Public Water Corporation

MIWR – GONU

MWRI - GOSS

Technical Guidelines for the Construction and Management of Household Latrines

A Manual for Field Staff and Practitioners
April 2009

DEVELOPED IN PARTNERSHIP WITH
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Ministry of Irrigation and Water Resources – Government of National Unity

Foreword

Significant progress in the provision of water and sanitation services in Sudan has been achieved in the last few years. This is attributed to the increased access to many remote villages as a result of the three major peace agreements, the Comprehensive Peace Agreement (CPA) between north and south Sudan, the Darfur Peace Agreement (DPA) and the Eastern Sudan Peace Agreement (ESPA), that were signed in 2005 and 2006 respectively. This access has allowed the Ministries of Irrigation and Water Resource (MIWR) of the Government of National Unity (GoNU), state governments and sector partners (including NGOs and the private sector) to expand water and sanitation services in many areas. This prioritizing of the expansion and sustainability of water and sanitation services in urban and rural areas throughout the county, including to the nomadic population has resulted in a steady annual increase in water and sanitation coverage for the citizens of Sudan.

With this expansion in implementation, the MIWR recognized the need to harmonize the various methodologies utilized by the various actors in the implementation of water and sanitation interventions. It was agreed that this could be best achieved through the development and distribution of Technical Guidelines, outlining best practices for the development of the 14 types of water supply and sanitation facilities in the Sudan. These Technical Guidelines, compiled in a systematic manner will undoubtedly set standards and provide guidance for all water and sanitation sector implementing partners.

The MIWR of the GoNU of the Sudan is grateful to UNICEF, Sudan for financial and technical support in the preparation of the Technical Guidelines.

I believe these Technical Guidelines will go a long way to improving WES sector programmes, allowing for scaling up implementation of activities towards achieving the MDG goal for water supply and sanitation in Sudan.

Minister
Ministry of Irrigation and Water Resources
Government of National Unity, Khartoum

Date ……

Ministry of Water Resources and Irrigation – Government of Southern Sudan

Foreword

The historic signing of the Comprehensive Peace Agreement (CPA) in January 2005, culminated in the establishment of an autonomous Government of Southern Sudan (GOSS) and its various ministries, including the Ministry of Water Resources and Irrigation (MWRI). The CPA has enabled the GOSS to focus on the rehabilitation and development of the basic services. The processing of the Southern Sudan Water Policy within the framework of the 2005 Interim Constitution of Southern Sudan (ICSS) and the Interim National Constitution (INC) was led by the MWRI. This Water Policy is expected to guide the sector in the planning and monitoring of water facilities during implementation. The Water Policy addresses issues like Rural Water Supply and Sanitation (RWSS) and Urban Water Supply and Sanitation (UWSS). The Southern Sudan Legislative Assembly (SSLA) of GOSS approved the Water Policy of Southern Sudan in November 2007.

The importance of developing effective water supply and sanitation services is universally recognized as a basis for improving the overall health and productivity of the population, and is particularly important for the welfare of women and children under five. Considering the current low coverage of safe drinking water supply and basic sanitation facilities as a result of the protracted civil war in the country during the last five decades, there are enormous challenges ahead. With the unrecorded number of IDPs and returnees that have resettled in their traditional homelands and the emergence of new settlements/towns in all ten states of SS, the demand for water and sanitation services is immense. There is need for implicit policies, strategies, guidelines and manuals to ensure provision of sustainable supply of quality and accessible water and sanitation services.

The preparation of these WES Technical Guidelines at this stage is very timely, as it enables us to further develop our strategies and prepare action plans for the implementation of the Water Policy. It will also allow us to strengthen existing best practices as well as to test new experiences that will create room for future development.

During the development and finalization of these Guidelines for water supply and sanitation facilities, we have consulted WASH sector partners at State level and partner non-government agencies through successive consultative meetings, and appreciate their contribution, which has assisted in finalizing these documents.

The MIWR of the GOSS is thankful to UNICEF, Juba for financial and technical support for the preparation of these Technical Guidelines.

We call upon our WASH sector partners to give us their continuous feedback from the field for the improvement of these Guidelines. We believe that successful implementation and future sustainable service provision will depend on effective coordination and close collaboration among all partners including government, non-government and beneficiary communities.

Mr. Joseph Duer Jakok,
Minister of Water Resources and Irrigation
Government of Southern Sudan, Juba
Date …….

Acknowledgements

Special thanks go to Mr Mohammed Hassan Mahmud Amar, Mr Eisa Mohammed and Mr Mudawi Ibrahim for their directions on GONU's sector policy; Engineer Isaac Liabwel on GOSS's water policy; Mr Sampath Kumar and Dr. Maxwell Stephen Donkor for their direction on the WASH sector from the UNICEF perspective and for the provision of relevant documents & information, and facilitating & organizing a number of forums to discuss ideas reflected in the draft documents.

The author would also like to thank WES and UNICEF staff of North Darfur, North Kordofan, South Kordofan, Sinnar, Gedarif, Kassala, Red Sea and Blue Nile States and staff of DRWSS, UWC in Central Equatoria, Western Bahir el Ghazal, Warap and Upper Nile States and staff of UNICEF Zonal Offices who organized meetings with sector partners and successful field trips to various facilities.

Many thanks to Emmanuel Parmenas from MWRI, and Mr Mohammed Habib and Mr Jemal Al Amin from PWC, for their contribution in collecting documents and information at the national and state levels, facilitating field trips and contacting relevant persons at state level and to the latter two for their support in translating documents and information from Arabic to English.

The completion of this document would not have been possible without the contributions and comments of staff of SWC, PWC, MIWR, MCRD, MWRI, MOH in GONU, MAF, MARF, MOH MHLE, MWLCT and SSMO in GOSS, UNICEF, National and International NGOs like Oxfam GB, Pact Sudan, SNV, SC-UK, Medair, and review workshop participants at state and national levels and members of technical working groups.

Acronyms

ACU	**- Area Coordination Unit**
AP	**- Aqua Privy**
APO	**- Assistant Project Officer**
CPA	**- Comprehensive Peace Agreement**
CATS	**- Community Approach for Total Sanitation**
DG	**- Director General**
DPA	**- Darfur Peace Agreement**
ESPA	**- Eastern Sudan Peace Agreement**
FMOH	**- Federal Ministry of Health**
GB	**- Great Britain**
GONU	**-Government of National Unity**
GOSS	**-Government of Southern Sudan**
GWWD	**- Ground Water and Wadis Department**
IRC	**- International Rescue Committee**
IPL	**- Improved Pit Latrine**
MCRD	**- Ministry of Cooperatives and Rural Development of GOSS**
MIWR	**- Ministry of Irrigation and Water Resources of GONU**
MWRI	**- Ministry of Water Resources and Irrigation of GOSS**
NGO	**- Non-Governmental Organization**
NK	**- North Kordofan**
ODF	**-Open Defecation Free**
PFL	**- Pour Flush Latrine**
PO	**- Project Officer**
PVC	**- Polyvinylchloride**
PWC	**- Public Water Corporation**
RHS	**- Rectangular Hollow Steel**
RWC	**- Rural Water Corporation**
Sanplat	**-Sanitation platform**
SC	**- Save the Children**
SMOH	**- State Ministry of Health**
SPO	**- Senior Project Officer**
SWC	**- State Water Corporation**
TPL	**- Traditional Pit Latrines**
UNDP-TAG	**- United Nation Development Program Technical Advisory Group**
UNICEF	**- United Nation Children's Fund**
USA	**- United States of America**
VIP	**- Ventilated Improved Latrine**
Watsan	**- Water and Sanitation**
WES	**- Water and Environmental Sanitation**
WFP	**- World Food Program**

Definition of technical terms

Composting	The process of converting biodegradable contents of human excreta into useful manure or fertilizer
Household (family) latrine	A latrine that is being used by a single household or a family
Human excreta	Waste matter discharged from human body e.g. faeces or urine
Sanitation	Conditions or procedures related to the collection and disposal of sewage and garbage. In these Guidelines, this refers to the safe collection and disposal of human excreta.
Squatting slab	A slab in the latrine for the facilitation of squatting to relieve excreta from the body.
Vault	Burial chamber. In this technical guideline, it is related to the chamber used for retention and decomposing purposes of faeces from ecosan latrines.

Document Summary

This summary provides a brief overview of the document and is only meant as a quick reference to the main norms. Reference to the whole document is advised for accurate implementation.

Norms

General consideration in planning and design

As the design examples shown in these Guidelines are indicative, the local authorities at State/Mahalia-County levels may consider revising the designs to suit their own requirements.

The following factors should be considered by all stakeholders in the planning and designing of on-site sanitation facilities, for the success of the systems. These are discussed in more detail on Section 2.

- Affordability
- Aesthetics
- Social customs and habits
- Soil conditions
- Contamination of ground water
- Water logging
- Availability of water
- Maintenance/replacement of facilities
- Sustainability.

Types of household latrines discussed in these Guidelines:

Improved Pit Latrines,
Ventilated Improved Pit Latrines,
Pour Flush Latrines with Leaching Pits,
Aqua Privies and
Compost (Ecosan) Latrines.

Guideline for the selection of the type of household latrines to be constructed

- It should be simple in design, construction, and Operation and Maintenance (O & M)
- It should be affordable by at least 80% of the families within the community.
- It should be low-cost as compared to the conventional sewerage systems
- It should be hygienic and should not contaminate ground water.
- It should ensure safe disposal of excreta.
- It should be culturally acceptable to the users and allow regular service without interruption.
- It should not deprive the user of a minimum level of safety and privacy.
- It should be close to a hand washing facility for hygiene promotion
- Site selection within the house should comply with local authority regulations when such regulations exist.

1. Introduction

1.1 The purpose of this Document

The Ministry of Irrigation and Water Resources (MIWR), GONU, and the Ministry of Water Resources and Irrigation, (MWRI), GOSS, are responsible for the policy and strategy development, coordination, planning, management, monitoring and evaluation of water supply and sanitation facilities in the country. In order to reduce disparities, improve standards, accelerate implementation and to standardise design and costs, the two ministries agreed to harmonize the methodologies utilised in the implementation of WATSAN interventions Currently, there is no standardised document providing Technical Guidelines for implementation by WES or other water and sanitation agencies and this is detrimental to the longevity of structures and the sustainability of interventions.

In 2006 MIWR and MWRI decided to develop Technical Guidelines for the construction and management of rural water supply and sanitation facilities. These Guidelines are a collection of global and national good practices in water and sanitation that have been collated. The process of the development of the Technical Guidelines is outlined in Annex 1.

These simple Guidelines are primarily intended as a reference for field staff and practitioners in the water and sanitation sector challenged by situations and conditions in the field.

Updating of the Guidelines is recommended biennially; to ensure newer and better practices are incorporated as they are developed/ introduced. Water and sanitation sector implementing partners should contribute in providing feedback to the MIWR and MWRI as necessary during the updating.

1.2 Available sanitation technology options

Sanitation systems worldwide can be classified into two major categories, namely: off-site and on-site sanitation systems. The off-site systems include: the conventional sewerage system with proper treatment and disposal, and small-bore sewers. The on-site systems include a number of technology options: dry pit latrines, borehole latrines, ventilated improved pit latrines, eco-san latrines, pour-flush latrines with single or twin pits, aqua privies, composting latrines, and septic tanks. The off-site systems are not suitable in peri-urban and rural areas of developing countries like Sudan for the reasons indicated below:

- A Conventional sewerage system is highly capital intensive and beyond the financial resources of service providers in developing countries and particularly for scattered and small populations. It also involves sophisticated treatment systems and skilled operators for management, operation and maintenance and a large quantity of water is wasted in flushing toilets. In rural areas, where the density of the population is

relatively low and houses are scattered and at great distances, the cost of a conventional sewerage system is neither cost effective nor sustainable.

- Small-bore sewers are cheaper than conventional sewerage systems. They have been constructed in few places but have not been very successful and replicated. The main requirement is that the sewage should not contain settle-able solids, which have to be arrested in intercepting tanks that are provided at individual dwellings. The intercepting tanks have to be cleaned at short intervals. In practice, it is very difficult to ensure such regular attention and the system can get choked and fail to function properly. The effluent has to be treated before it can be disposed off on land or into a water source. As the cost of treatment is high, small-bore sewers are also considered unsuitable for rural areas.

Appropriate low cost on-site sanitation technologies which are affordable, hygienic, culturally acceptable, environmentally friendly and sustainable are the best option for rural areas in developing countries like Sudan.

2 General design considerations for on-site sanitation

"On-site sanitation can be defined as a system where human excreta are retained and treated on the site of defecation in a way that is hygienic and does not adversely affect the environment."[1]

The following factors should be considered by all stakeholders in the planning and designing of on-site sanitation facilities, for the success of the system. In addition, the various designs indicated in the Guidelines are indicative and local authorities at State/Mahilia-County level may consider revising these designs to suit their own requirements.

- Affordability: Without compromising the basic and minimum requirement of health and environmental protection, and the engineering aspect, the affordability of the system should be a priority, especially for low income groups. This will encourage all community members to build their own latrines using their own resources, thereby supporting the strategy of Community Approaches for Total Sanitation (**CATS**) based on the principle of Open Defecation Free (**ODF**). Use of locally available materials should be promoted, and .people should be allowed to choose construction material, and type of superstructure depending on their financial capacity. Authorities promoting low-cost sanitation should be flexible on the specifications of superstructures.
- Aesthetics: The system should be such that it is free from smell, flies and other insects. The superstructure should provide the minimum requirement of privacy to the users, especially women. The disposal system must be designed so that it does not create any environmental nuisance by way of vector breeding or water logging, nor foul the environment with bad odors. East-West air flow for good ventilation should be considered in positioning the latrine.

[1] World Health Organization

- Social customs and habits: If water is used for anal cleansing a pan with a water seal should be suitable, otherwise the seat does not need a water seal. Many cultures consider human excreta as a dangerous and unpleasant waste product and will not handle it even when it is fully decomposed. A final disposal system like a pit latrine would be suitable in this case. Other social customs and habits like a separate toilet for men and women, sitting direction in the squatting space etc. need to be considered as per community's preferences.
- Soil conditions: The soil should act both as a seepage system for the liquid and also as a filtering media for the removal of pathogens. Soil absorption system should also allow for minimum liquid residence time before the same reaches a water sources. In well consolidated and aggregated fine sand and clay, the vertical layer of about 0.7m[2] of such material would trap most pathogenic micro-organisms. However an additional impermeable envelope at the bottom and around the lining of the pit would minimize the chance of pollution of ground water. Therefore a minimum of about 0.7m vertical layer should be secured between the bottom of the pit and ground water level
- Contamination of ground water: If the soakage or leach pit is constructed close to an underground source of water such as a hand pump or well, adequate minimum distance between the pit and the water source must be maintained so that the bacteria are not able to travel to the water source and contaminate it. In porous soil of fine sand and clay, the ground water velocity would depend on hydraulic gradient and pore size. In fine sand (<0.2mm) and hydraulic gradient <0.01, the velocity would be <1m/day. Given that bacterial survival time is 10 days, a separation limit of 10m would be adequate for such hydrogeological conditions. However, situation specific requirements are recommended for adverse hydrogeological situations. If soil strata is rocky but fissured or the soil is too porous (coarse sand, limestone formations, etc) a sand envelope should be provided around the pit. Otherwise faeces need to be composted in water-tight compartments.
- Water logging: Where the area gets water logged the platform and pits should be constructed slightly above the ground to create a mound around them.
- Availability of water: Where water availability is limited and the use of water for anal cleansing is common, hand flushing of the excreta/urine using a small portable water container may be practiced as it uses less amount of water than the proper water flushing toilet seats. And again where availability of water is limited and people using paper and other materials for anal cleansing, dry options for cleaning should be encouraged with proper arrangement to check undesirable smell and breeding of flies and insects.
- The basic design adopted has to be affordable by at least 80% of the families within the community.
- The latrine slab should have a handle to facilitate lifting for emptying the latrine pit or for relocation.

3 Mobilization of stakeholders

[2] Minimum height of filter bed for slow sand filtration is ranging between 0.5 to 0.6m. IRC Technical Paper No 24.

Identifying and mobilizing potential stakeholders is an important step in the realization and sustainability of a rural water supply system. Various stakeholders play various roles at different stages of a project cycle. Roles and responsibilities can be assigned using participatory techniques like participatory rural appraisal. Involvement of the community (including women) in decision making at all stages of the project will promote sustainability. For example in site selection, technology choice; preferred design, like the superstructure, distance from their living quarters, etc. Community contribution for the construction, operation and maintenance, in selection of the water management committees and village mechanics etc could be identified through their involvement in the decision making process.

Local authorities also play a significant role in the facilitation of the implementation of the water supply system. Problems that may arise during the implementation of the water supply system such as for example, land ownership, could be easily solved if the local authorities are brought on board and are involved in the decision making process.

Problems can only be identified by the active involvement of the stakeholder. The long process involved in getting community engagement, especially when awareness of sanitation practices is low, will be decreased if the implementing agency uses a demand-driven approach to achieve total sanitation. Use of community Approach for Total Sanitation (CATS) for achieving and sustaining open defecation free (ODF) status entails facilitation of community's analysis for their sanitation profile and community action to reach ODF. The design of a latrine should be based on support of this principle, especially one that is modified to suit local conditions. A prerequisite is that each and every family in the community can afford and is willing to build their own latrine with their own resources.

4 Guideline for selection of household latrines

A household latrine to be selected for implementation should be checked against the following basic requirements.

- It should be simple in design, construction, operation and maintenance. Local and semi-skilled persons should be able to construct it.
- It should be affordable by at least 80% of the families within the community.
- It should be low-cost as compared to the conventional sewerage systems. It should allow as much as possible the use of locally available materials that will not negatively impact the environment.
- It should be hygienic (free from bad smell), inaccessible to insects, flies and animals) and should not contaminate ground water.
- It should ensure safe disposal of excreta.
- It should be culturally acceptable to the users and allow regular service without interruption.
- It should not deprive minimum safety and privacy to the users, and it should have the following basic components:

- A platform in which the user can defecate easily and safely. The platform may have a squatting pan or a simple drop hole or a straight pipe.
- A superstructure to provide privacy and protection against rain, wind and sun.
- A substructure for storage and disposal of excreta, and
- An arrangement for prevention of odor like water seal and vent pipe.
- The latrine slab should have a handle to facilitate lifting for emptying the latrine pit or for relocation.

- It should be close to a hand washing facility for hygiene promotion
- Site selection within the house should comply with local authority regulations when such regulations exist

5 Household latrines

HH latrines, when planned, designed, constructed, used and managed properly in conjunction with hygiene promotion activities, can contribute significantly to the reduction of waterborne diseases in rural settings.

5.1 Types of household latrines

The types of latrines that have been considered for comparison include: improved traditional pit latrines, ventilated improved latrines, pour-flush latrines, aqua privies and composting (ecosan) latrines.

Improved Pit Latrines (IPL)

An IPL has two major components: an underground pit to accumulate the excreta, and the superstructure for squatting, protection from rain, sun etc, and privacy. The pit is covered either by concrete or plastic slab. The pit may or may not be lined. The drop hole on the slab is covered by a lid when the latrine is not being used. The superstructure is made of locally available materials like bricks, wood etc for the walls and thatch or corrugated iron for the roof. The user has the choice of material.

This type of latrine is appropriate for rural and low-income urban areas, where it is mainly used as a household facility and for rural institutions. The cost for this type of latrine includes: materials (50-80%), transport (0-25%), and local labour (15-35%). The cost also depends on the volume of the pit, quality of lining (when lining has been applied), slab and superstructure, the use of locally available materials, and the region of implementation.

Ventilated Improved Pit (VIP) latrines:

A VIP latrine is similar to IPL with the advantage of having a vent pipe attached to the pit that ventilates out the foul air from the pit. An open drop hole and dark squatting space are desirable for effectiveness of air ventilation and flies control in the VIP latrines.

A VIP latrine is appropriate for rural or peri-urban areas for household and public use. The cost for this type of latrine includes: materials (60-80%), transport (5-30%), and local labour (10-25%). %). As for the IPL, the cost also depends on the volume of the pit, quality of lining (when lining has been applied), slab and superstructure, the use of

locally available materials, and the region of implementation. The price of VIP latrine is higher than the improved traditional pit latrine, because of the vent pipe. . The VIP can be single or double, with each pit having it's own vent pipe under one superstructure.

Pour-Flush (PF) Latrine with Leaching Pit

The PF has a squatting pan with a water seal, in addition to a leaching pit and the superstructure. The squatting pan and the water seal can be fixed independently or on top of the pit. When the pan is fixed independently, a connecting pipe is necessary to convey the excreta with the flushed out water to the leaching pit.

This type of on-site sanitation facility is appropriate for rural and peri-urban areas where there is sufficient water for flushing and the soil is permeable. About 2 to 5 litres of water is required for flushing depending mainly on the pan design and the distance to the pit.

Aqua Privies (AP)

AP latrines are similar to PF except that the pan is connected, with a drop pipe, to the pit which is underneath the pan. The pit should always be filled with liquid and the drop pipe is submerged about 75cm below the level of the liquid.

Aqua privies are more appropriate for rural and semi-urban areas where water is available and the service of emptying the pit is not a problem. This system requires a soak away that will allow the liquid effluent to soak into the ground. Raw sewage is a health hazard.

Compost (Ecosan) Latrine (CL)

An Ecosan (ecological sanitation) latrine allows the storage of urine, faeces and waste water from anal cleansing in composting (ecosan) latrine. An Ecosan latrine is environmentally friendly, as it returns plant nutrients in human urine and faeces to the soil, thereby providing organic fertilisers and improving the soil structure, instead of polluting the environment.

This type of latrine is appropriate in areas where people would use human excreta as a fertilizer.

5.2 Steps in selection of different types of household latrines

Comparison of different types of latrines against the criteria set under section 2

Type of latrine	Affordability in terms of cost	Reduces smell and insect breeding	Suitable for Social customs and habits		Water requirement for flushing
			Water users	Non water users	
IPL	It is the cheapest of all	No	Not appropriate as it gets filled quickly	Appropriate	No
VIP	More expensive than IPL	Yes	Not appropriate as it gets filled quickly	Appropriate	No

PF	The most expensive if it is twin pit	Yes	Appropriate	Not appropriate	Yes
CL	More expensive than IPL and single pit VIP	No	Not appropriate	Appropriate	No
AP	More expensive than IPL and VIPL	Yes if the level of the liquid is properly maintained	Appropriate	Not appropriate	Yes

Referring to the table above, IPL is the next step up from a traditional latrine when an improvement is desired. The VIP is a further step up, as it gets rid of the smell and the infestation of insects, but only if social customs and habits allow the use of dry anal cleansing. Double pit VIP latrine or CL are appropriate, where the idea of recycling human waste is acceptable.

When cost is not an issue and water is available for flushing, the PF is a good option. A PF can have a single pit where the idea of recycling human waste is culturally unacceptable or double pits where it is. In current rural circumstances in Sudan, the AP may not be appropriate as the content in the tank which is unsafe for public health (unless it is treated), must be removed regularly. Also, the effluent requires a soak pit which may pollute the shallow groundwater. The AP requires a bigger capacity tank for human waste (both solid and liquid) before the effluent is directed to the soak pit. The final decision on the type of latrine to be constructed rests with the user and is dependant on the cost, appropriateness to customs and habits, and the operation and maintenance of the system.

The acceptability of human waste as a fertilizer requires further investigation in rural Sudan, It is, therefore, recommended that the promotion of a double pit VIP or CL in rural Sudan is done **only on a pilot basis** in order to test the acceptance and the sustainability of these types of facilities.

6 Design and construction of household latrines

6.1 Design and construction

Minimum standards

- The standard practice should be one sanitary latrine per household in normal conditions.
- During emergencies: one sanitary latrine for 50 people within 50 m distance should be made available during the initial stage of the emergency and should progressively reach reduce to 20 people (or 3 to 4 households) per single sanitary latrine within a period of 6 months.
- Pits can be square, rectangular or circular. If they are circular, they are commonly 0.8 to 1.5m wide in diameter. Circular pits are recommended in loose formation, and they need to be lined.
- Depth of a pit may vary from 3 to 7 meters depending upon the stability of the soil.

- It is recommended that latrines pits be located far from the drinking water sources such as tube wells and hand dug wells (preferably more than 30 meters but not less than 15m under any circumstances). The necessary distance depends on hydro-geological conditions such as texture of the soil and groundwater depth and flow. When groundwater levels are high or when the soil is too hard to dig, the pit may have to be raised above ground level as shown in Figures 1 and 2.

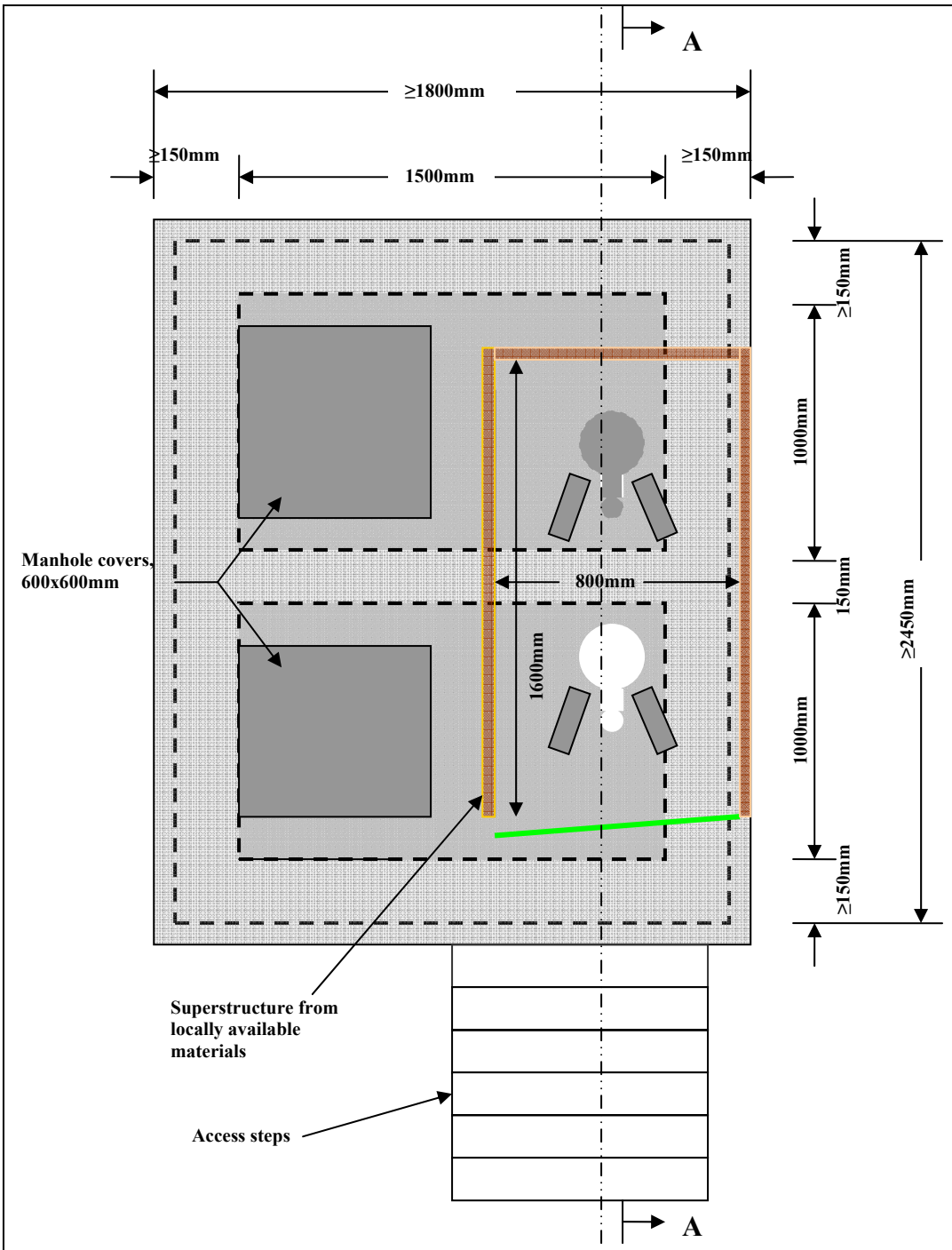


Figure 1: Plan of a latrine in permanent shallow ground water table areas and near to a water source that requires protection

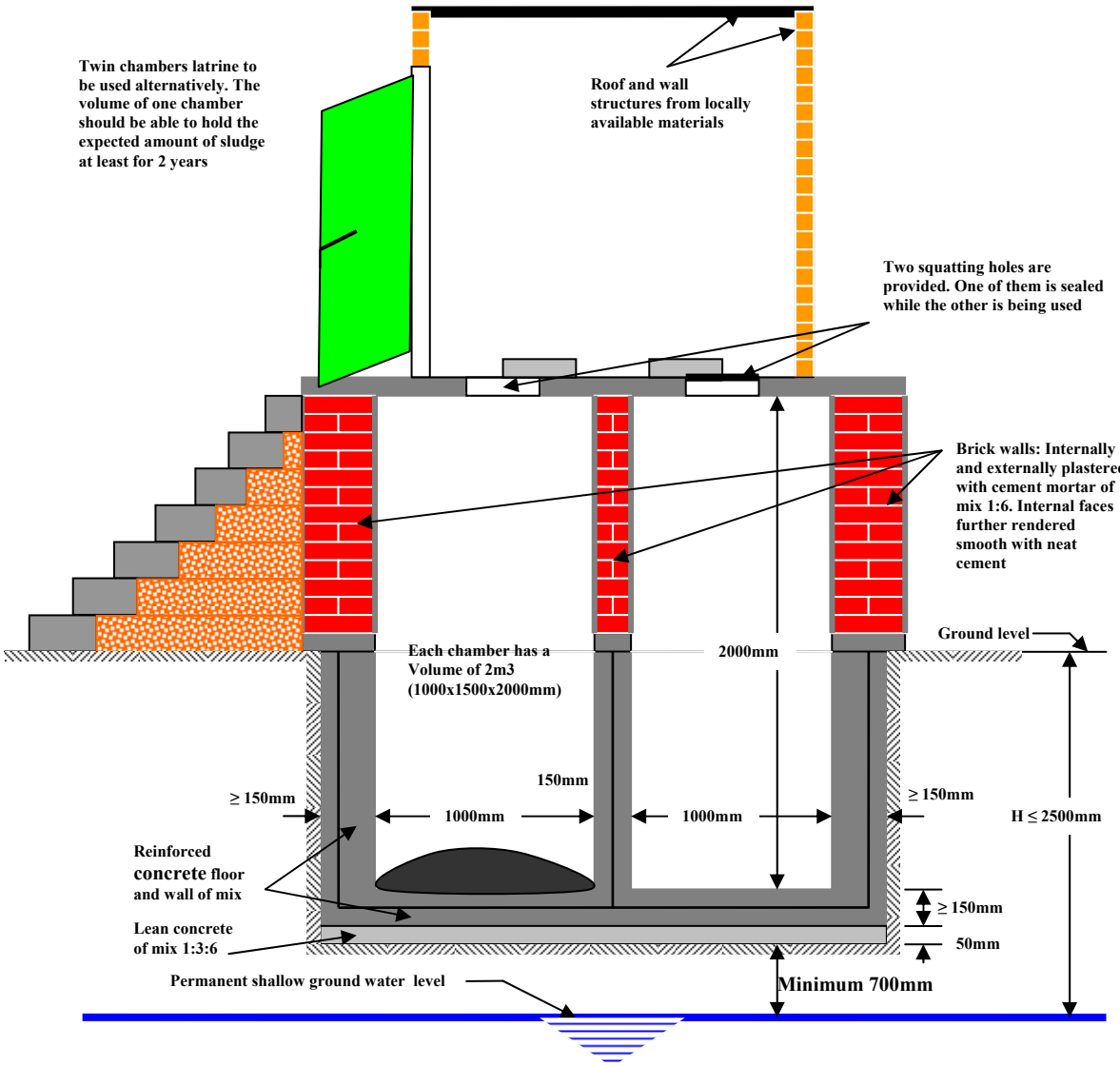


Figure 2: Section A-A of a latrine in permanent shallow ground water areas. Ground water is expected in less than 2.5 meters depth and a nearby water source requires protection from pollution

6.1.1 Volume of a pit:

6.1.1.1 Improved pit latrines

Traditional pit latrines usually consist of a single pit with a drop hole, covered with a slab. The superstructure provides shelter and privacy. Amendments to make improved pit latrines (Figures 1 to 11) consist of:

- A hygienic self-draining floor made of smooth, durable material and with raised floor foot rests. The construction of the pit cover (the slab) can be made of concrete or plastic san plats. The latter are recommended during the initial stage of an emergency to speed up intervention. Once the emergency situation returns to a more stable phase, opting for concrete san plats might be more economical.
- A tight fitting lid to cover the drop hole to reduce smells and keep insects out of the pit.
- The floor is raised at least 0.15m above ground level to prevent flooding.
- Adequate pit lining to prevent it from collapsing when the soil is unstable.
- An adequate foundation to prevent damage of the slab and superstructure.

The volume of the pit of traditional latrine (for pit less than 4m deep) may be calculated from the equation

$$V = 1.33\ CPN$$

Where:
C is sludge accumulation rate or effective capacity per capita per year in $m^3/c/y$. This figure varies from 0.04 to 0.09[3] and 0.045 to 0.050[4]. For Sudan situation $0.06m^3$ was arbitrary taken even though there are no available researched data for this.
P is the number of people using the latrine.
N is the number of years the pit is to be used before emptying. The factor 1.33 has been introduced as the pit is to be emptied or filled with earth when it is three quarters full.

For pits deeper than 4 meters, the equation could be modified as:

$$V = CPN + 1,\ \text{to allow the filling of the upper 1 meter with earth}$$

The volume of a pit, calculated using the above equation for a household of 6 people and the amount of sludge to be accumulated at a rate of 0.06 m3/p/y in a pit in three years period, will be 0.90 m3. The required volume of pit is then 1.44m3.

[3] Engineering in Emergencies, second edition 2002, Jan Davis and Robert Lambert

[4] Indian research institutes and UNDP TAG- Global projects

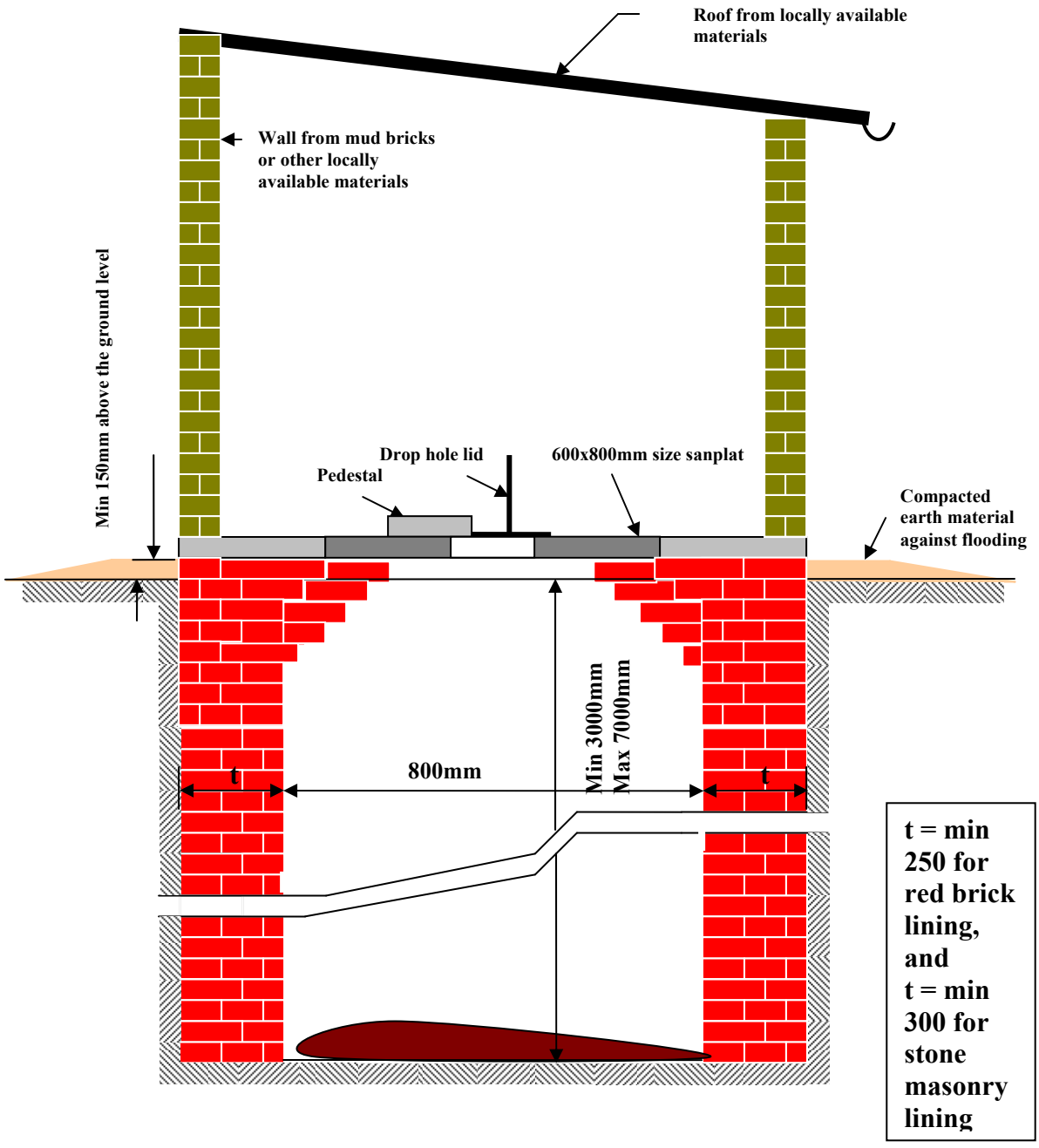


Figure 3: Cross section of an improved pit latrine in loose formation and where there is no shallow ground water table

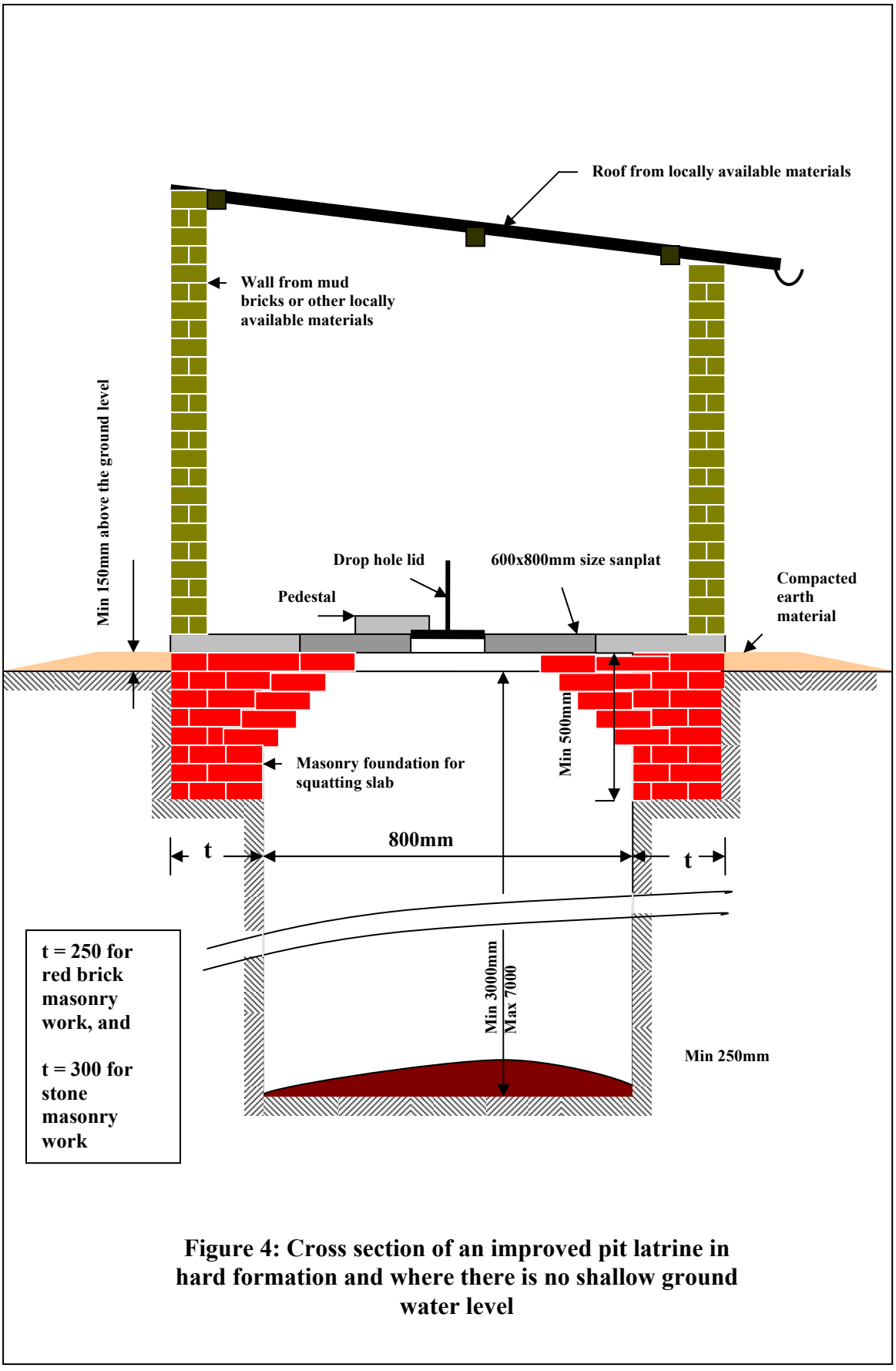


Figure 4: Cross section of an improved pit latrine in hard formation and where there is no shallow ground water level

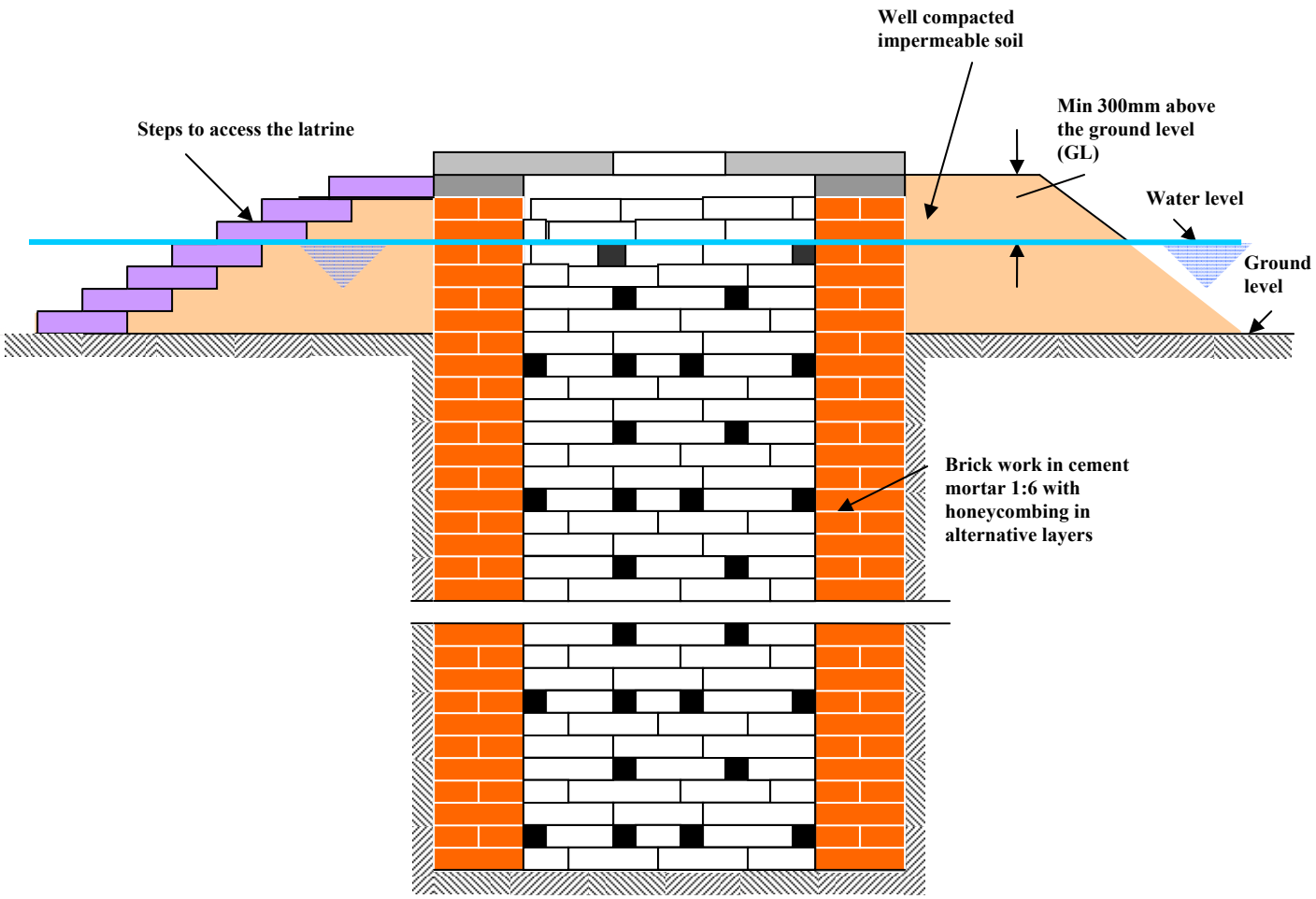


Figure 5: Lining of pit in water logged areas

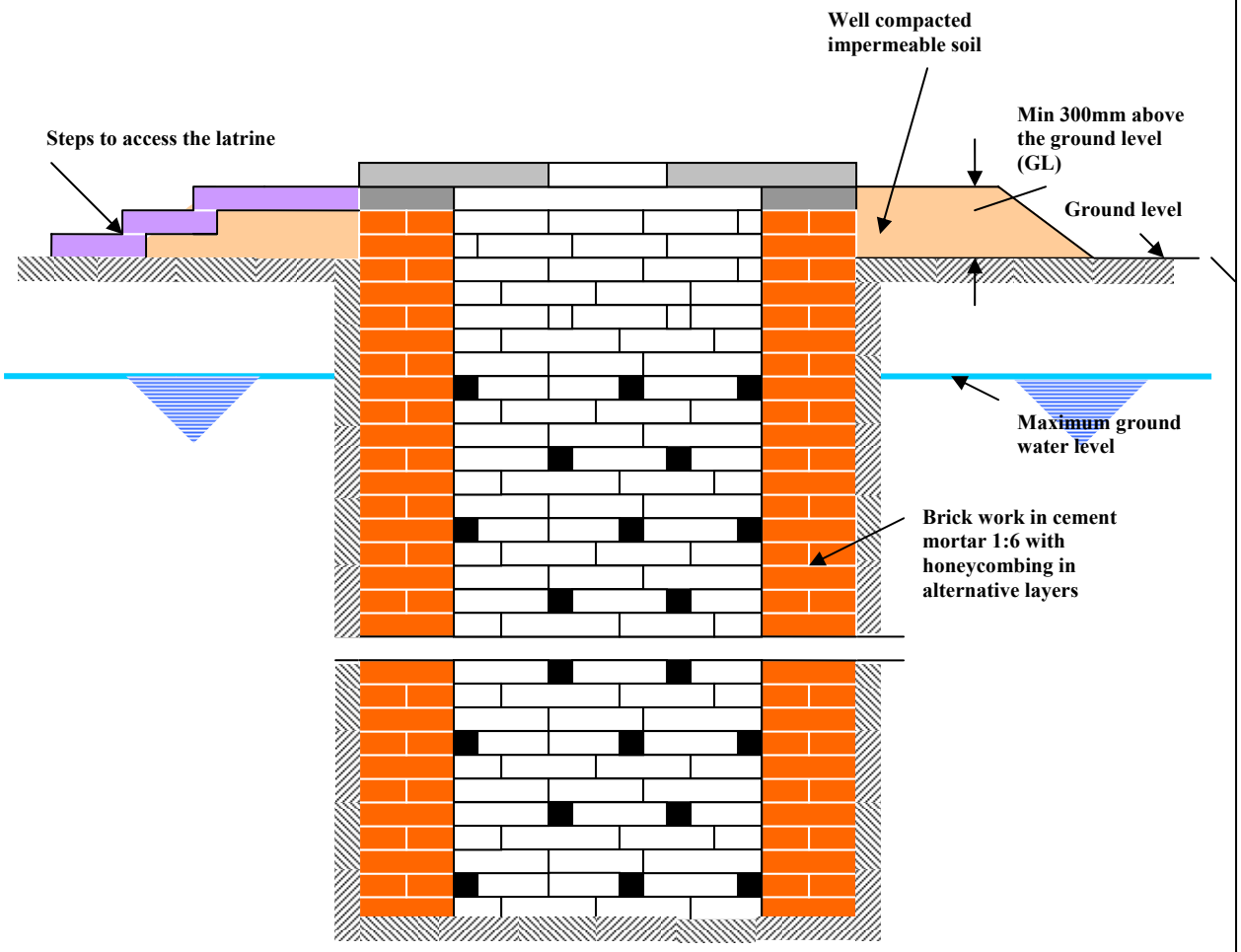


Figure 6: Lining of pit in varying shallow ground water level areas

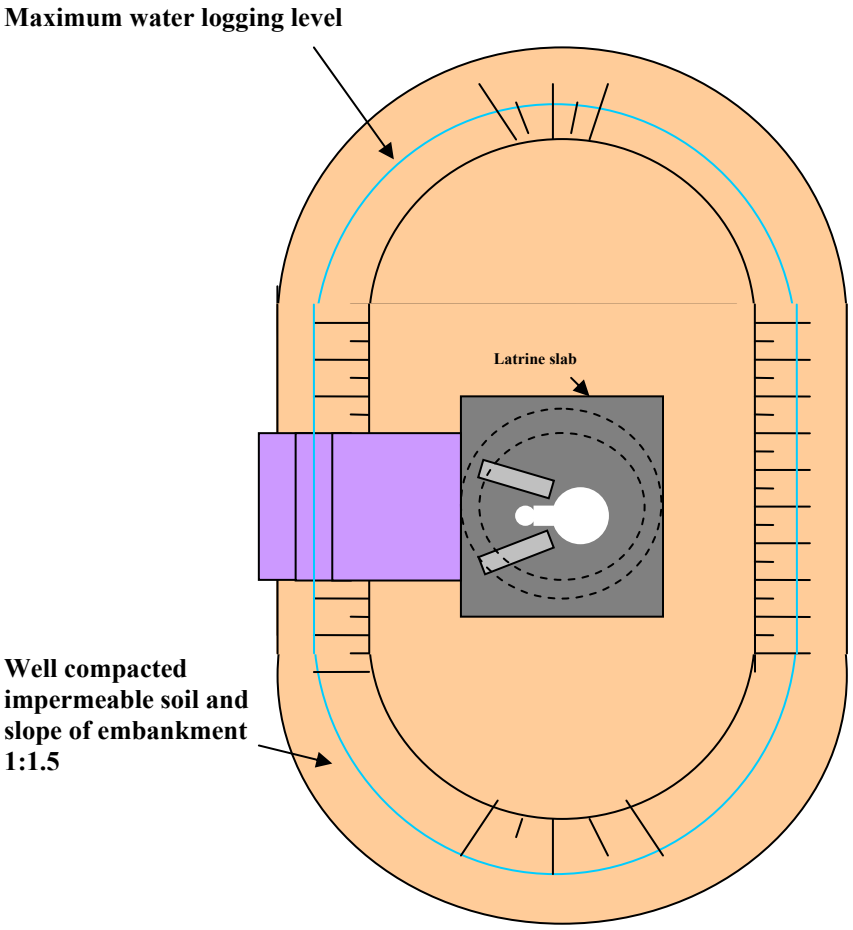


Figure 7: Plan of protection of latrines in water logging areas with compacted soil mount

Not to scale

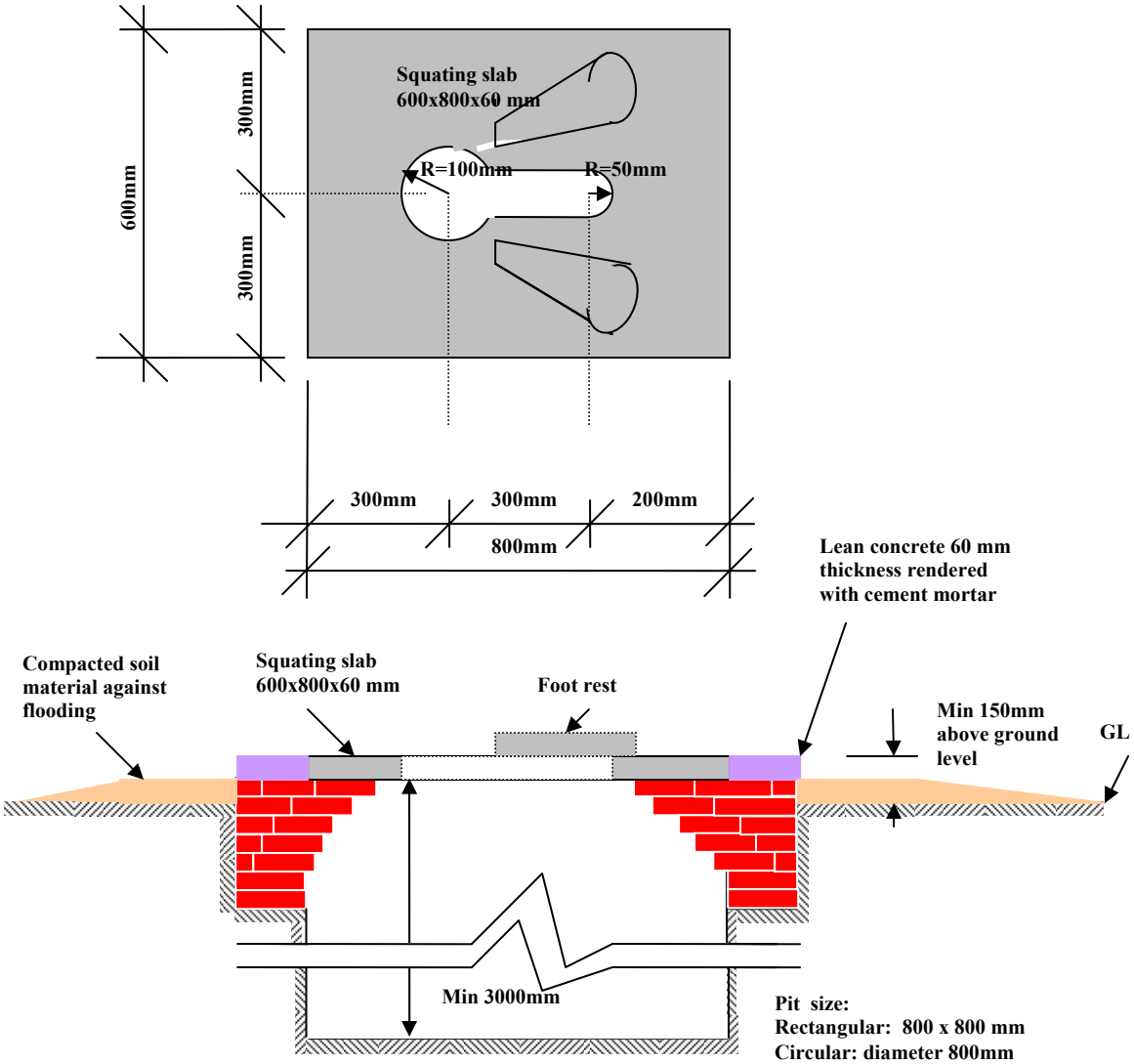


Figure 8: Detail of squatting slab for improved pit latrine in stable soil formation. Pit could be rectangular or circular

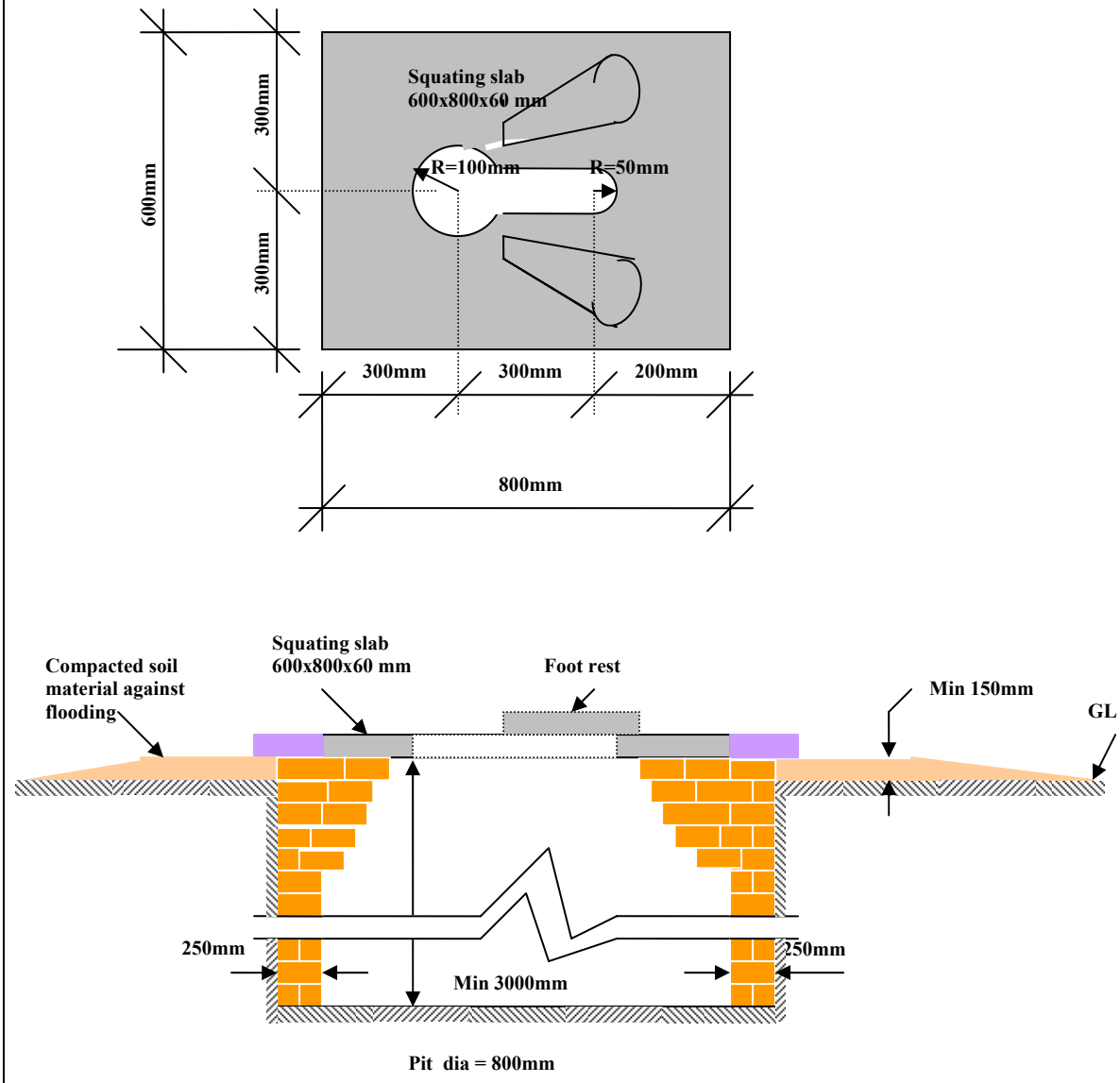


Figure 9: Detail of squatting slab for improved pit latrine in unstable soil formation.

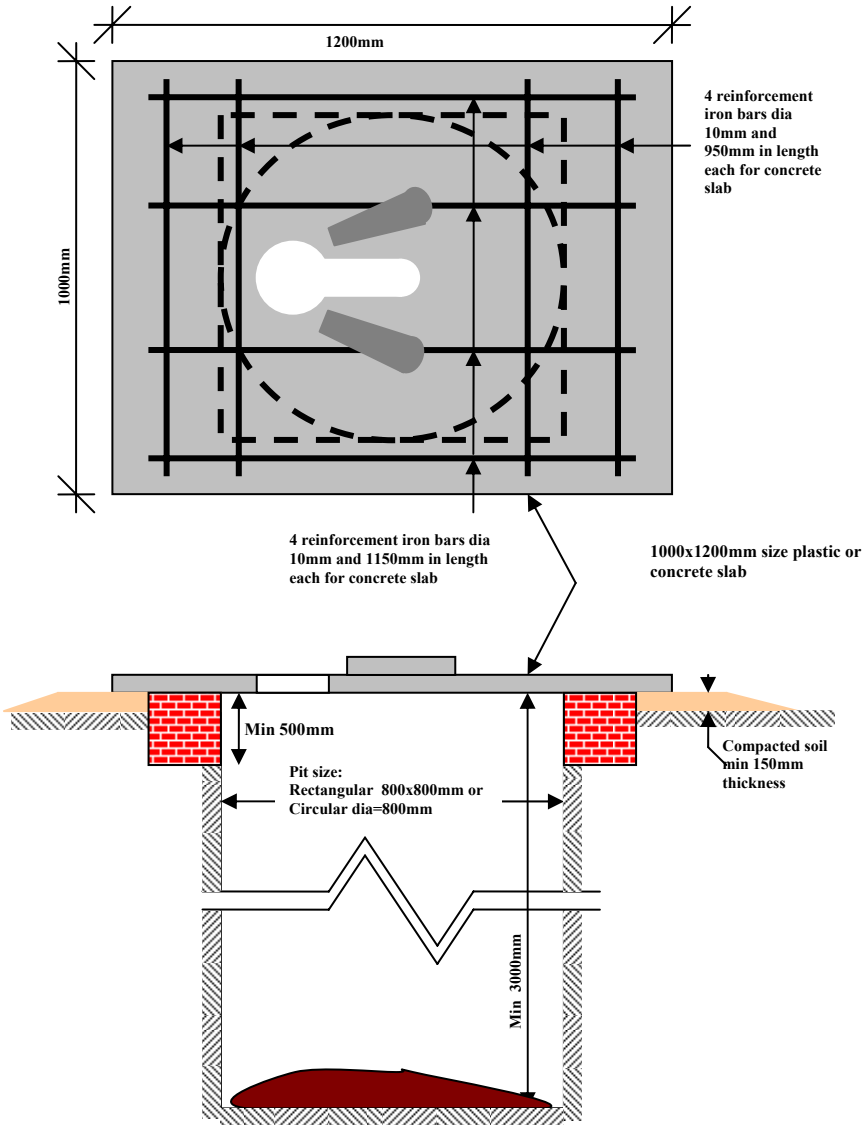


Figure 10a: 1200x1000mm size concrete or plastic slab for improved pit latrine.

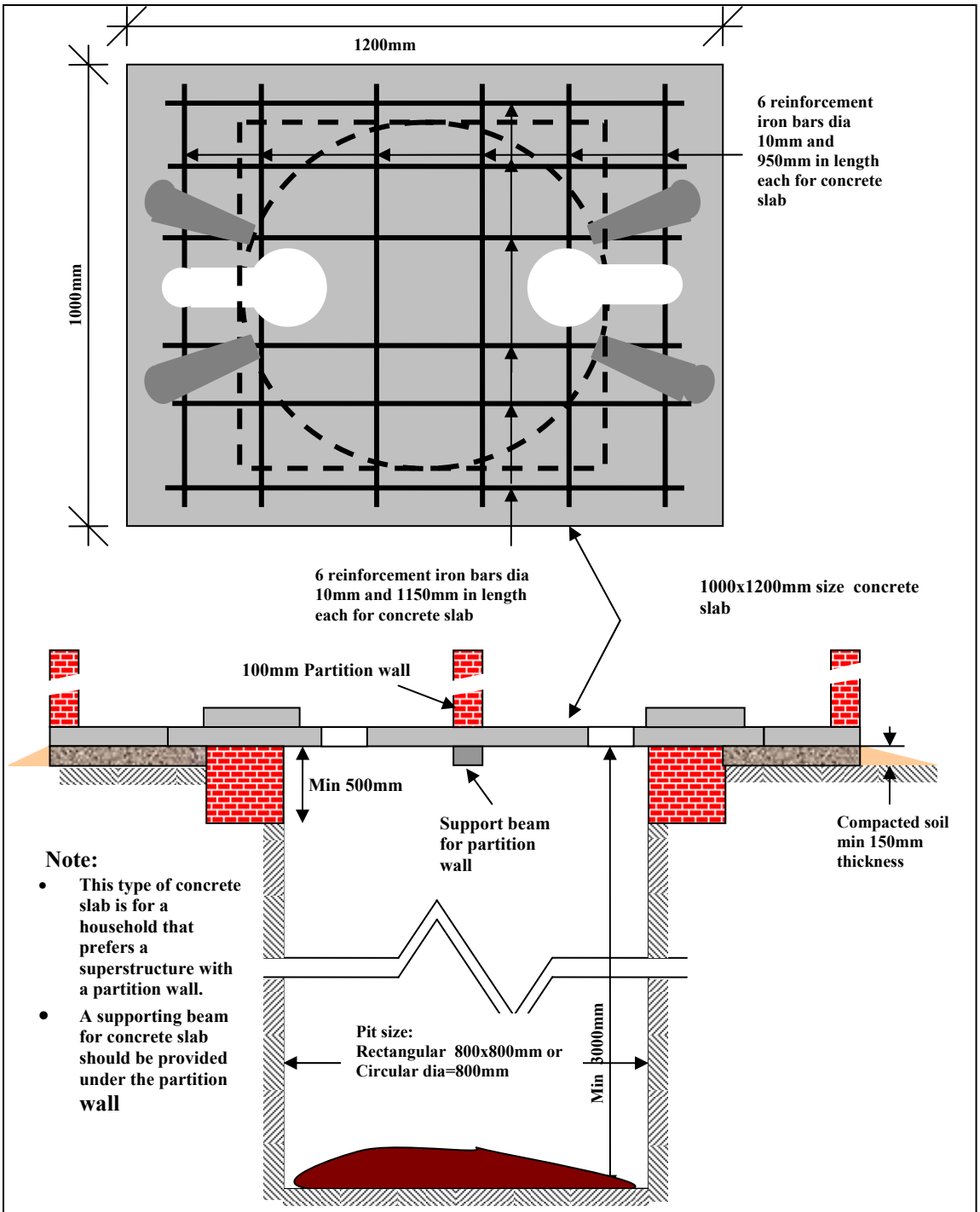


Figure 10b: 1200x1000mm size concrete slab for improved pit latrine with partition wall.

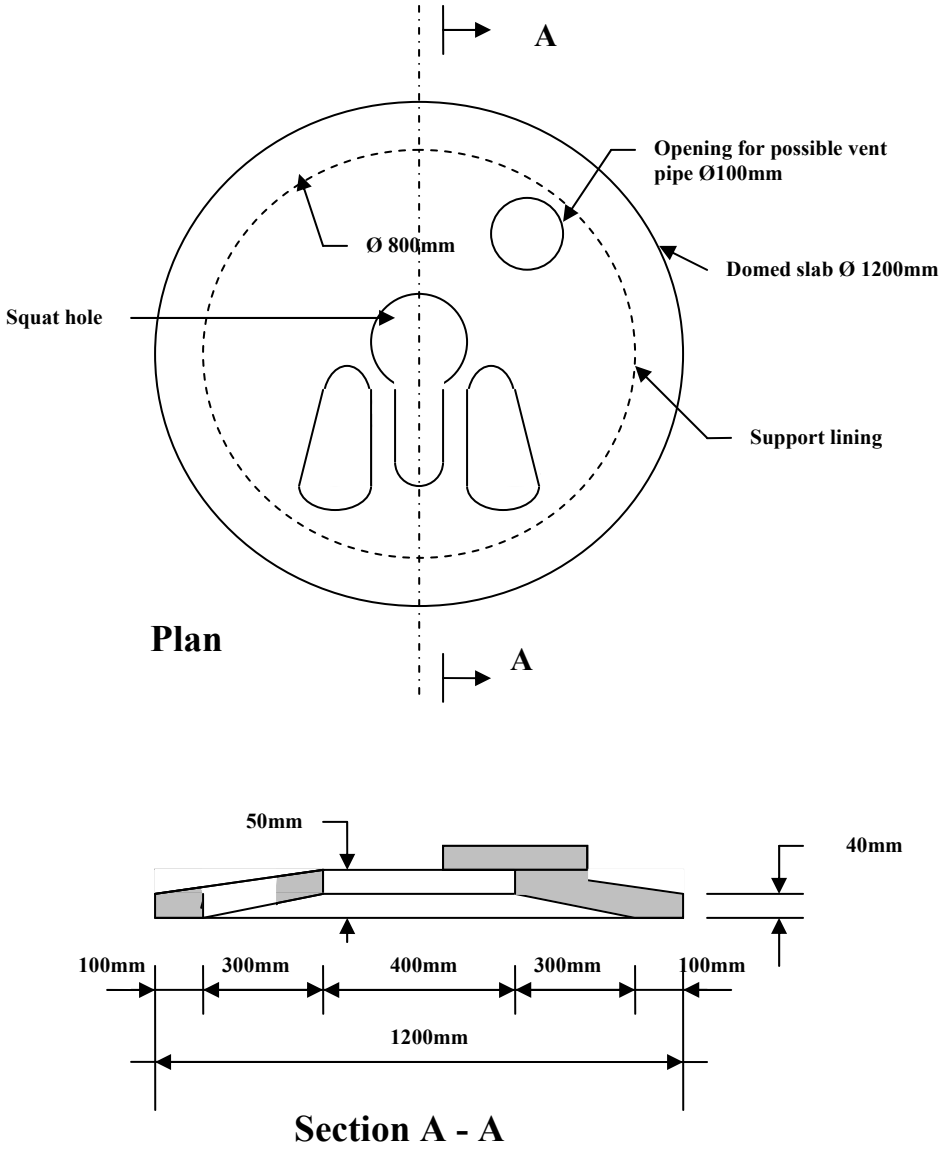


Figure 11: Domed slab adapted from Mozambique experience

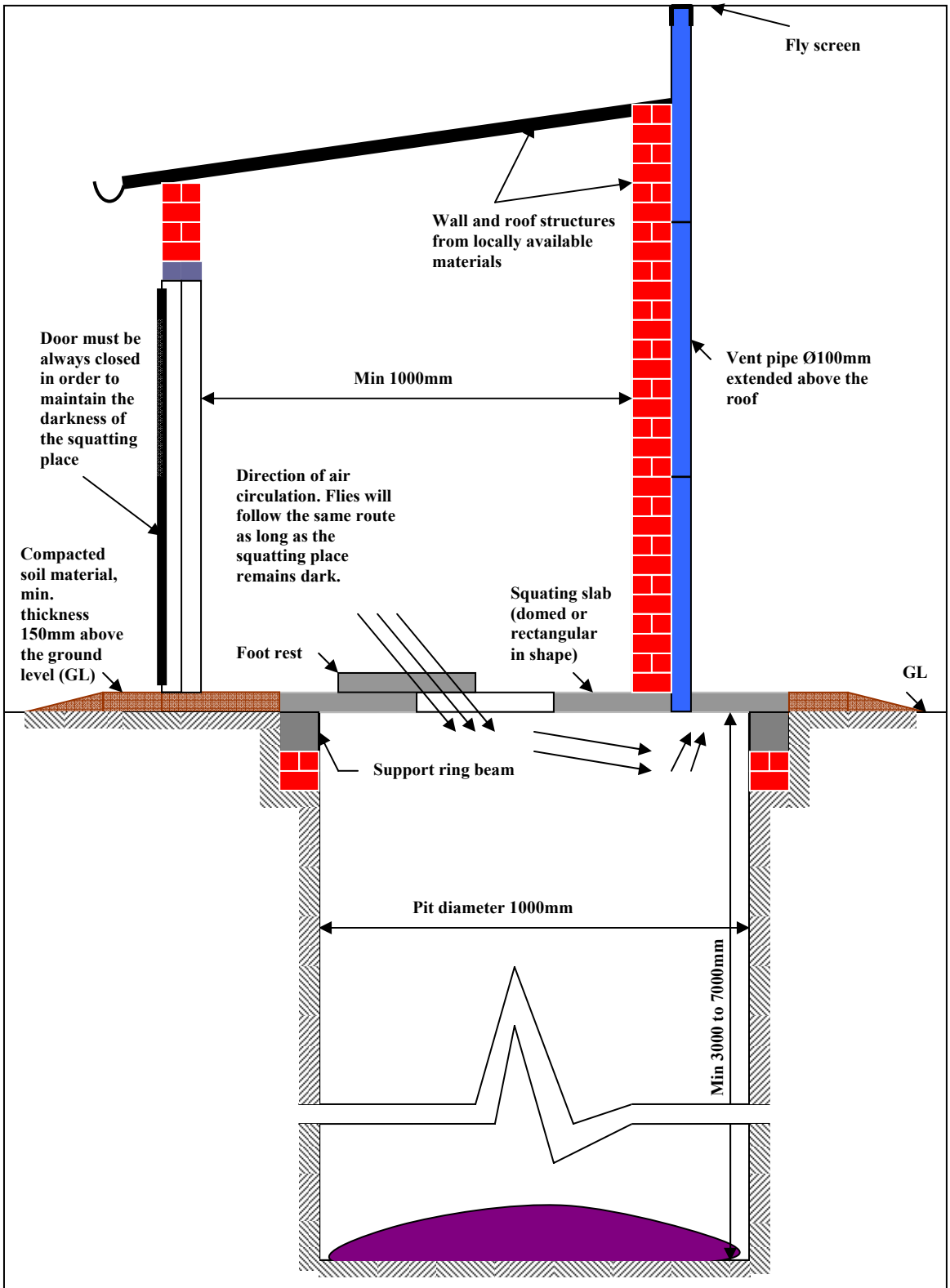


Figure 12: Ventilated Improved Latrine in hard formation

Figure 13: VIP latrine with a superstructure of mud brick wall and thatched roof

6.1.1.2 Ventilated Improved Pit latrines

Bearing in mind, social and cultural preferences of the users, VIP latrine (Figure 12) can be one of the best options where users practice dry methods of anal cleansing. VIP Latrines are, in this case, designed to reduce two of the problems frequently encountered in traditional pit latrines, namely the smell and insect breeding. VIP latrines differ from traditional pit latrines by a vent pipe covered with a fly screen (Figure 12). 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 inside of the latrine is suitably dark, the insects will fly up the vent pipe to the light. As the fly screen, will not let them escape, they are trapped at the top of the pipe until they dehydrate and die. Female flies that search for an egg-laying site are attracted by the odors from the vent pipe but are prevented from flying down the pipe by the fly screen at the top.

Procedures to consider when installing a vent pipe:

- The vent pipe must be put outside the superstructure and in the direction where it will be heated by solar radiation during the day.
- A 4 inch or more diameter pipe should be used in order to minimize obstructions to the air flow and to let as much light into the pit as possible for the attraction of flies.
- It should be installed as high as possible in order to ensure the top of the pipe is in the air stream.

- It should be placed directly over the pit in order for the light to attract flies to it.
- It should be covered at the top with a mesh resistant to the effects of radiation and corrosive gases.

VIP latrines can also be constructed with double pits where recycling of human waste is culturally acceptable. The cover slab, in this case, has two drop holes, one over each pit. One pit is used at any one time. When one of the pits is full, its drop hole is covered and sealed 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 soil conditioners. The pit can be used again when the second pit has filled up. This alternating cycle can be repeated indefinitely.

Diameter of a pit: The diameter of the pit may vary but a standard size of 1.0 m (excluding the lining) and 1.2 m for the slab is recommended. These dimensions will provide a support of about 0.10m all round the pit. A standard size facilitates the manufacture of the slabs.

6.1.1.3 Pour-Flush Latrine with Leaching Pit

A Pour-flush latrine with a leaching pit is installed with a pan with a water seal (a U-shaped conduit partly filled with water) in the defecation hole. This overcomes the problems of flies, mosquitoes and odour. After use, the latrine is flushed by pouring water into the pan. The concrete floor slab with the pan is either on top of the leaching pit (direct system) or a short distance from one pit (single offset) or two pits (double offset) . Pits are usually lined for strength, but adequately permeable for infiltration.

In offset systems a short length of sufficiently sloping PVC tube leads from the U-trap down to the pit, or in case of a double pit system, to a diversion box which diverts the flush to one of the pits (Figures 14 to 16). The double offset system enables alternating use of the two pits. When the first pit is full, it is covered and left for at least twelve to eighteen months, the period necessary for effective pathogen destruction. After this period, by which time the second pit is filled up, the decomposed contents of the first pit can safely be removed and used as organic fertilizers. Pour-flush latrines are suitable where people use water for anal cleansing.

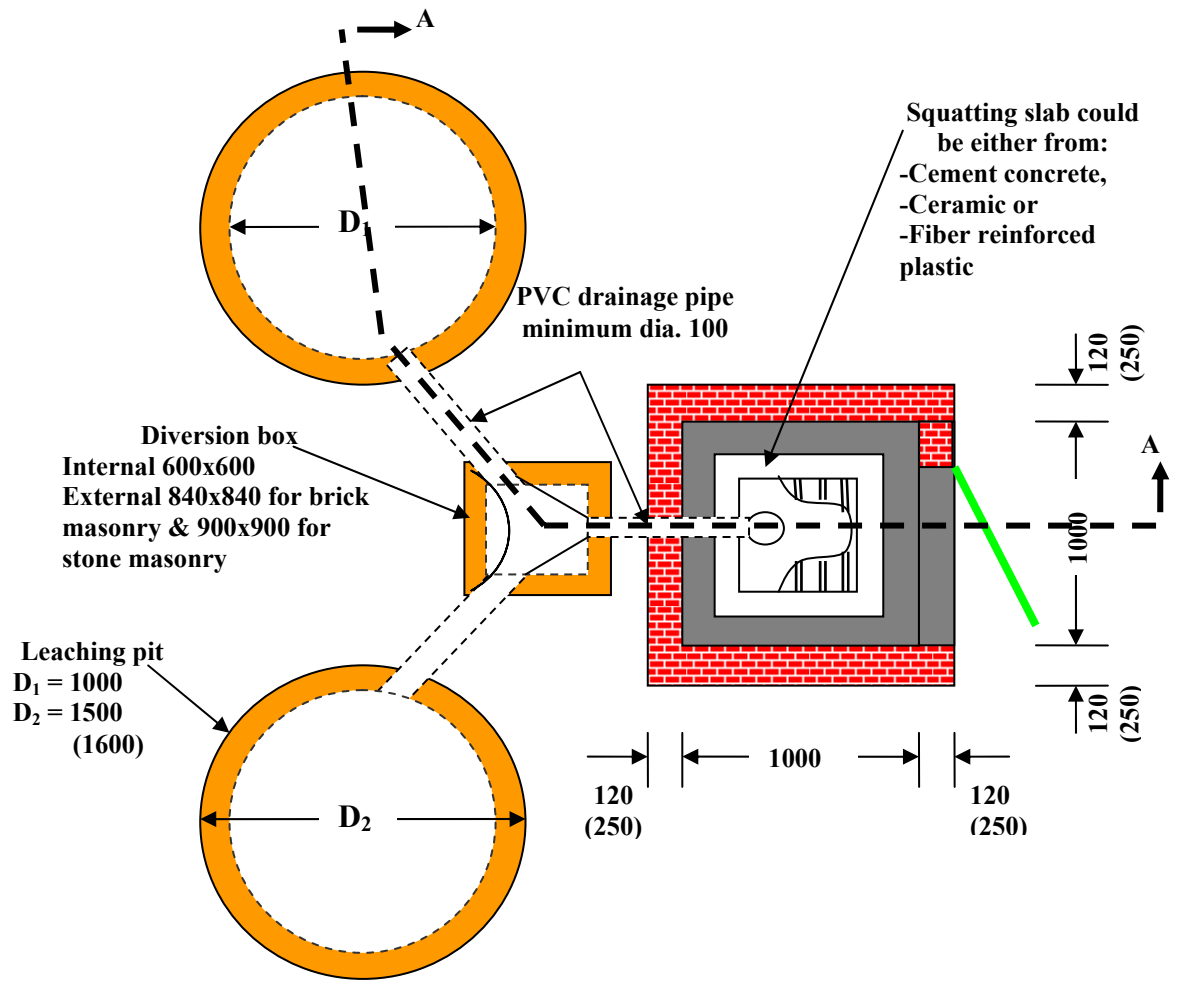


Figure 14: Schematic Plan of Pour Flush Household Latrine

All dimensions are in mm unless otherwise specified

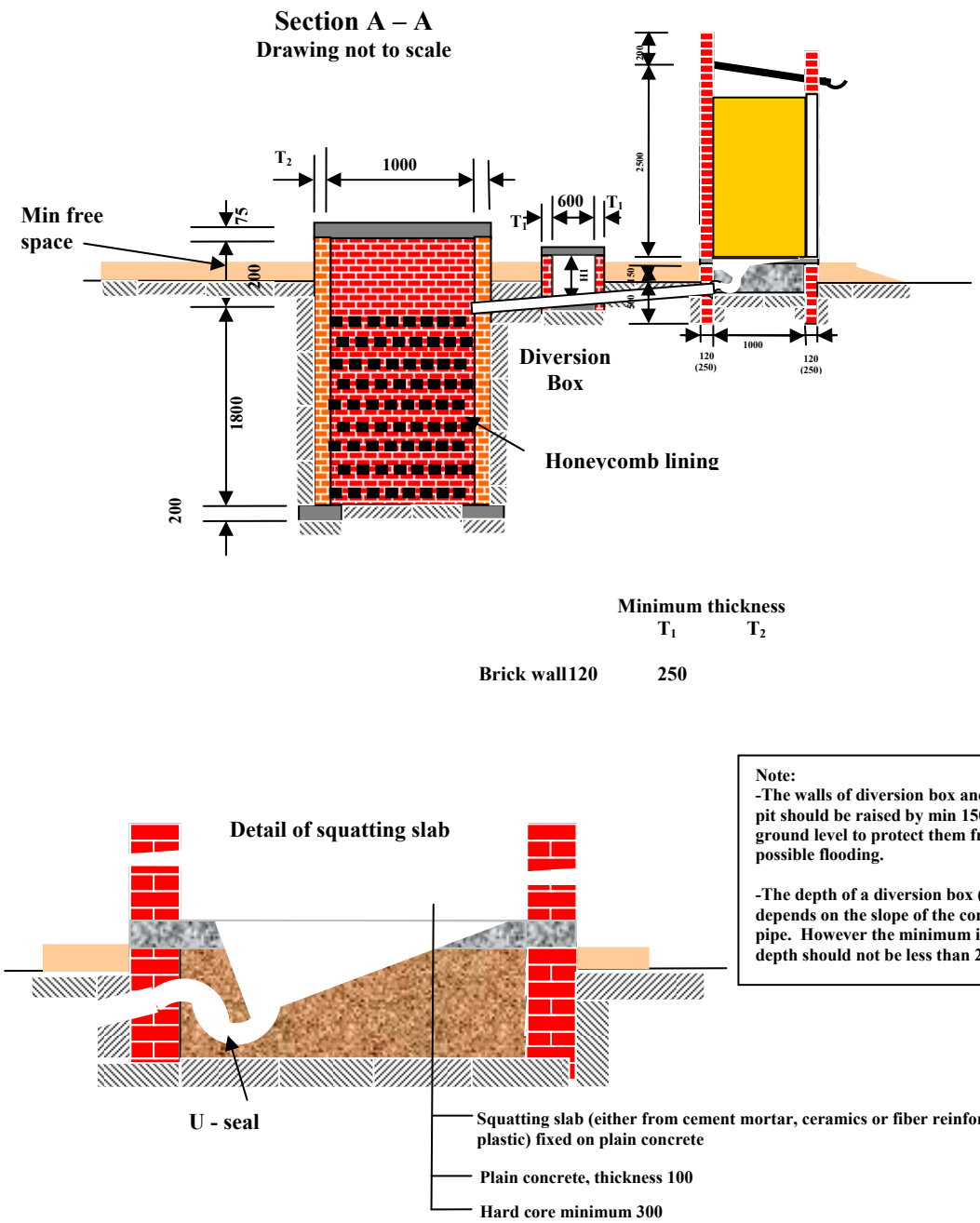
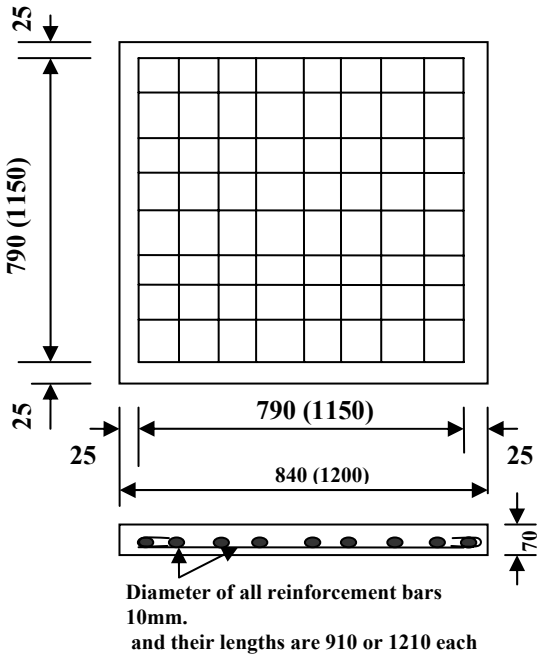
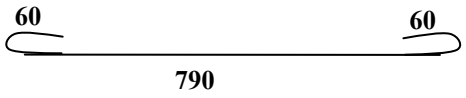


Figure 15: Sectional Drawing of Pour Flush Household Latrine
All dimensions are in mm unless otherwise specified





Reinforcement schedule for diversion box

-For brick lining:2x9 steel bars of diameter 10mm, c/c 100, and length of 910 each
-For masonry lining: 2x12 steel bars of diameter 10mm, c/c 95, and length of 1210 each

Reinforcement schedule for cover slab of leaching pits of diameter 1500

Type	Shape	Length	Quantity	Total length
A	—	1450	2	2900
B	—	1425	4	5700
C	—	1420	4	5680
D	—	1180	4	4720
E	—	920	4	3680
F	—	375	4	1500
G	o	1610	1	1610
H	o	3050	1	3050
I	o	4495	1	4495

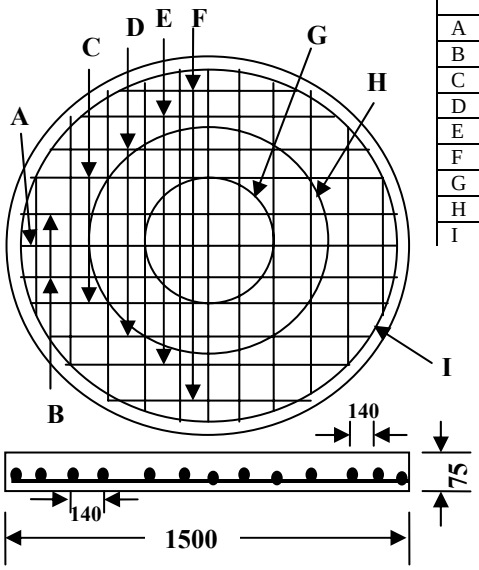


Figure 16: Reinforcement schedule for pour flush latrine

The size of the leaching pit depends on a number of factors such as: the property of the soil; number of users; water table conditions; and the quantity of water being used for flushing and anal cleansing. The volume of the pit can be calculated using the equation given above. However, from global experience it is recommended that the volume of the pit is increased by 50% during wet conditions from that during dry condition. This means a circular leaching pit that has 1m diameter , will require volume 1.44m3 in wet conditions.

6.1.1.4 Composting (ecosan) latrine

This type of latrine can be constructed with single or double vaults, and consists of watertight chamber(s) to collect faeces. Urine is collected separately as the contents of the vault need to be kept relatively dry. The urine is diverted to a urine container placed outside the latrine and can be diluted with 3 to 6 parts of water for use as a fertilizer for a vegetable or fruit garden. Otherwise, it can be diverted away to a soak-away pit. In areas where water is used for anal cleansing, a separate diversion system should be incorporated so that this water can be diverted to a soak-away pit. .

The pedestal or squatting plate should therefore have three sections: one that allows faeces to go down to the pit, one to convey urine to a urine collection container (pot) and one to carry waste water from anal cleansing to a soak-away pit.

A separate location for composting of faeces should be allowed for a single vault ecosan latrine. The organic soil fertiliser will be pathogen free and ready for use in a year.

Volume of a vault: The estimated volume of faeces produced over a period of two years by a household of 6 people is 0.72m3 and the required volume of a vault to accommodate this volume is 0.96m3. A vault of internal volume of $1m^3$ (1m width, 1m length and 1m depth) would therefore serve a single household for 2 years The volume should be doubled for a double vault ecosan latrine.

6.1.2 Depth of a pit:

6.1.2.1 ITPL

The depth of an ITPL pit may vary from 3 to 7 meters depending upon the stability of the soil and the volume of sludge. For 1.44m3 of sludge, a pit of diameter of 0.8m should be 2.86m deep. A 3m deep pit should serve a maximum of three years.

As a general rule, if latrines are going to be implemented in areas where surface water is expected to flood, the lining of the latrine and squatting slab should be raised above the expected line of flooding at least by 0.15m. In hard formations, where digging is difficult, the pit should be constructed above the hard formation, and the lining and squatting platform raised above the ground level in order to ensure the required depth. In this case, the lining must be water tight to avoid seepage out of the latrines onto the ground, and to prevent any surface water getting into the latrine..

6.1.2.2 VIP

Depth of pits can be calculated keeping roughly the area around 1.0m^2. The depth of a VIP pit must be at least 3 meters. In very stable soil, the depth can be increased. A minimum working diameter of 0.8m must be allowed for all types of soil conditions.

6.1.2.3 PFL

For a PFL of volume 1.44m3, the circular leaching pit should have a diameter of 1.0m and a depth of 1.83m. Increasing the depth to 2m will increase the serving life to a little over 2 years.

6.1.2.4 Composting (ecosan) latrine

The depth of the vault is 1m. In areas where the groundwater table is not shallow, part the vault (up to 25%) can be constructed underground. An opening of 0.6m by 0.6m that securely sealed with a concrete door should be provided on one of the walls of each vault to be opened when the vault needs to be emptied. Unless a manhole cover is provided on top of the vault, constructing the whole depth of the vault below the ground will make the emptying of the vault impossible.

The urine, which is separated from the faeces, will be collected in a container (plastic or clay pot), which should be placed outside of the squatting platform, usually beside the vault.

6.1.3 Lining of a pit

6.1.3.1 IPL

There is no need to line this pit in stable soil. However, care should be taken to ensure that rainwater does not enter the pit. This is done by raising the floor by at least 0.15m. In unstable soils, the pit can be lined with locally available materials like mud bricks (common in Darfur – see picture below), ordinary bricks or stones without cement mortar. Sand filled sacks are an option for circular pits during emergencies.

Pit lined with mud bricks in North Darfur

6.1.3.2 VIP

There is not need to line this pit in stable soil, however, a top ring beam should be provided so that the slab may be fixed properly to avoid rainwater getting into the pit. In unstable soils the pit can be lined with locally available bricks or stones without cement mortar joints to ensure percolation. In some instances, e.g. in loose soil, the pit can be lined with concrete rings.

6.1.3.3 PF

A leaching pit can lined with bricks or stones. The honeycombing lining method in alternative layers is recommended up to the wet level. This method facilitates the infiltration of the liquid part into the surrounding soil.

6.1.4 Squatting platform

6.1.4.1 IPL

Three options are recommended for non-emergency situations;

1) Sanplat size of 600 x 800mm (Figures 8 and 9),
2) A concrete slab of size 1000 x 1200mm (Figure 10)
3) A dome-shaped squatting slab (Figure 11).

When option 1 and 2 are used, a slender lining should be used to avoid the use of wooden support beams, which attract termites. These can attack the squatting platform. In the interests of the environment, the use of wooden components is not recommended for the

construction of latrines in Darfur[5] and any other environment with vegetation degradation risks

The slab should be at least 150mm above the ground surface to avoid possible flooding of the latrine.

When using a dome-shaped slab, a diameter of 1.2m is preferred (from Mozambique experience) with a foundation (masonry) at least 0.1m all round excluding the lining. This type of slab doesn't require reinforcement bars. The slab will have a hole for squatting and built in footrests. An additional vent hole fitted with a socket is provided to allow installation of a vent pipe (optional) to upgrade the latrine into a ventilated improved pit latrine. If not upgraded to VIP, the vent pipe hole should be covered possibly by a well fitted bucket containing ash which could be dispersed into the squat hole by the user after defecation.

The squat hole needs to be covered with a tight lid of suitable locally available material, to prevent the entry of flies and insects into the pit when the latrine is idle. A handle must be attached to the lid to facilitate lifting, to avoid contact with urine and faeces, especially for children.

During emergencies, plastic slabs of 600x800mm or 1000x1200mm can be used during the start of the emergency.

6.1.4.2 VIP

The squatting slab could be circular, dome shaped or rectangular. It should have a squatting and vent pipe holes. In the case of a double pit latrine, each pit should have to have its own vent pipe and squatting hole. The slab should have built-in footrests. As the dome shape and circular concrete slabs are not reinforced, the optimum mix ratio of cement: sand: aggregate for the concrete slab needs to be determined depending on quality of concrete type. A mix ratio of cement: sand: aggregate of ½: 2: 1 has been used in Mozambique successfully for a dome shaped cement concrete slab.

6.1.4.3 PF

The squatting slab is usually a concrete floor with a pan (made from concrete, ceramics or fiber reinforced plastic) with a U-water seal attached. The squatting slab can be placed on top of the pit in the case of a single pit arrangement or independently off the pits in a double pit system. In the case of double pit system, a diversion box is provided for alternate use of the pits.

6.1.4.4 Composting (Ecosan) Latrine

The squatting pan may have two or three sections depending one the method of anal cleansing. If water is used for anal cleansing, the pan will have three sections: one that allows faeces to go down to the pit, one to convey urine to a urine collection container (pot) and one to carry waste water from anal cleansing to a soak-away pit.

[5] TEARFUND, 2007, Darfur: Relief in in a vulnerable environment

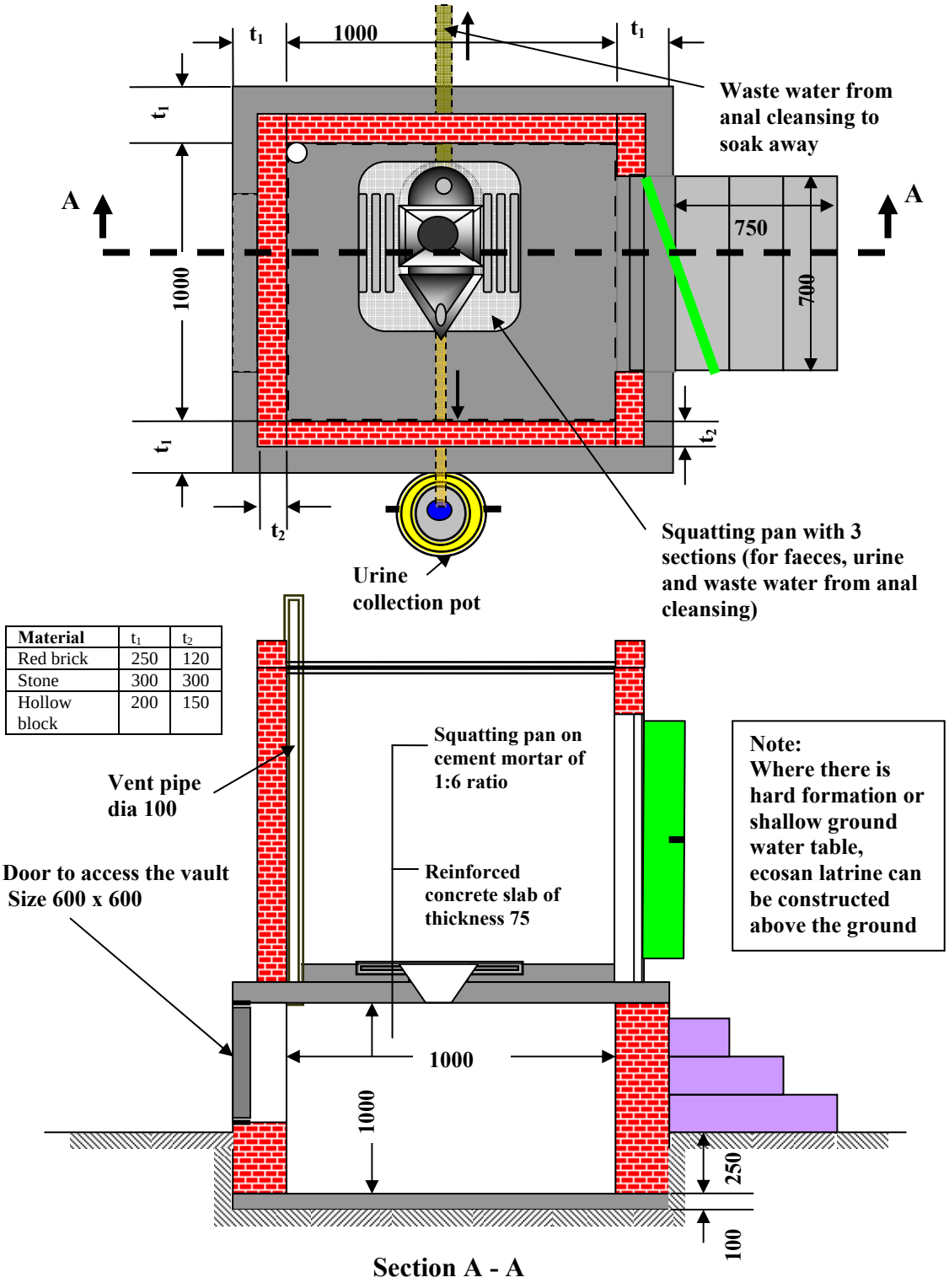


Figure 17: Typical Ecosan Household Latrine with single vault
All dimensions are in mm and drawing not to scale

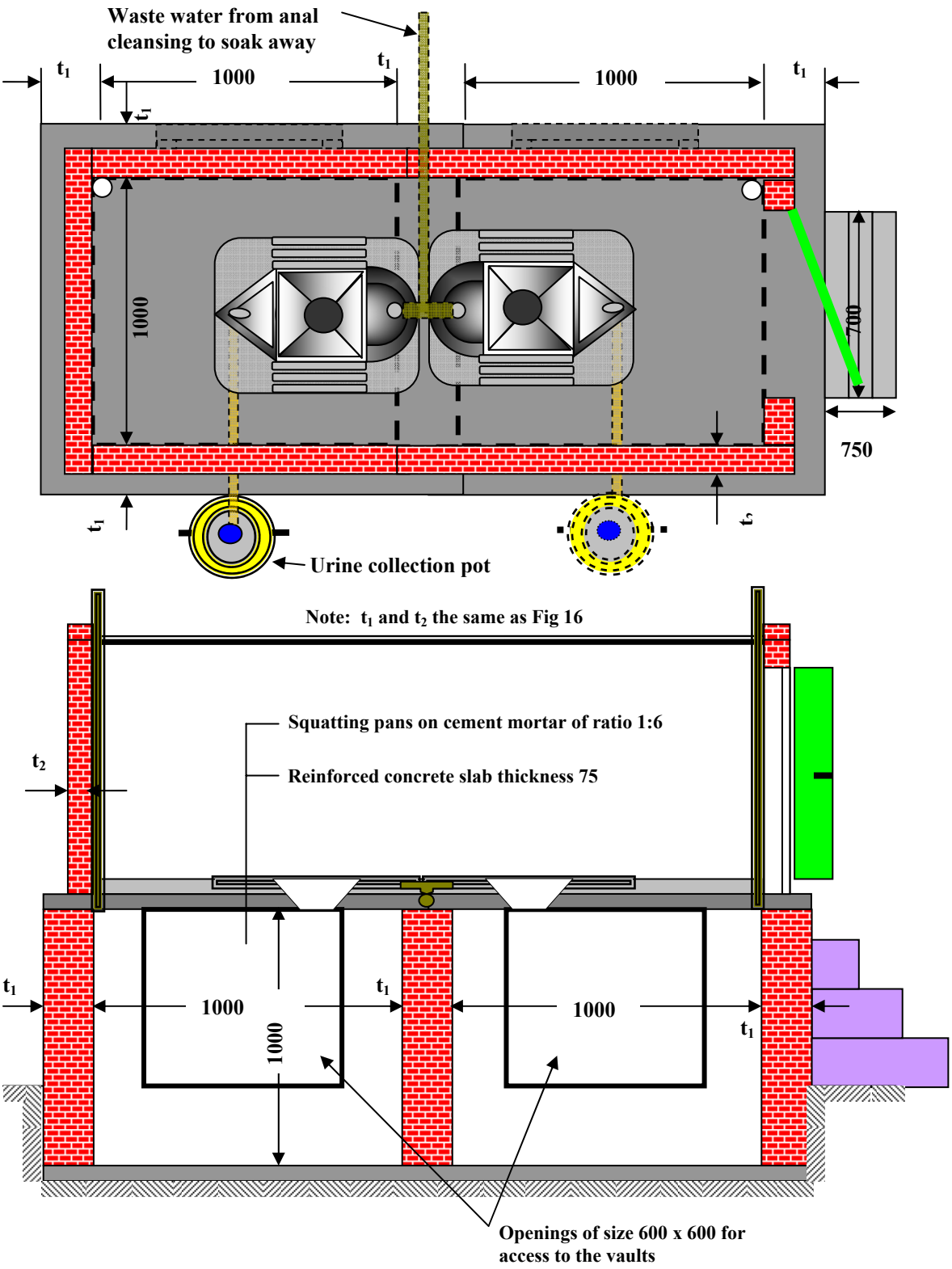


Figure 18: Double vault composting (ecosan) household latrine
All dimensions are in mm and drawing not to scale

In case water is not used for anal cleansing, the squatting pan will have only two sections, one for the diversion of urine and the other for the faeces. The pan can manufactured from ceramic or fiber reinforced plastic.

The squatting pan should be placed on reinforced concrete slab of 7.5cm thickness. The opening of the pan for the faeces should have a cover which should be tightly closed after each use.

6.1.5 Superstructure

6.1.5.1 IPL

Locally available materials like mud bricks, red bricks, etc as shown in Figure 13 must be encouraged for the construction of the superstructure. The type of material can be chosen by the users so long as it provides privacy, convenience and comfort, and is affordable. Plastic sheeting may be used for the superstructure during emergencies for quicker erection.

6.1.5.2 VIP

Once again, locally available materials like mud bricks, red bricks, etc. must be encouraged for the construction of the superstructure. The type of material can be chosen by the users. The superstructure (the wall, door and roof) should provide darkness to the pit in order the VIP latrine functions properly. The squatting hole should be coverless, to allow air circulation. The door should face the direction of the wind to maximize the ventilation rate. The squatting space should be large enough, and not less than 1000mm in both directions if it is rectangular or 1000mm in diameter if in a spiral form.

6.1.5.3 PF

In this type, locally available materials like mud bricks, red bricks, etc. must be encouraged for the construction of the walls of the superstructure. The roof can be also constructed from durable local materials. The type of material can be chosen by the users so long as it provides privacy, convenience and comfort. The squatting space should not be less than 1000mm in both directions.

6.1.5.4 Composting (Ecosan) Latrine

The walls of the superstructure of this type can be constructed from locally available materials like mud bricks, red bricks, stone masonry, etc. The roof should be constructed such that it does not allow any rain into the vault.

6.1.6 Vent pipe

6.1.6.1 VIP

The vent pipe is an essential component of the VIP latrine as it controls odours and prevents flies and insects. The vent pipe can be a PVC pipe of minimum diameter 100mm. The vent pipe can also be built in situ from local bricks formed into a square shape with an internal opening of 180mm. Alternatively, the vent pipes can be made from cement-rendered reeds, bamboo or similar materials. When local reeds or similar

materials (thin poles or bamboo sticks split longitudinally into 10-20mm wide strips) are used, they are tied together with wire or string to form a mat measuring 2.5 m by 1 m. The mat is then rolled around four or five rings of saplings to form a tube of some 300mm external diameter. The fly screen is then fixed to one end. Cement mortar (1:3 ration of cement to sand) is applied to the tube along its entire length but only around half of its circumference. When this has hardened, the vent pipe is fixed in position and the other side is then plastered with cement mortar. The vent pipe should extend a minimum of 500mm above the highest part of the roof.
If the cost of the PVC pipe is unaffordable, locally available materials should be considered for the fabrication of the vent pipe. However, operational and maintenance costs including replacement need to taken into account, when making this decision.

6.2 Advantages and disadvantages of different types of household latrines

Improved Pit Latrines
Advantages
- Construction cost is low and suits a poor community.
- Can be constructed by the household or unskilled labour in a short time.

Disadvantages
- Supported on wooden poles which are subject to decay resulting in the pit collapsing.
- Odor fly problem
- Non - esthetic
- Floor is difficult to clean
- Not durable and difficult to dig in hard formation.

Ventilated Improved Pit Latrines
Advantages:
- Free from odor and flies
- Ensures continuous use by allowing alternate pits to be used and in the case of a double pit VIP latrine, manual cleaning is safe after the excreta has decomposed during a period of 18 to 24 months
- Minimum consumption of water and so can function even in less permeable soils.
- Easy to construct and maintain.
- Suitable where anal cleansing is done with dry materials
- Suitable in impervious soils and rocky strata.

Disadvantages:
- Unsuitable where anal cleansing is with water.
- Pit cleaning is manual
- Superstructure needs to be removed when the pit is filled up in case of single pit VIP latrine. Greater care is required in changing over the use of pits in the case of a double pit VIP latrine
- Costly in comparison to other pit and single pit pour-flush latrines.
- If proper vent and fly trap are not provided flies will breed.

- Proper cleaning of the floor is difficult due to restricted use of water.

Pour Flush Latrines

Advantages:

- Sanitary and durable
- Provides all the health benefits which a conventional sewerage system provides.
- A pedestal type seat can be used to replace the toilet seat if required
- Odourless due to the water seal.
- Vent pipe is not required as the gases get dispersed in the soil through holes in the pit lining.
- Only a small quantity of water is required (about 2 litres) for flushing.
- The squatting seat requires less space to construct.
- Can be constructed with local labour and materials.

Disadvantages:

- It is not suitable in rocky areas, for impermeable soils, if solid materials are used for anal cleansing and if the site is flooded or water table is too close to the ground surface.
- Cannot be upgraded to a high volume flushing
- Maintenance costs high e.g frequent replacements of U-trap.

Composting (Ecosan) Latrine

Advantages

- Suitable in rocky areas and where there is a shallow ground water level as construction can be above ground
- Water required is only for cleaning the latrine; no need of water for flushing.
- Separately collected urine and composted faeces could be valuable resources (fertilizers) that may be used in agricultural gardening.

Disadvantages:

- If any liquid (urine or water) is not properly separated, the system will not function properly.
- In areas where the recycling of human faeces is not accepted, implementation might be difficult.

7 Management, O & M of household latrines

The overall management, O & M responsibility including replacement of household latrines lies with the individual household. This has to be made clear at the outset. Communities should agree and be informed at household level on how the facilities are to be operated and maintained as suggested below.

Improved Pit Latrine:

The operation of a pit latrine is quite simple and consists of regularly cleaning the slab with little quantity of water (and a little disinfectant, if available) to remove any excreta

and urine. The tight fitting lid has to be replaced after use to ensure insect control and smell reduction. In addition appropriate anal cleansing materials should be available in or near the latrine. Ash can be sprinkled in the pit to reduce smell and insect breading. Non biodegradable materials like stones, plastic, rags etc should not be thrown into the pit as they reduce the effective volume of the pit and hinder mechanical emptying.

Monthly maintenance includes checking the slab for cracks, and the superstructure for structural damage; ensuring that the lid remains tight fitting and 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 on: where to relocate the sludge; timely digging of another pit and transfer the slab and the superstructure to the new pit (where the slab and superstructure materials are reusable). The contents of the old pit must then be covered with at least 0.5m of top soil to provide a hygienic seal. In addition the old pit should be completely isolated or protected and definitely kept out of the reach of children and animals by covering with locally available material like thorn bushes.

Immediate action must be taken if the following problems occur: parasites in cracks in the floor (as a result of unsuitable materials for the floor slab or improper curing of concrete); damaged or broken lids that have fallen into the pit; flooding of the latrine by surface water, etc.

Ventilated Improved Pit Latrines

The operation of a pit latrine is quite simple and consists of regularly cleaning the slab with water (and a little disinfectant, if available) to remove any excreta and urine. The door must always be closed and the roof should be covered so the superstructure remains dark inside. The drop hole should never be covered as this hinders airflow. Appropriate anal cleansing materials should be available in or near the latrine. Non biodegradable materials like stones, plastic, rags etc should not be thrown in the pit as they reduce the effective volume of the pit and hinder mechanical emptying.

Problems associated with VIP latrines: bad quality of the floor slab due to inappropriate materials or improper curing of concrete; inferior quality of fly screens that may get damaged by the effects of solar radiation; foul gases; and flooding or undermining of improperly sited latrines. If the superstructure allows too much light into the vault through the squatting hole, flies will be attracted by the light to go up through the squat hole and fly out into the superstructure instead of going up through the vent pipe where they will be trapped by the vent pipe mesh cover. This may jeopardize the whole VIP concept. Odor problems may occur during the night and early morning hours in latrines relying more on solar radiation for the air flow in the vent pipe than on wind speed. Leakages between pits can occur because the dividing wall is not impermeable or the soil is too permeable. In hard soils it may be impossible to dig a proper pit. VIP latrines can not prevent mosquitoes breeding in the pits. People may not be able to bear the much higher costs for construction of a VIP latrine in comparison to a simple pit latrine. Cultural resistance against handling human waste may prevent households from emptying their double-pit themselves. Usually local labour can be hired to do the job. And finally,

children may be afraid to use the latrine because of the dark or because of fear of falling into the pit

Taking into consideration the above problems and limitations, every month the floor has to be checked for cracks, and the vent pipe and fly screen inspected to ensure they are not corroded or damaged. Repair of the superstructure, especially light leaks may also be necessary. When the contents of the pit reach the 0.5m below the slab, a new pit should be dug and the old pit covered with top soil. The old pit could be emptied mechanically, but this should not be done when the excreta is fresh, as this could pause a major health risk. In a twin pit system, the other pit can be used when one is full. The full pit can be emptied safely by hand after its contents have been standing for a year or more.

Pour Flush Latrines:
Before use the pan is wetted with a little water to avoid faeces sticking to the pan. After use, the pan is flushed with a no more than 2 liters of water. If water is scarce, laundry, bathing or any other waste water may be used. No material that could obstruct the U trap should be thrown into the pan. The floor, squatting pan, or seat, door handles and other parts of the superstructure must be cleaned daily with brush, soap and water. Wastewater from bathing or washing clothes should not be drained into the pit (unless used for flushing), but disposed of elsewhere. Rain water should not be allowed to enter the leach pits. Do not provide a water tap in the latrine as this will shorten the lifespan of the leaching pits.

Monthly checks of the pan and U-trap for damage, and the diversion box for blockage must be conducted. If the excreta is not flush away quickly, the PVC pipes or diversion box may be choked. Immediate unblocking using scoops and long twigs are recommended. Single pits have to be abandoned and covered with at least 0.5m soil when full, or be emptied by mechanical means. In a double pit system the user should regularly monitor the level of contents in the pit. If the full pit was properly closed for at least twelve to fifteen months, it can safely be emptied by hand. The contents have decomposed into harmless humus which forms a good fertilizer. The pipe leading to the full pit should be sealed and the flow diverted to the empty pit.

Composting (Ecosan) Latrine

This type of latrine should be constructed and operated within a pilot scheme in order to determine whether it would be popular for replication in a community or not. In areas where a pilot scheme has been initiated, the users should follow the following operational and maintenance procedures.

Initially, a layer of absorbent material (sand and gravel) is put in the vault and after each use, the faeces is covered with ash (or lime, sawdust, shredded leaves or vegetable matter) to deodorize the faeces, soak-up excessive moisture and improve the carbon/nitrogen ratio, which ensures that sufficient nitrogen is retained to make a good fertilizer. In a single-vault ecosan latrine, when the vault is full, the contents should be removed to another composting location and should decompose anaerobically. The

contents can be removed from the vault through the door at the side of the vault, built for this purpose. . The contents in the composting location should be covered with dry earth and kept for at least one year to make them pathogen free.

In double vault ecosan latrines, when the first vault is three quarters full, it is completely filled with dry powdered earth and sealed. The contents are left untouched for at least a year to decompose anaerobically and available for use as fertiliser. The second vault is used until it is three quarters full and the first vault is emptied by hand.

8 Recommendations

The following recommendations are suggested for consideration during the construction and in the use of household latrines

General Recommendations

- A bucket system which is still in use in some places should be totally discouraged due to the associated health risks.
- As the responsibility of the O & M of household latrines lies with every individual household, involving the household in the decision making process at the beginning of the project cycle is very important. This will imbue a sense of ownership and facilitate the responsibility and cost sharing exercise during implementation.
- Provision of only latrines alone is not sufficient to induce behavioural change in the community. Sustained hygiene promotion activities through social mobilization should be in place in every project area. As an example, sanitation promotion could include the establishment of sanitation centres through slab production and training of masons. A sanitation promotion centre comprises two village health committee members, three masons and a guard. The masons need to be trained in slab production so that they can provide communities with quality and durable slabs.
- Implementation of the project should be always initiated in households that demand the facilities.
- Costs of construction should be shared among all stakeholders (households, local and national authorities and supporting partners).
- As much as possible local knowledge and materials should be used. Where capacity is lacking, it should be created/strengthened through training e.g. of local masons. The provision of tools is also an asset.
- The local and national authorities should be aware of the health and environmental impact of the project and establish a monitoring mechanism for them. WES and MoH could lead on that.
- Authorities should follow these agreed upon standards during construction of latrines.
- Monitoring visits to document the O & M of household latrines is important.

Specific Recommendations

1. Improved Pit Latrines

Taking into considerations the following points will minimize the problems and limitations of improved pit latrines.

- Proper sites should be selected in consultation with households and if that is not possible preventive action should be included in the design.
- Proper supervision should be provided on the quality of workmanship to avoid the problems mentioned above.

2. Ventilated Improved Pit (VIP) Latrine

Limitations and frequent problems associated with VIP latrines are: In hard soils it may be impossible to dig a proper pit. Pits should preferably not reach groundwater level and latrines must be 30 meters away from ground and surface water sources. VIP latrines cannot prevent mosquitoes breeding in the pits. People may not be able to shoulder the much higher costs of construction of a VIP latrine in comparison to a simple pit latrine. Cultural resistance against handling human waste may prevent households from emptying their double pit themselves.

During the construction time there might have been bad quality of the floor slab due to inappropriate materials or improper curing of concrete. Inferior quality fly screens get damaged easily by the effects of solar radiation and foul gases. Improperly sited latrines can get flooded or undermined. Children may be afraid to use the latrine because of the dark or because of fear of falling into the pit. Odour problems may occur during the night and early morning hours in latrines relying more on solar radiation for the air flow in the vent pipe than on wind speed. Leakages between pits can occur because the dividing wall is not impermeable or the soil is too permeable.

Therefore,

- Where latrines are used by a single household, the O & M tasks must be implemented by the household itself or by hired labour.
- If more than one household uses one latrine, cleaning arrangements must be agreed on a rotational to avoid conflict.
- Pits can only be emptied manually if their contents have been left to decompose for at least a year. In all other cases either a new pit has to be dug when a pit is full or the pit has to be emptied mechanically.
- If double pits latrines are used, the users need to understand the concept of the system fully in order to be able to operate it properly.
- User education must cover aspects such as reasons for switching pits, using one pit at a time, use of excreta as manure and the need to leave the full pit at least a year before emptying.
- Users also need to know how to switch the pit and how to empty it, even when they do not do these tasks themselves.
- Where these tasks are carried out by the private (informal) sector, the labourers also have to be educated in the concept of the system and its operational requirements.

3. Pour Flush Latrines

Pour-flush latrines are unsuitable 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. Double offset pits are usually much smaller than single pits because they need to last for twelve to eighteen months at least before they can be emptied by hand. In a direct pit

system less water is needed for flushing than in an offset system. Pour-flush latrines may be upgraded to a septic tank with drainage field or soak away or be connected to a small-bore sewerage system whenever this is required and feasible.

Frequent problems associated with pour-flush latrines are: Blockage of U-trap because of bad design, construction or improper use. Damage of U-trap caused by improper unblocking (sometimes U-traps are broken on purpose to prevent blockage). There could be blocked diversion boxes or PVC pipes. Contents in pit do not decompose safely because the double pits are too close to each other without an effective seal between them, allowing liquids to percolate from one pit to the other. Where pour-flush pans are not available full-flush pans may be used, but they require more water (7-12 liters) and can be a problems if water availability is limited.

The limitations of pour-flush latrines include: leaching pits are only functioning in permeable soils; latrines must be at least 30 meters away from water sources; can only be used in areas where sufficient water is available for flushing.

Therefore,

- Where latrines are used by a single household, the O & M tasks must be implemented by the household itself or by hired labour.
- If more than one household uses one latrine, cleaning arrangements must be agreed on a rotational to avoid conflict.
- Pits can only be emptied manually if their contents have been left to decompose for at least a year. In all other cases either a new pit has to be dug when a pit is full or the pit has to be emptied mechanically.
- If double pits latrines are used, the users need to understand the concept of the system fully in order to be able to operate it properly.
- User education must cover aspects such as reasons for switching pits, using one pit at a time, use of excreta as manure and the need to leave the full pit at least a year before emptying.
- Users also need to know how to switch the pit and how to empty it, even when they do not do these tasks themselves.
- Where these tasks are carried out by the private (informal) sector, the labourers also have to be educated in the concept of the system and its operational requirements.

4. Composting (Ecosan) Latrine

Composting (ecosan) latrines have not been successful except in Vietnam and Central America (in El Salvador, Guatimala etc). The main reason was that people were reluctant to recycle human waste as a useful resource. In this regard, this type of latrine should be tested first as a pilot project at various locations and the acceptance/rejection of this system documented. Ministries of Agriculture could be potential partner in promoting ecosan latrines.

In all cases, hygiene and sanitation promotion activities should be conducted in tandem with the construction of latrines.

Annexes

1. The process of development and finalization of the technical guidelines and manuals
2. People Contacted
3. Technical working group members
4. Some selected bibliography and references

Annex 1: The Development of these Technical Guidelines

The Technical Guidelines development process was completed in two stages: the preparation and the finalization.

A. The Preparation Stage

The preparation stage began in April 2006 with the agreement to select eight WASH facilities. At the request of the GONU, 3 additional water supply facilities were added, making the total eleven. The preparation stage that included information collection and analysis was completed in December 2006.

Collection of Information:

Technical and managerial information related to the development of the 14 Technical Guidelines was collected from the following sources:

- PWC/WES, SWCs and GWWD.
- UNICEF, WHO, World bank and NGOs.
- National institutions like SSMO.
- International institutions like IRC and WEDC.
- Donors like DFID.
- Different countries' standards like BS, IS, DIN, etc.
- Field trips to 14 states in the northern and southern states of Sudan to visit the different existing facilities and to have live discussion with the sector professionals and community members.

Analysis of collected information:

The Steering Committee, which comprised senior staff from PWC, WES and UNICEF together with the consultant, analyzed the collected information, which led to the development of the outlines of the documents in a zero draft. The draft documents were shared with the Steering Committee at Khartoum level. The committee met to discuss the drafts, and provided comments, which were incorporated, resulting in the first draft.

The first draft was widely circulated to PWC, UNICEF, various SWCs, INGOs and GoSS for information and feedback. All relevant feedback from the sector actors were incorporated into the documents and the second draft prepared and presented to the first national review workshop in December 2006. The relevant recommendations and comments of the national review workshop were incorporated into the documents resulting in a third draft.. The first National Review Workshop recommended that this draft of the Technical Guidelines be shared with a wider range of stakeholders, including specific technical working groups.

B. The Finalization Stage

The finalization of the 14 Technical Guidelines involved wider consultation with WASH sector partners through technical working group discussions, 3 regional review workshops, wider consultation and revision by GoSS and a national review workshop at the final stage.

Technical Working Group Discussions:
Professionals from various ministries participated in these technical working group discussions. MIWR, MOH, University of Khartoum, Sudan Academy of Science, private sector, NGOs, PWC/WES, UNICEF and Khartoum Water Corporation were also represented in these groups. This technical consultation process started in July 2007 and continued up to December 2007 resulting in the fourth draft of Technical Guidelines.

Regional Review Workshops:
Three Regional Review Workshops were conducted in Nyala, Wad Medani and Juba in November-December 2007 for GoSS and state level inputs into the documents. The Juba workshop recommended that the need for wider consultation within Southern Sudan to review the documents and to incorporate Southern Sudan specific contexts into the documents such as information relating to the location and different hydrogeological situations. These 3 workshops, resulted in the fifth draft.

Wider Consultation by GoSS:
Based on the recommendation of the Juba Review Workshop, a wider consultation process was started in July 2008 and completed in October 2008. The process included state level consultation with sector actors, technical working group discussions and a final consultation workshop in Juba. The process was concluded by the finalization and the approval of the final draft documents which were reviewed at a final National Workshop.

Final National Workshop:
The final National Workshop was conducted in April 2009 in Khartoum under the guidance and the presence of H.E. Eng. Kamal Ali Mohamed, Minister of Irrigation and Water Resources of GONU, Eng. Isaac Liabwel, Undersecretary, Ministry of Water Resources and Irrigation of GoSS, Eng. Mohammed Hassan Mahmud Amar, DG of PWC and Eng. Adam Ibrahim, Minister of Physical Planning and Public Utilities of South Darfur State.

The workshop was attended by ninety two participants representing MIWR, MWRI, MOH, PWC, WES, GWWD, Engineering Council, SWCs, SMoH, University of Khartoum, UNICEF, WHO, IOM, ICRC, NGOs, USAID and private sector.

The National Workshop has reviewed the 14 WASH Technical Guidelines and approved them as the national WASH Technical Guidelines.

The workshop recommendations included:

- Publication and wide distribution of the Guidelines;
- Translation of the Guidelines into Arabic and other major Sudanese languages;
- Organization of training and advocacy courses/workshops related to the Guidelines;
- Adoption of supportive policies, strategies, laws and regulations to ensure best utilization of the Guidelines;

- Development of a system for feedback to receive comments from implementing partners for inclusion in future updates of the Guidelines. MIWR/PWC, MWRI and SWCs were selected as focal points for that purpose.

Annex 2: People contacted

At Khartoum level

1. Mr Mohammed Hassan Mahmoud Amar, Director General, PWC
2. Mr Eisa Mohammed, National WES Coordinator, WES/PWC
3. Mr Mohammed Habib, National Project Coordinator, PWC
4. Mr Sampath Kumar, Chief WES Section, UNICEF
5. Mr Vishwas Joshi, PO, UNICEF
6. Mr Zaid Jurji, PO, UNICEF
7. Mr Stanely Hall, SPO, UNICEF
8. Mr Fouad Yassa, PO, UNICEF
9. Mrs Awatif Khalil, APO, UNICEF
10. Mr Samuel Riak, PO, UNICEF
11. Dr Isam M. Abdel Magid, Faculty of Engineering, University of Khartoum
12. Mr. Bedreldeen Ahmed Ali, Engineering Department, FMOH

North Darfur, El Fashier

1. Osman Bukhari Ibrahim	SMOH	DG Envoronmental Health
2. Abdul Azim Ahmed	SWC	Mechanical Engineer
3. Abdella M. Adam	WES	Drilling Engineer
4. Mohammed Mohammedein	WES	Mechanical Engineer
5. Omer Abdurahman Adam	GWWD	Hydrogeologist
6.Nour Eldin Adam	WES	Surveying Engineer
7. Abdella Adam Ibrahim	WES	Geologist
8. Tayalla El Medomi	UNICEF	Water Engineer
9. Mohammed Mohammedein Subi	SWC	Acting DG & Manager of RW
10. Salma Hassan	WES	Social Mobilzer
11. Ahmed Abu Elgasim	WES	Acting GM
12. Hassan Sheik Nur	Oxfam GB	Public Health Engineering Coord.
13. Jaka Magoma	IRC	Environmental Health Manager

North Kordofan, El Obeid

1. Hassan Adam Suleiman	ACU WES	Monitoring Officer
2. Ahmed El Abeid	RWC	Surface Water Section
3.Alehmin Ahmed	WES	Mechanical Engineer
4. Saeed Elmahdi	WES	Programme Manager
5. Asia Mahmoud Mohmed	ACU WES	W Coord. Kordofan Section
6. Yassin Abbas	NWC, NK	RWC Manager
7. Mahgoup Dahia	WES, NK	Mini Water Yard Officer
8. Abeer Ali Elnour	WES, NK	Civil Engineer
9. Mutasim Hamad	WES, NK	Monitoring Officer
10. Makin Mohammed Toto	WES, NK	Drilling Engineer
11. Salah Mohammed	GWWD	Director General

South Kordofan

1. Adil Awad Farog	SWC	Geologist
2. Jakob Jebbrel	SWC	Engineer
3. Haidar Ariah Abdel Bari	SWC	Geologist
4. Mohammed Morgan Yhya	SWC	WES PA
5. Gamaa Aziz	UNICEF	APO
6. Fatima Toto	SWC	Urban Water Management
7. Sunaya Zroog	SWC	Urban Water Management
8. Mymona Taha	SWC	Urban Water Management
9. Adam Mohammed Ibrahim	SWC	Urban Water Management
10. Ali Gabaur Ahmad	SWC	Urban Water Management
11. Elzaki Eisa	WES	Drilling Engineer
12. Kamal Bashir	SC/USA	Watsan
13. Osman Elnour	SWC	DG
14. Dr Abdel Rahim Ahmed	UNICEF	APO
15. Hassaballa Hamad	SWC	Rural Water Management
16. Absaida	SWC	Mechanic
17. Awatif Elhag	WFP	Field Monitor
18. Al Amin Shawish	Sudan Aid	Coordination Officer

People Contacted in Southern Sudan, July 2008

1. Juma Chisto, Operator of Kator Emergency Water Supply, Juba
2. Habib Dolas, Member of Watsan committee, Hai Jebel
3. Andew Wan Stephen, Member of Watsan committee, Hai Jebel
4. Francis Yokwe, Member of Watsan committee, Hai Jebel
5. William Ali Jakob, Member of Watsan committee, Hai Jebel
6. William Nadow Simon, Member of Watsan committee, Hai Jebel
7. Ali Sama, Director General, Rural Water Department, Central Equatoria State (CES)
8. Engineer Samuel Toban Longa, Deputy Area Manager, UWC, CES
9. Sabil Sabrino, Director General UWC, WBeG
10. James Morter, Technician, UWC, Wau
11. Carmen Garrigos, RPO, Unicef Wau
12. Sevit Veterino, Director General, RWC, WBeG
13. Stephen Alek, Director General, Ministry of Physical Infrastructure (MPI), Warap
14. John Marie, Director of Finance, MPI, Warap State
15. Angelo Okol, Deputy Director of O&M, Warap State
16. Santino Ohak Yomon, Director, RWSS, Upper Nile State
17. Abdulkadir Musse, RPO, Unicef Malakal
18. Dok Jok Dok, Governor, Upper Nile State
19. Yoanes Agawis, Acting Minister, MPI, Upper Nile State
20. Bruce Pagedud, Watsan Manager, Solidarites, Malakal
21. Garang William Woul, SRCS, Malakal

22. Peter Onak, WVI, Malakal
23. Gailda Kwenda, ACF, Malakal
24. Amardine Atsain, ACF, Malakal
25. Peter Mumo Gathwu, Care, Malakal
26. Engineer John Kangatini, MPI, Upper Nile State
27. Wilson Ajwek Ayik, MoH, Upper Nile State
28. James Deng Akurkuac, Department of RWSS, Upper Nile State
29. Oman Clement Anei, SIM
30. Abuk N. Manyok, Unicef, Malakal
31. Jakob A. Mathiong, Unicef, Malakal
32. Emmanuel Badang, UNMIS/RRR
33. Emmanuel Parmenas, DG of O&M, MCRD GOSS
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Annex 3. Technical Working Group Members

A) At Khartoum level

1) For Slow Sand Filters

   Dr Mohammed Adam Khadam, University of Khartoum
   Dr V. Haraprasad, UNICEF
   Mr. Ibrahim Adam, PWC
   Mr Eshetu Abate, UNICEF - Consultant

2) For Borehole Hand pumps, Hand dug well Hand pumps, Hand dug well Water yards, Mini Water yards and Water yards

   Mr. Mohamed Hassan Ibrahim, GWW
   Mr. Mohy Al Deen Mohamed Kabeer, GWW
   Mr. Abd el Raziq Mukhtar, Private Consultant
   Mr. Mohamed Salih Mahmoud, PWC
   Mr. Mohamed Ahmed Bukab, PWC
   Mr. Mudawi Ibrahim, PWC/WES
   Mr. Yasir Ismail, PWC/WES
   Mr Eshetu Abate, UNICEF - Consultant

3) For Improved Small Dams

   Dr. Mohamed Osman Akoud, University of Khartoum
   Professor Saif el Deen Hamad, MIWR
   Mr. Mohamed Salih Mohamed Abdulla, PWC
   Mr Eshetu Abate, UNICEF - Consultant

4) For Improved Haffirs

   Mr. Mohamed Hassan Al Tayeb, Private Consultant
   Mr. Hisham Al Amir Yousif, PWC
   Mr. Hamad Abdulla Zayed, PWC
   Mr Eshetu Abate, UNICEF - Consultant

5) For Drinking Water Treatment Plants, Drinking Water Distribution Networks and Protected Springs & Roof Water Harvesting

   Dr Mohamed Adam Khadam, University of Khartoum
   Mr. Burhan Ahmed Al Mustafa, Khartoum State Water Corporation (KSWC)
   Mr Eshetu Abate, UNICEF - Consultant

6) For Household Latrines, School Latrines and Rural Health Institution Latrines

Mr. Sampath Kumar, UNICEF
Mr. Fouad Yassa, UNICEF
Dr. Isam Mohamed Abd Al Magid, Sudan Academy of Science
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B) At Juba level:

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Mr. Alier Oka, MWRI
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Annex 4: Selected bibliography and references:

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10. Ecological Sanitation, editors and co-authors; Uno Winbald and Mayling Simpson-Hébert

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