a meter of the floor slab. As a general rule upgrading is considered worthwhile if the pit has at least some three years of its lifetime left.

In practical terms it is best to assume a minimum useful life of the existing latrine (say 3 years) and establish a minimum depth from the latrine floor to the level of the pit contents, which corresponds to the minimum useful life.

The minimum depth (Dmin) required can be calculated as follows:

$$D_{min} = \frac{P \times S \times N}{A} + 0.5\text{m}$$

whereby:

P = average number of users; persons
S = solids accumulation rate m^3/person/year
N = minimum useful life required; years
A = cross sectional area of the pit; m^2

The reason why 0.5m is added to the minimum depth is to ensure that there will be at least 0.5m of soil coverage to the contents after the pit is finally abandoned, thereby preventing fly larvae and other insects penetrating and possibly spreading disease.

Long term infiltration rate

Leach-pit effluent enters the soil first by infiltrating the pit-soil interface and then by percolating away through the surrounding soil into the groundwater or soil water; part of the effluent may be removed from the soil by plant transpiration. The infiltrative capacity will be lower than the percolative capacity due to clogging of the soil pores at the pit-soil interface. Traditionally, percolative capacity has been established in the field by "falling head" percolation tests, and so it is a measure of the percolation rate of clean water through virgin (unclogged) soil. While serving as a useful guide to the hydraulic conductivity of the soil under saturated conditions, the method does not account adequately for flow being restricted by the clogging matt nor for flow under unsaturated conditions. These factors can be best accounted for by evaluating for any particular soil the change in permeability brought about by changes in moisture tension; this is established by the "crust" test. From crust tests done on a wide range of different soils, recommended design values of the long-term infiltrative capacity can be derived for typical soil conditions; these values are shown in the table below. Thus, if the soil characteristics of the proposed site are evaluated and the soil texture (loam, sand, silty clay etc.) established, an estimate can be made of the long-term infiltrative capacity of a well-designed and properly constructed and maintained leach pit. For a large-scale project where resources exist to undertake the more complex "crust" test in situ, it is recommended that this be done, developing a family of site-specific hydraulic conductivity/soil moisture tension curves from which the long-term infiltrative capacity can be established.

Recommended Maximum Effluent Loading Rates for Leach Pits

Soil type	Long-term infiltrative Loading rate (litres/m^2 day)
Sand	50
Sandy loam, loams	30
Porous silty loams, porous silty clay loams	20
Compact silty loams, compact silty clay loams clay*	10

* Expansive clay should be absent; if present, the pour-flush latrine is generally unfeasible.

From: Mara, D.D. (1985). The Design of Pour-Flush Latrines. TAG Technical Note No. 15.

Hydraulic loading rate

The hydraulic loading rate is the total volume of liquids entering the leach pit and is expressed in litres per day, although it is often more convenient to consider per capita loadings (in litres per capita per day/lcd). The volume of wastewater entering the leach pit depends on a variety of factors, both technical and socio-cultural. The following formula can be used to estimate the volume (q) of wastewater generated in lcd:

$$q = N_f (V_w + V_c) + V_f + (aN_uV_f) + V_u$$

where

- H_f = number of times faeces passed per day (usually two, sometimes three);
- V_w = volume of flushing water, litres/flush;
- V_c = volume of water used for anal cleansing, litres/cleansing;
- V_f = volume of faeces passed, lcd (approximately equivalent to the wet weight faeces in kg/day; typical values lie between 0.25 and 0.35kg);
- N_u = number of times urine passed per person per day;
- a = 1 if the toilet is flushed after urine only is passed; = 0 if it is not;
- V_u = volume of urine produced, lcd (typically 1.2).

This equation accounts for variations in excreta quantities and excretion frequency, both largely dependent on diet, and for socio-cultural factors such as flushing after urine only has been passed and whether water is used for anal cleansing. It assumes, however, that all of each person's excreta reaches the leach pit; this may not be the case (for example, excretion may also occur at the place of work; people, especially children, may not always urinate in the toilet). This leads to an overestimate of the hydraulic loading, but in practice this may not be too great in many societies. Hence overdesign of the leach pit will be minimal. It will be apparent from the equation that elicitation from the community, or from its leaders, of local practices and preferences in relation to defecation and urination is an essential part of leach-pit design.

From: Mara, D.D. (1985). The Design of Pour-Flush Latrines.

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