Ministries of Health, Education and Water Resources
In collaboration with UNICEF

Design and Construction Manual For **Water Supply and Sanitary Facilities** In Primary Schools in Ethiopia

Acknowledgment

The Federal Ministries of Health and Education are delighted with the publication of this Design and Construction Manual for WASH Facilities in Primary Schools – the first document of its kind for Ethiopia. The manual represents over one year of collaborative work undertaken by the Government at Federal, Regional and Woreda levels, with the support of UNICEF and contributions from many other organisations and individuals.

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Abbreviations

CHB	Concrete Hollow Block
CIS	Corrugated Iron Sheet
cm	Centimetre
GS	Galvanized Steel
kg	Kilogram
mm	Millimeter
MoEd	Ministry of Education
MoH	Ministry of Health
MoWR	Ministry of Water Resources
NGO	Non Governmental Organization
O&M	Operation and Maintenance
PTA	Parent Teachers Association
RC	Reinforced Concrete
UNICEF	United Nations Children Fund
VIP	Ventilated Improved Pit
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization

Preface

Water supply, sanitation and hygiene – or more simply, 'WASH', are prerequisites of an effective education. Without adequate WASH facilities, not only des the quality of education suffer, but some students, especially girls, may be discouraged from attending school at all. Equally, there is a wealth of evidence that tells us that with adequate, child friendly facilities and effective hygiene promotion, school enrolment and retention will benefit, together with the quality of education received.

Whatever the theory, it is clear that we must design and build – and then maintain – more appropriate facilities. Above all, these must cater to the specific needs of school boys and girls – and they must also be cost effective, easy to clean with limited water – and safe to use. To avoid costly mistakes, this school WASH manual, developed with the three 'WASH Ministries – Education, Health and Water Resources – and numerous other stakeholders including school children themselves – is very much needed.

The designs set out in this manual are not prescriptive. Instead they serve as a well informed guide that will help ensure an appropriate, child-friendly product. The designs are intended to augment rather than replace sound engineering judgment which are made on a site specific, case by case basis. Furthermore, if at all possible, the design and construction of school WASH facilities should be seen as part of a broader school development plan.

All users of this manual should respect the fact that all local, state and federal codes and regulations wherever applicable must be satisfied on all projects. In the event that these standards differ from state or federal requirements, the more restrictive and minimum standard shall apply.

Finally, no manual can retain its value without being periodically reviewed and updated if need be. The Ministry of Education will lead this process and ensure that the manual is so improved over the years, with the aim of achieving universal access to WASH facilities in all of the countries schools.

TABLE OF CONTENTS

Section 1: Introduction

1.1 School Water Supply, Sanitation & Hygiene is a Priority

Water supply and sanitation facilities in schools, coupled with the promotion of hygiene, have a great influence on the quality of education received by school children, especially girls. This rule is supported by a mass of evidence from around the world. It only holds true, however, if the facilities provided are appropriately designed, well built, and are coupled with an effective management system. Above all, the facilities provided must be 'Child Friendly' - easy for a child to use, and providing a clean, safe and secure environment.

The reality for many primary school children in Ethiopia is quite different. There are two problems. First, many primary schools, about 30% in fact, do not have any toilet. Second, very few school toilets are well designed and well managed. Many are abandoned – a colossal waste of scarce resources.

One problem is that many school toilets are filthy. In some cases, there are not enough toilets for the number of students. Others cannot be emptied without demolishing most of the superstructure. The result is full and overflowing pits. Hand washing facilities are rare, even if there is water in the school. Some toilets are so dark inside that younger students are too scared to enter. In some cases, girls do not want to use the toilets because they do not provide the level of privacy and security they need. And in many cases, the toilets are locked to avoid having to keep them clean (Figure 1).

Figure 1: The locked School Toilet

The poor status of water supply, sanitation and hygiene (WASH) in most Ethiopian primary schools makes it very difficult for all students, girls in particular, to get the quality of education they deserve in a safe and conducive environment, irrespective of their right to education.

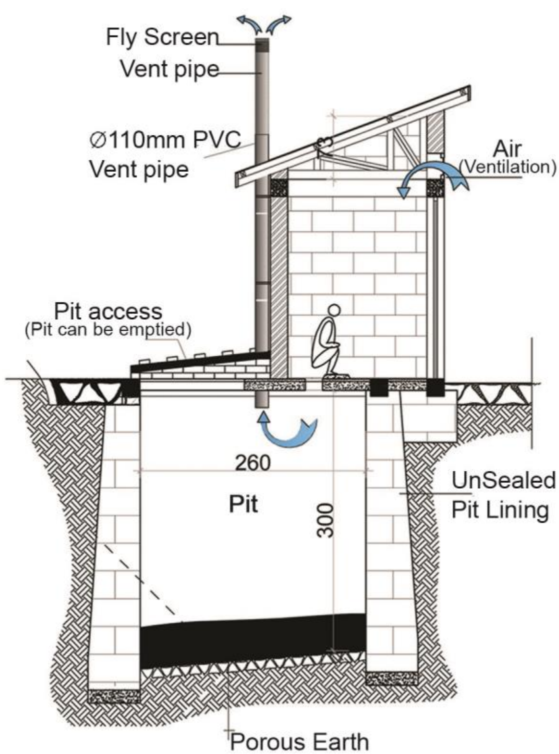
Improving this situation requires, above all, that school water supply and sanitation facilities are well managed, and linked to hygiene education and promotion. But it is also essential that the facilities are well designed and well constructed in the first place. This is why the manual is so important.

1.2 The Scope of this Manual

This manual is intended to provide all those involved in the design and construction of sanitary facilities (toilets, urinals and hand washing facilities: with practical guidance on how to get it right. The overall focus is on primary schools; secondary schools in general are much better off in terms of access to water supply and sanitation.

The manual focuses on a tried and tested technical solution: dry, on-site sanitation. This takes the form of a ventilated pit (VIP) latrine. Water flushed systems, involving a septic tank or connection to a sewerage system, are not considered. This is because the manual focuses on rural schools, where the need is greatest and reliable access to water often a problem. At the same time, the VIP design is very useful in an urban context in which a regular water supply cannot be assured. A water flushed school toilet with no water will cease to function within hours. The result at best is inconvenience, at worst as serious health risk.

Figure 2 : Section of a 'deep pit' VIP latrine



Two types of VIP design are presented: a conventional deep pit design and an alternating shallow pit design. The second type features a relatively shallow pit, making this more useful in areas where excavation is difficult due to hard rock, collapsing soils or a high water table. The alternating shallow pit design is also very useful when the composted contents of the pit are to be used as a fertilizer or soil conditioner.

This manual is not just about toilets. These are only one important part of a system. The manual also covers urinals, which reduce the numbers of toilet cubicles needed; hand washing facilities and drainage.

More sophisticated water flushed toilet designs have not been considered here because their operation depends on a reliable water supply, difficult to guarantee in most rural settings, and adequate drainage. Also, the manual focuses on sanitation facilities rather than school water supply, although water supply options are summarized. The design of a school drinking water fountain is also provided.

Extending the scope of this manual to include more sanitation options, and details of rain water harvesting and water re-use is planned for a second volume.

Finally, whilst this is a design and construction manual, the management of school WASH facilities is also critical if we are to have a positive impact on absenteeism, retention and the quality of education received. Whilst one section of this manual introduces the management of school WASH facilities, this important subject is covered in much more depth in a separate guideline.

1.3 Structure of this Manual

The manual is divided into twelve sections, this introduction being the first. This is followed by **Section 2**, focusing on the 'child friendly' principles that underpin all effective school WASH interventions.

Section 3: revisits the basic toilet design that forms the core of this manual – the VIP latrine, and how it should be applied in a school environment. Whilst many sanitary engineers will be familiar with the VIP, it is clear from field visits that some revision of the basics is needed.

Section 4: concerns the initial steps in designing a VIP based school sanitation system – describing how to get the number, location, and orientation of facilities right. This aspect of design is often overlooked by school authorities and engineers alike. Too often, we find that an otherwise well designed toilet block is not used because it is not in the right place!

Section 5: focuses on the detailed design of a conventional deep pit VIP school toilet, from excavating the pit to fitting the fly screen on the vent pipe. The detailed design, including engineering drawings and a Bill of Quantities for a 'four seat' block has been included in Section 12.

Section 6: focuses on an alternating shallow pit design. Detailed designs are also included in Section 12. This type of toilet is very useful when excavating a deep (3 meter plus) pit will be a problem, for example, because of hard rock, unstable sand or a high water table. The shallow pit design also facilitates pit emptying, and the composted faeces can be uses as a fertilizer or soil conditioner. Certainly, if the school wants to grow a cash crop to supplement its funds, this design can really help.

Section 7: concerns the urinal – an often overlooked aspect of a school WASH system. One well designed urinal can reduce the number of toilet stands needed by a third substantially reducing costs. Whilst the design includes a soak pit, we recommend that urine be used as a valuable nitrogen rich fertilizer to boost school income.

Section 8: is all about hand-washing. Ensuring that students have appropriate facilities to wash their hands – and for girls to wash and dry their menstrual cloths with an appropriate degree of privacy – is essential. The practice of hand-washing with soap after visiting the toilet is in fact one of the most effective public health interventions there is. Instilling this behavior in the school – helped by appropriate, easy to use hand washing facilities – is the core of any school hygiene education programme.

Section 9: deals with how best to manage waste water from urinals and pits, and grey water from hand-washing stands. In this manual we describe infiltration pits and trenches. Whilst we support the use of urine and water as a fertilizer, details of how to do this are included in the planned second volume to this manual.

Section 10: summarises a number of school water supply options. In fact, the designs and related technical advice is relatively available from the Woreda Water Office or Regional water Bureau. The detailed design of a basic 'child friendly' drinking water fountain has however been included, as this is different to an equivalent structure designed for fully grown adults.

Section 11: concerns the management of school WASH facilities. As this is a design and construction manual, only a summary of this very important subject is presented, including a number of important principles that must be respected in order to ensure that the facilities build are both used and maintained. School WASH management is so important that it is the subject of a separate guideline.

Finally, detailed designs and Bills of Quantity are presented in **Section 12.** The designs are sufficient to build the structures described in the text, including a four stand deep pit and four stand alternating pit VIP toilet. In practice, an engineer or technician should use these designs and the text to compile a set of site specific working drawings.

Section 2: Child Friendly Principles

Before going into any detail concerning the layout, orientation, design or construction of school sanitation facilities, it is very important to understand the special context in which these are to be used. This is after all a school environment populated in the main by children. And children are not just small adults. Children have specific perceptions and needs. These must be taken into account from the outset.

Neither are all children the same. In particular, we have to consider and differentiate between the different needs of girls and boys, of short children and tall children, of able bodied children and disabled children, of pre-adolescent and adolescent children. For many engineers, used to designing and building for adults, this is a challenge.

To help, here are some *Child Friendly* principles which are central to the design and construction of School WASH Facilities.

Box 1: Child Friendly Principles

1. Girls and boys should be consulted about the number, location, orientation and design of school WASH facilities. This consultation should be organized with girls and boys separately, discussions facilitated by women and men respectively.

2. The numbers of toilets should be sufficient to ensure that students do not have to wait in a queue to use the toilet for anything more than a few minutes. Urinals can help reduce load on the toilets at peak times. Equally, the school administration should arrange and if necessary stagger school breaks to avoid overloading

3. WASH structures in schools must be physically safe for users to use - in terms of the structural stability; in terms of a child not being able to fall through an oversized drop hole; in terms of children not risking abuse, bullying or attack when approaching, using or leaving the facilities provided

4. Physically separate facilities must be provided for girls and boys, spaced sufficiently apart to ensure that girls do not feel embarrassed but secure when approaching and using the facilities. Separate hand-washing areas should also be provided, affording privacy for girls who may need to wash and dry menstrual cloths.

5. The orientation of facilities – specifically the direction that the toilet entrance faces, must also take into account the perceived security and safety of girls. The orientation of the squatting plate should also take into account cultural and religious norms

6. The location of toilets needs special consideration. Too close, and users may feel embossed as peers can see them from the class room; the smell from the vent pipe may be offensive. Too far, and it may take too long to get to the toilet for a child with a small bladder. Remote toilets are often neglected, and may be perceived as unsafe.

7. The detailed design of the facilities provided must also be child friendly. Steps must be easy to climb. Door handles must be easy to reach. The toilet interior cannot be too dark. Squatting plates must be designed to accommodate a child's feet rather than those of an adult.

8. Hand-washing facilities must be provided in each toilet block, together with water and soap. The hand-washing stand must be sized to facilitate its use by smaller as well as larger children. The facility must provide an acceptable degree of privacy for girls. The design must facilitate the filling of water containers by children

9. Facilities provided must include provision for disabled children, with at least one toilet cubicle for girls and one for boys modified accordingly. In terms of design, ramps and hand rails should be provided, with more internal space for a caregiver to assist if necessary. Disabled girls and boys should be consulted with their able bodied peers to get the design right.

10. WASH facilities and related practices should be designed to encourage children to understand their environment and conserve scarce resources, especially water resources. With the right technology and safe supervision, urine, waste water and composted faecal matter from toilet pits can be reused to support agricultural production and boost the school's budget.

Section 3: VIP Refresher

In terms of the toilet itself, this manual focuses on a simple, tried and tested design – the Ventilated Improved Pit or VIP. This is because VIP toilets are relatively simple to design, build and maintain. Their operation and cleaning uses relatively little water; certainly they do not depend on a regular water supply. The design can be adapted for different circumstances. And the resulting toilet can be relatively low cost. For almost all conditions in rural areas, VIP technology can be used. As set out in the introduction, the technology has merit in many urban settings where a reliable water supply cannot be guaranteed.

Having said this, it is still possible to get it wrong. A VIP without a well sited vent pipe, a fly screen or adequate ventilation will not work. The pit has to be the right size. The interior may be too light (as explained, too dark may be a problem for children as well). All these problems can be seen in the field. Why - because the designer or builder has not remembered how the basic VIP works.

3.1 The Basic VIP: How it Works

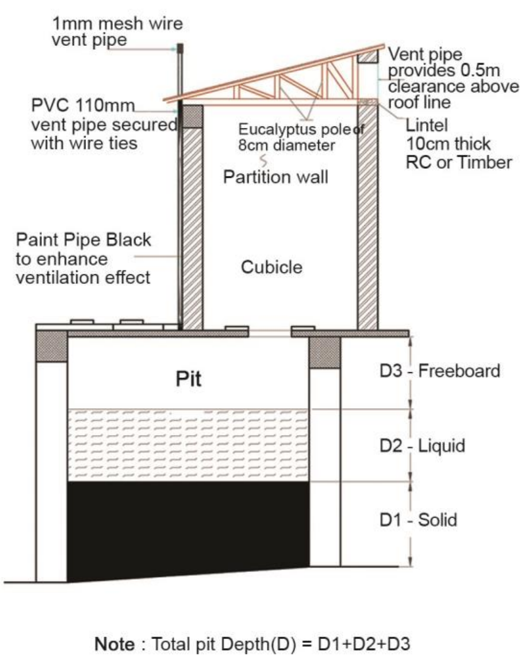


Figure 3 : The basic VIP Latrine

Like a simple pit, the basic VIP separates humans from excreta (urine and feaces), which fall into a pit through a drop hole. Liquid leaches through the pit walls, and solid material breaks down. Unlike a simple pit design, however, the VIP has two critical features which make it safer and less smelly.

Firstly, the vent pipe causes an updraft that draws fumes up from the pit. The effect is more pronounced when wind passes over the top of the pipe, so it should extend about the roof line. As air is drawn out of the pit, it is replaced from air from the cubicle – which is effectively ventilated. Air vents must be built in to the cubicle to ensure that fresh air gets in, typically above and below the door. As simple smoke test can be used to see how the air flows - drop some smoking grass down the pit and see what happens.

Secondly, whilst flies can enter the pit through the drop hole, and breed there, they cannot escape, as they are attached to the sunlight at the top of the vent pipe. This is brighter than the light entering the pipe from the drop hole. Escape from the vent pipe is prevented by a wire mesh – they fall back and die in the pit. If the interior of the cubicle is too light, flies would indeed fly up through the drop hole and out, carrying faeces with them. If the cubicle is too dark, children will be scared to use it, so the right balance has to be found.

3.2 What Can Go Wrong?

Basic problems encountered with the execution of this simple design include:

- The pit is too small, insufficient for the number of users, so it fills up to quickly and need emptying after only a few years
- The pit cannot be easily emptied, so the only option remaining is to seal it off and build a new toilet elsewhere
- The pit is not lined, the soil cannot take the weight of the superstructure, and the toilet superstructure collapses into the pit
- The pit walls are fully sealed – there is no provision for leaching liquid mater into the surrounding soil, as a result, the pit floods;
- Waste water is diverted into the pit, more than can be absorbed by the soil, so the pit floods.
- After excavating a hole, a single massive pit is built, rather than a number of individual pits separated by partitioning. This may save on pit lining materials, but it makes covering the pit with a slab more difficult and expensive, and significantly reduces the ventilation effect.
- The vent pipe is missing, or its diameter is too small. The pit is effectively unventilated and the toilet is very smelly. Alternatively, the vent pipe may be too short, so it does not protrude above the roof line, reducing the ventilation effect.
- No provision is made for air to get into the cubicle – again, there can be no air flow through the cubicle, which is smelly as a result.
- The fly screen is missing – so the toilet becomes a source of flies, potentially spreading disease
- The vent pipe is poorly located in the corner of the cover slab, or connected with an elbow - so little or no light penetrates the pit through the pipe. As a result, flies escape through the drop hole
- The cubicle is too bright – so flies are attached to the drop hole and make there escape. Alternatively, if the cubicle is too dark, kids are too scared to use it. A bal ance has to be found.

All these issues are reflected in the Sections of this manual that detail the design and construction of the school toilet itself. Understanding how a VIP works is however essential to ensure that these common problems do not occur!

Section 4: Numbers, Location and Orientation

So far, this manual has only described the basics that underpin school WASH. From here onwards, the manual gets technical. Before getting into detailed design, however, we have to decide how many toilets are needed, where these should be placed, together with other facilities, and how they should be orientated – in particular, the location of entrances / exits.

Box 2: Relevant Principles

Girls and boys should be consulted about the number, location and orientation of school WASH facilities. This consultation should be organized with girls and boys separately, discussion facilitated by women and men respectively.

Physically separate facilities must be provided for girls and boys, spaced apart to ensure that girls do not feel embarrassed but secure when approaching and using the facilities. Separate hand-washing areas should also be provided, affording privacy for girls who may need to wash and dry menstrual cloths.

The orientation of facilities – for example, the direction that the toilet entrance faces, must also take into account the perceived security and safety of girls. The orientation of the squatting plate should also take this into account, as well as cultural and religious norms

The location of toilets needs special consideration. Too close, and users may feel embossed as peers can see them from the class room; the smell from the vent pipe may be offensive. Too far, and it may take too long to get to the toilet for a child with a small bladder. Remote toilets are often neglected, and may be perceived as unsafe by both boys and girls.

4.1 Numbers

Number in this case refers to the number of toilet stands (toilet cubicles) that are needed. The current Government norm is that applies to primary schools in Ethiopia is one stand for every 100 girls and one stand for every 150 boys, with physically separate facilities for girls and boys (Sanitation protocol, FMoH, 2005). In other African countries, design ratios of 1:50 – 1:100 are common, but these standards are not always met due to resource constraints. This is also the case in much of rural Ethiopia, where the 'on the ground' average is one stand per 200 students or more.

The use of appropriately designed urinals for both girls and boys reduces the number of toilets stands needed by one third or more. This approach should be standardized in Ethiopia as it significantly reduces construction costs.

In determining the number and location of toilet stands needed, planners (engineers and school authorities) should take into account the projected population of the school, with a recommended planning horizon of 3-5 years. Most primary schools in Ethiopia start off relatively 'small' with 250-300 students, and develop over time to around 600-750 students.

The following table (Table 1) indicates the number of toilet stands required for schools of different sizes. It is based on a 1:100 toilet stand - student ratio, *with both girl and boys having access to appropriate urinals.* The minimum number of stands for both boys and girls is two, ensuring a degree of 'emergency' capacity.

One important point is that the toilets provided are used by students and staff alike, with no separate facilities for teachers. This is not just a cost-saving measure. Teaching staff have an important role play in encouraging the proper use of school toilets and ensuring their upkeep. Having separate facilities for staff may undermine this responsibility.

No of Boys	Min. No. of Stands	No of Girls Min.	No. of Stands
Up to 100	2	Up to 100	2
100-200	2	100-200	2
200-300	3	200-300	3
300-400	4	300-400	4
400- 500	5	400- 500	5
500-600	6	500-600	6

Table 1: Numbers of students, number of stands

These figures show the minimum number of toilet stands required. If resources allow, adopting a 1:50 toilet stand / student ratio is preferred, reducing pressure on toilets, increasing their fill up time, and making their upkeep easier to manage.

4.2 Location

Many schools were visited during the preparation of this manual. A common problem encountered concerned the location of school toilet blocks in relation to the classroom and boundary wall. The relative location of boys and girls toilets (basically, the distance between them) is also very important.

Getting the location right is very important factor in ensuring that toilets are used. In line with the principles listed earlier, girls and boy students must be consulted. This consultation should be undertaken separately, the girl group led by a woman, the boys group led by a male (here it makes sense to enlist the help of teachers).

Factors to consider in locating toilet blocks are set out in the following table. Inevitably, with all these factors to consider, the location of school toilets is going to be a compromise. This reinforces the necessity of consultation, with school girls and boys and their teachers. Drilling a test hole with an auger (or digging a test pit if this is not available) to see what lies underneath the surface can save considerable amount of time and money.

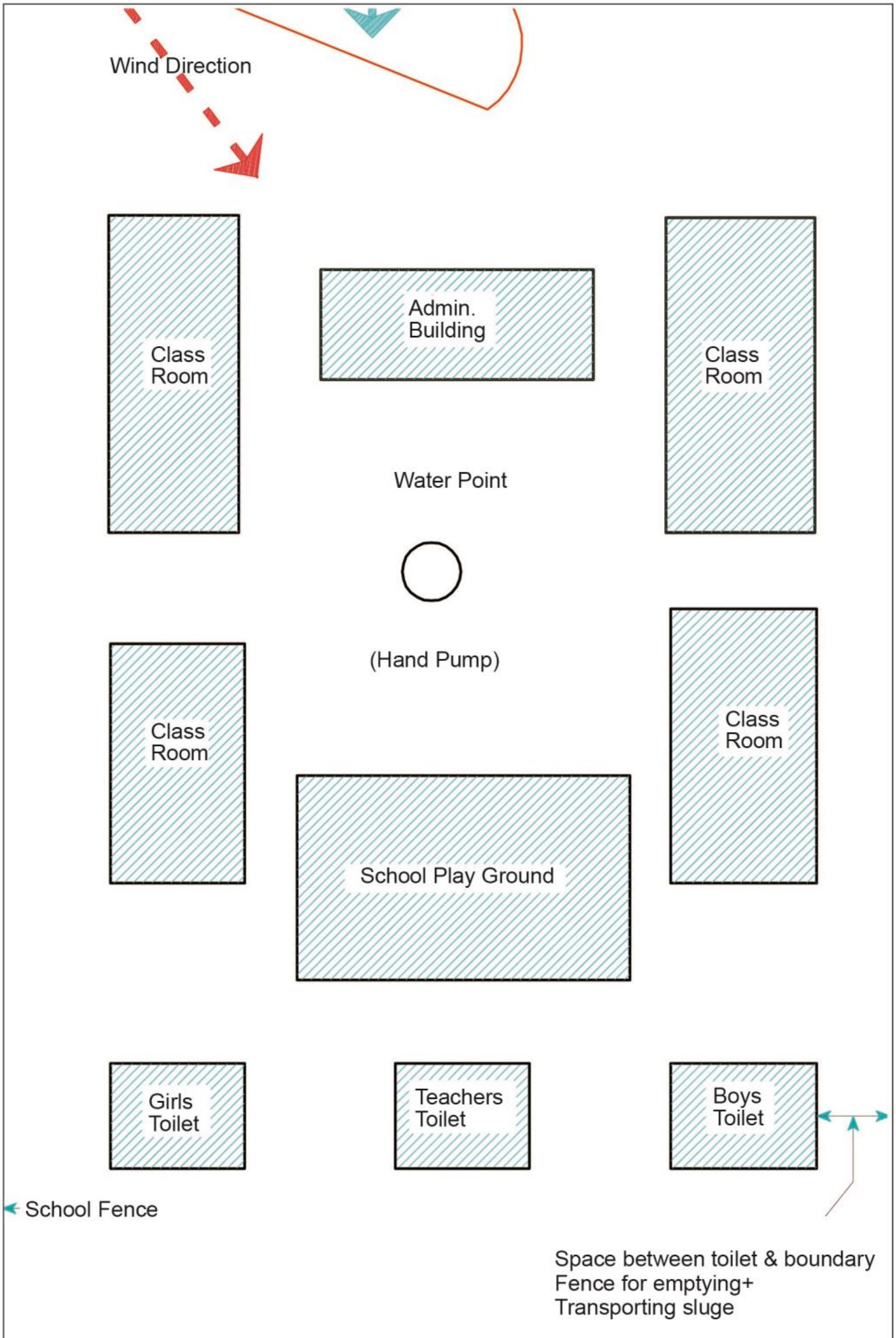
Factor Check	Check
The normal wind direction – it is best if the toilet's vent pipes are down- wind of the classrooms	✓
The distance from the toilet block to the class – between 30 and 50 metres if possible. More than 50 meters may be too far for a small child in a desperate hurry, and in terms of toilet management and upkeep, its best to keep the toilet nearer rather than far from the classroom	✓
The distance to the boundary wall – if the toilet is placed on the boundary, there may be a risk of students extending their trip to the toilet to a trip outside the school. Equally, girls in particular may feel insecure – here its best to get their opinion	✓
The need to empty toilet pits when they are full. If the sludge or compost is to be picked up by a tractor-trailer, then there needs to be enough space for vehicle access.	✓
The distance between the boys' and girls' toilets. Again, this is best fixed with consultation. 15 meters or more may be needed to secure the privacy and security needed by girls. It is also important to get the relative orientation of girls and boys toilets blocks right – see below	✓
The distance to a well or borehole – a minimum of 30 metres is recommended to avoid any risk of contamination	✓
Future plans to expand the school	✓
Soil conditions – avoiding rocky outcrops, unstable ground conditions and depressions with a shallow water table. Here a small earth auger can be used to test ground conditions if there is any doubt	✓
Drainage – ensuring that rain water does not flood the pit	✓

Table 2: Location Checklist

4.3 Orientation

Other than location, it is very important to get the orientation of the toilet blocks right as well. Social and cultural considerations are paramount – so again, it's important to consult with boys and girls. In particular, this concerns the direction the toilets (and here we mean the toilets' entrance) faces. For example, if the entrance of a girl's toilet is opposite a classroom or the entrance to the boys' toilet, girls may not want to use it. Alternatively, if the entrance faces a nearby boundary wall, boys and girls may feel insecure for another set of reasons. Orientation, like location, is case specific, but consultation is critical to encourage rather than discourage the use of toilets.

Figure 4 shows one possible layout of school WASH facilities. There is no blueprint, but the changes of the toilets being used are much higher if the guidance set out above is followed. Inside the toilet block, the orientation of the squatting slab is also important, for example, respecting religious norms. This issue is dealt with later.



Note : School Toilet includes Urinals +hand washing facilities

Figure 4 : Possible layout of School Sanitation Facilities

Section 5: 'Deep pit' VIP School Toilet

Having looked at numbers, location and orientation, this section focuses on the design and construction of what is the most common and probably most useful school toilet type, the conventional VIP deep pit. Although this toilet is relatively common, so are mistakes associated with its design and construction. Many of these are fundamental (see Section 3: What can go wrong?). Other problems concern detail, for example, ensuring adequate ventilation, or the detailed design or finishing of the squatting plate.

Box 3: Key Principles

WASH structures in schools must be safe for users to use - in terms of the structural stability; in terms of a child not being able to fall through an oversized drop hole; in terms of children not risking abuse, bullying or attack when approaching, using or leaving the facilities provided

The detailed design of the toilet must be child friendly. Steps must be easy to climb. Door handles must be easy to reach. The toilet interior cannot be too dark. Squatting plates must be designed to accommodate a child's feet rather than those of an adult. Surfaces must be easy to clean. The drop hole must be correctly sized. Too large, it may be unsafe. Too small, cleaning will be needed after every visit. Ventilation is important to minimize any smell.

Facilities provided must include provision for disabled children, with at least one cubicle for girls and one for boys arranged accordingly. In terms of design, ramps and hand rails should be provided, with more internal space for a caregiver to assist if necessary. Disabled girls and boys should be consulted with their able bodied peers to get the design right.

5.1 Sizing the Pit

The heart of a pit latrine is its superstructure – the bit that's under the ground. It is critical to get this bit right, as any mistake may be impossible, or very expensive – to fix when the superstructure, the above ground part of the toilet, is finished. In particular, the pit has to be the right shape and size. Too small, it will full up too quickly; too big, and the cost of excavation and construction will be prohibitive.

It is important that designers, builders and the school authorities understand how the pit size is calculated. This is set out in Box 1 below. The calculation is relatively simple, and is based on a number of tried and tested assumptions. A different set of assumptions are used in the design of an alternating twin pit toilet (see Section 6).

The basic assumptions used here are:

1. The toilet is designed for 100 students per toilet stand (each with its own pit underneath) – taking into account the associated use of urinals
2. The toilet is designed for a minimum five year fill time
3. The school is open for 200 days a year
4. The pit area under each stand is set at 1.1 meters wide, 2.6 meters long
5. The average volume of excreta amounts to 25 liters per child per year, measured over the five years. This allows for (i) materials used for anal cleansing (ii) volume reduction due to decomposition over the 5 year period and (iii) the fact that the child will also defecate at or near home, either before or after the school day[1]
6. The average volume of fluid entering the toilet (urine and cleaning water) is 1 liter per child per day, of which 50% evaporates or percolates through the bottom of the pit
7. The infiltration rate of the soil is assumed to be 25 l / m^2 squared (this being side wall area) per day – equivalent to a sandy loam soil (See section 7). Soils with more clay will need connection to a soak pit or infiltration trench

Based on these assumptions the depth of the pit can be calculated (Box 4). The total pit depth 'D' required has to allow for (i) containment of accumulated solids, D1; (ii) the infiltration of liquid through side walls D2 and (iii) a reasonable free space (freeboard) beneath the toilet squatting plate, D3, 0.5 metres being used here. The total pit depth H is the sum of D1, D2 and D3 (Figure 5).

Box 4: Calculating Pit Depth 'D'

Solids

A. In one full year, volume of sludge = 100 students x 25 litres = 2,500 litres
B. In 5 school years, volume of sludge = 5 x 2,500 x (200/365) = 6,850 litres
C. Assumed pit area of 1.2 x 2.6 metres = 3.12 m^2
D. Resulting depth of sludge (D1) = 6,850 / 3.12 = **2.195 metres**

[1] *Compare this to a figure of 20-60 litres per adult per year (Franceys et al, 1992) – details in Section 12.*

Liquids

A. In one day, amount of liquid entering the pit is 1 litre per student = 100 litres. Of this, 50% is lost by evaporation and deep percolation, leaving 50 litres

B. Assumed infiltration rate of soil: 25 l / m2 / day

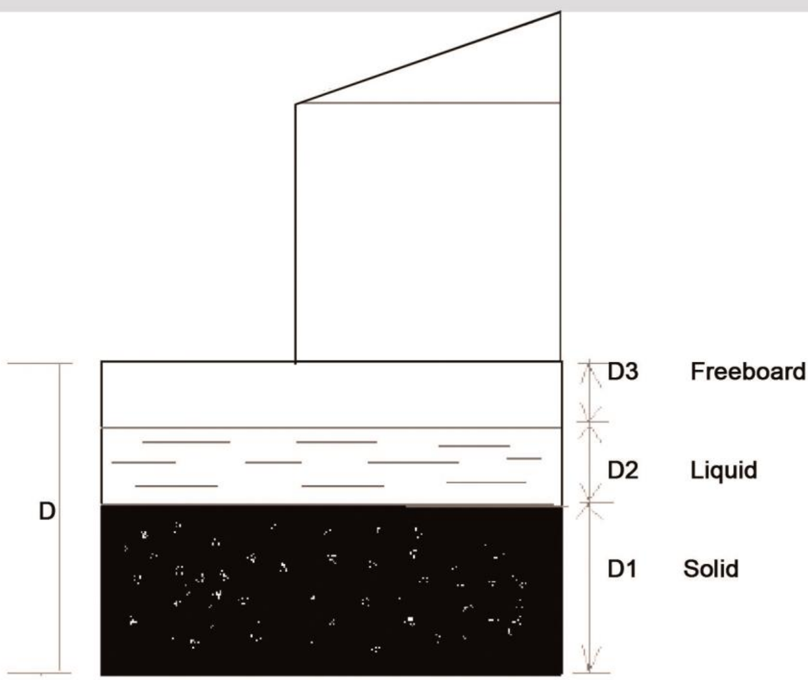
C. Wall area need to infiltrate liquid = 2 m2

D. Additional depth of pit needed to infiltrate liquid (H2) = 4 / (1.2+1.2+2.6+2.6)
D2 = **0.26 metres**

Freeboard

A. Additional safe space above solid and liquid below the slab: Minimum Freeboard (D3) = **0.5 metres** (given)

Total Depth of Pit (D) = 2.195 + 0.26+ 0.5 = 2.955 (rounded up to 3m)



Total Pit Depth (D) = D1 + D2 + D3

Figure 5 : Determining Pit Depth 'D'

The depth of pit needed is therefore just over 3 metres for a five year fill time. Further deepening the pit will add to the fill time as set out below in Table 3, but it also adds significantly to the difficulty and cost of excavation – as well as the risk of collapse to the laborers excavating the pit and the risks on contaminating shallow ground water.

Pit Depth	Fill Time
3 metres	5 years
4 metres	7.5 years
5 metres	10 years

Table 3: Pit Depth versus Fill Time

Ground water contamination is a potential health threat if the bottom of the pit is within two meters of the ground water table. To be safe, the toilet pits should not be located with 30 metres of any water source drawing ground water (such as a hand dug well).

If the soil in which the pit is being sunk has a lot of clay in it, then there may be a problem with its capacity to infiltrate liquid (urine and water for cleaning). In this situation, a 75 or 110 mm diameter overflow pipe should be included in the pit design, ensuring that excess liquid is drained to a soak pit or infiltration trench adjacent to the toilet.

In terms of excavation, the 'standard pit' should be three meters deep. The pit width is set at 3 metres, enough to ensure an internal width of 2.6 meters after lining. The pit length is of course variable, determined by the number and width of the toilet stands needed, and the width of the blocks used to line it. The urine and waste water drains into a physically separate soak pit or infiltration trench at least 5 meters away.

The minimum dimensions of the excavated pit, in this case sized for a 4 stand (i.e. a 4 partition or cubicle) toilet, are shown below in Figure 6. This information is summarized in Table 4, which includes basic pit dimensions for 2, 3, 5, and 6 stand designs.

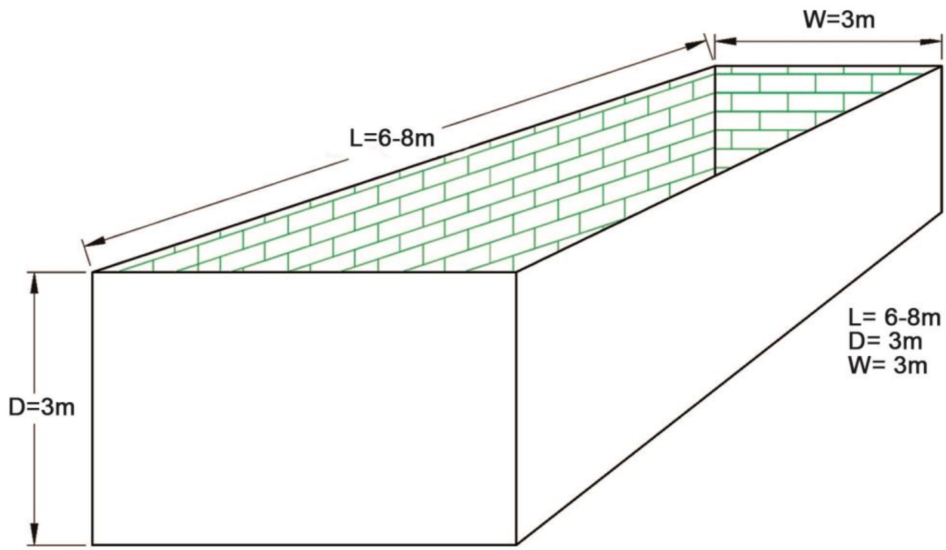


Figure 6 : Minimum Pit Dimensions for 4 stand deep pit toilet

Configuration	Excavated Length m	Excavated Width m	Excavated Depth m
2 stand	3.8	3	3
3 stand	5.3	3	3
4 stand	6.8	3	3
5 stand	8.3	3	3
6 stand	9.8	3	3

Table 4: Minimum Pit Dimensions (excavated size) for different toilet configurations. Note that space limitations normally prevent extension beyond a 6 stand design

Digging a pit of this size can be tricky, even dangerous, and the following box outlines some simple precautions that should be observed (Box 5).

Box 5: Safe Excavation

Excavating a three metre deep pit in any circumstances is a risky business. Above all, in unstable soils, the sides of the pit have to be sloped towards the bottom with an angle of 40 degrees or less – the natural 'angle of repose' of the soil. This means more time and more effort. Alternatively, shutter can be used, but this is often difficult to find or fabricate in rural areas, and complicates lining the pit.

In these circumstances, it may be better to change design to an alternating pit toilet – see Section Six. This features a relatively shallow pit only 1.5 meters deep. Even digging this may be dangerous if the sides collapse.

It is also important that those excavating the pit wear hard hats to protect them from falling objects, and safety glasses if they are breaking rock.

In a school environment, it is also important to ensure that children do not risk falling in the pit. The construction site should be fenced off, and children should be told not to approach because of the risks involved unless the visit is supervised. Once the day's work has ended, or before it has begun, a guard should be posted until all children have left the school.

The bottom of the pit should be sloped with a 10 - 20 cm (5-10%) fall towards its back wall. This is to help distribute excreta evenly and fill the pit efficiently.

Once the pit is excavated, the next step is to line it. ALL SCHOOL TOILET PITS MUST BE FULLY LINED REGARDLESS OF THE SOIL TYPE. This is because the toilet is designed to last ten years or more, the pit is designed to be emptied every five years or so, and the superstructure itself is heavy and has to be well supported. A school toilet also has to be safe. School toilets with unlined pits are prone to collapse, risking the lives of children using it.

The lining should be stone masonry, concrete hollow block (CHB) or burnt brick, depending on the materials and skills locally available, and the cost. The bottom course should be placed on a 5 cm mass concrete foundation. Ensuring that successive courses remain level and that the walls are vertical is the key to a safe superstructure. If stone masonry is used, the pit wall should be 60cm thick at the bottom, tapering to 40 cm thick at the top.

The lining should include partition walls, so that each toilet stand has its own pit underneath it. The individual partitions (measuring 1.2[2] wide by 2.6 meters long) are needed to ensure effective ventilation, and help stabilize the entire structure. Partition walls are best constructed from burn brick or CHB – masonry partitions would be relatively thick, reducing the pit volume.

[1] *1.5 m wide for disabled access*

It is important to use porous or open block-work or masonry when lining the pit. This allows liquid to infiltrate the pit sides into the surrounding soil, minimizing the risk of flooding. The bottom of the pit is not sealed. The top 50 cms of the lining should be fully sealed, to minimize the problems of flooding and tree roots breaking into the pit. *The partition walls should be fully sealed from top to bottom so that any one individual pit can be emptied.*

Finally, the gap between the pit sides and the lining must be carefully backfilled, ensuring that the soil is properly compacted layer by layer, to prevent voids forming which could later collapse. All these features are important and are shown in Figure 7.

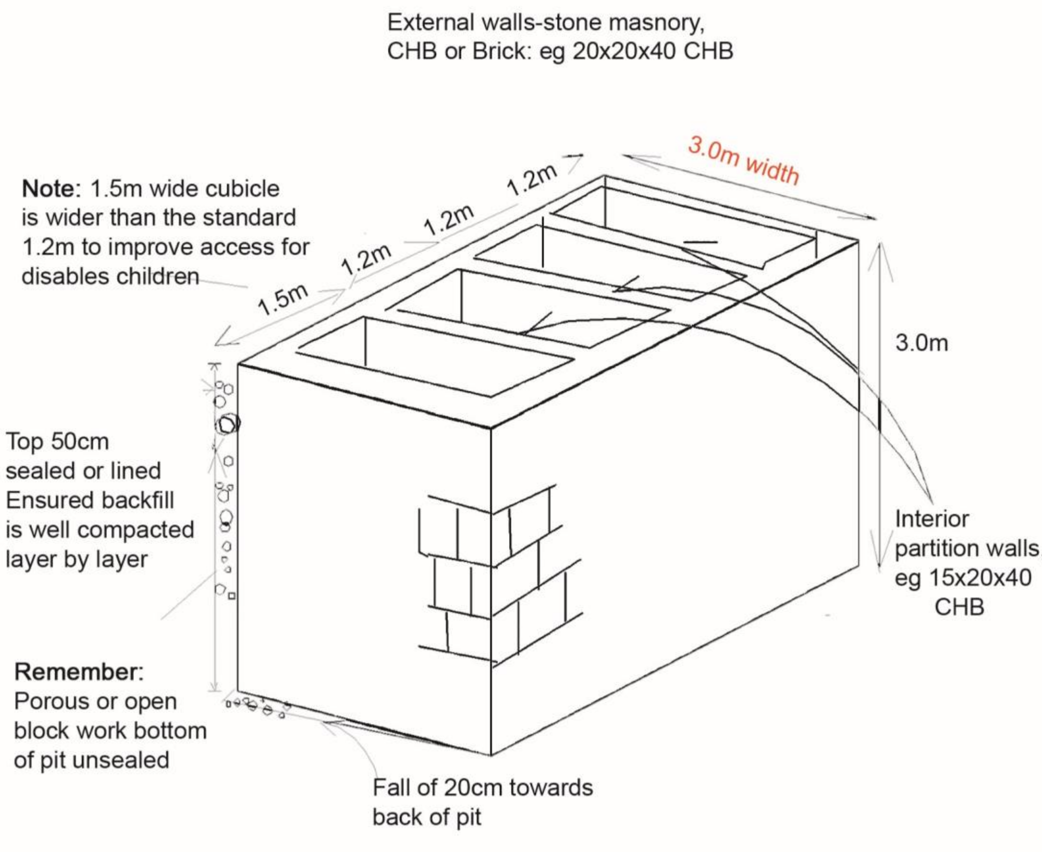


Figure 7 : Details of completed sub-structure, 4 stand deep VIP latrine

5.2 Toilet Superstructure

Grade Beam and Slab

Having completed the substructure, the next stage is to complete the toilet superstructure. This lies on top of the sub-structure. There are two options here, depending if the doors of the toilet cubicles are to open inwards or outwards.

If the doors open inwards, more space is required in the cubicle to allow for it to swing open, leaving space for the user to enter and close the door without tripping up on the squatting plate towards the back of the cubicle. The added length adds to construction costs. The advantage of an in-swinging door is that these are much less vulnerable to wind damage. And a toilet with damaged or missing doors is unlikely to be used.

The alternative is to arrange the doors to open outwards, saving on space, materials and costs, but risking damage to the doors if they are not properly secured.

The design in Section 12 is based on the in-swinging arrangement. The increased length of floor needed is achieved by extending the reinforced concrete grade beam that covers the pit wall by 60 cms to the front of the toilet. The beam, measuring 150 mm thick, provides a stable, level platform on which to lay the floor slab and back panels. The toilet floor is cast on the beam. The offset to the front provides the additional area needed, and ensured that there is still room at the back of the toilet for pit emptying (Figure 8).

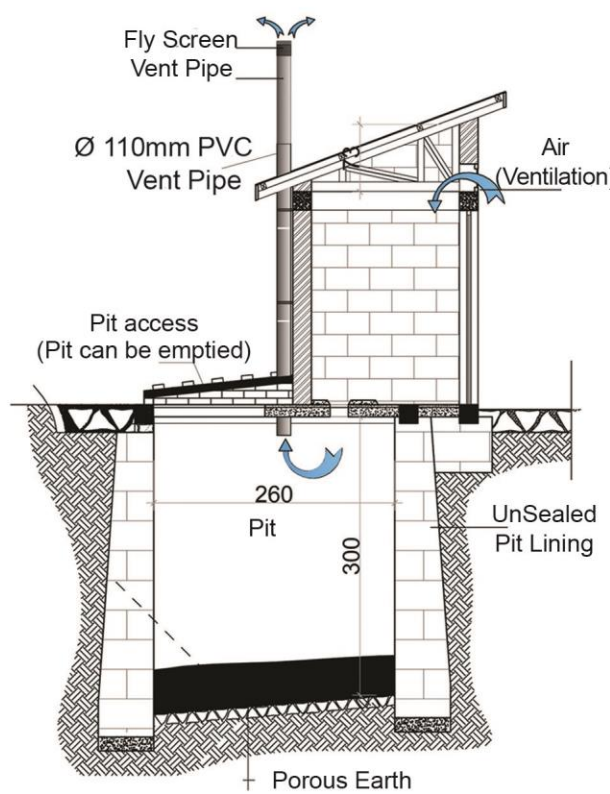
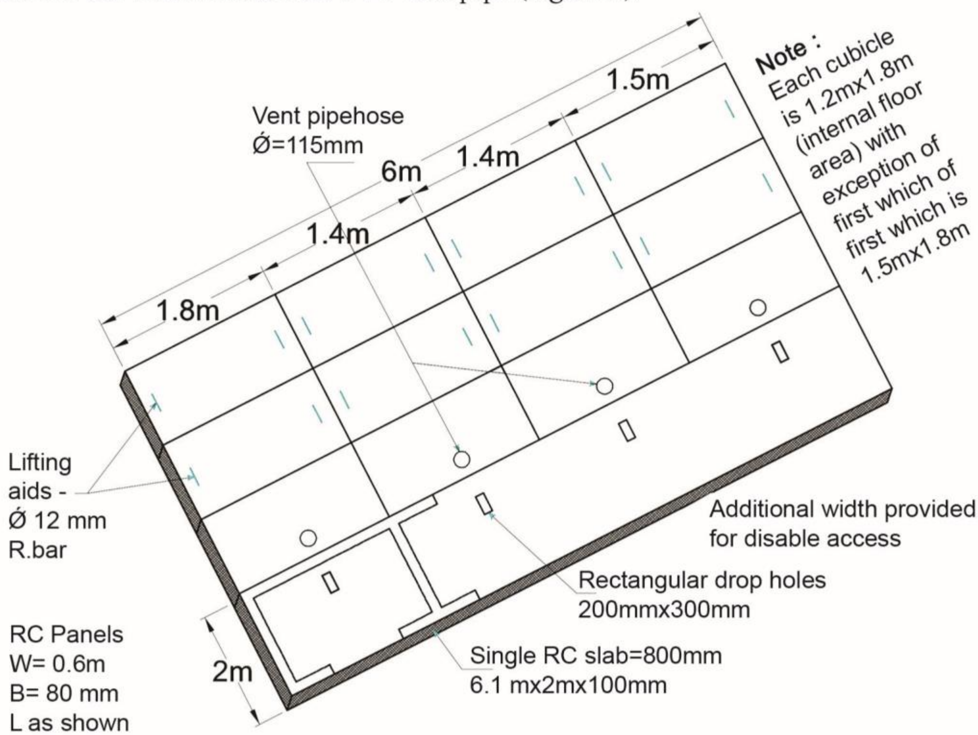


Figure 8 : Showing Superstructure offset (doors open inwards)

There is no need to extend the grade beam over the front of the pit wall if the toilet doors are to open outwards. However, this leaves the doors vulnerable to wind damage. For this reason, the offset is recommended.

A single 100 mm thick RC slab is then cast in situ on top of the forward half of the grade beam to form the toilet floor. 200 mm wide by 300 mm long drop holes should be cast in the slab, one in the centre of each toilet partition. High quality precast sanplats are later mortared over these holes . These have a smaller ergonomically designed drop hole, about 150 mm in width, and 250 mm in length, with a keyhole profile.

The rear 1.8 metres of the pit should be covered with 80 mm thick RC panels (ferro-cement may also be used). Fitted with handles formed from 12mm reinforcing bar, the two panels furthest from the superstructure are removed when the pit contents need leveling or the pit needs emptying. The front-most panel is fixed in place and includes a 115mm hole for the 110mm diameter PVC vent pipe (Figure 9).



Note : Dimensions are for a toilet with inwards opining doors.
For outward opening doors length A is reduced to 1.4m

Figure 9 : Slab arrangement

Superstructure Walls, Partitions and Doors

The standard toilet cubicles have a floor area of 1.2 metres (width) by 1.6 metres (length) if the doors are to open inwards, and 1.2 metres by 1.2 metres if the doors are to open outwards. This is sufficient for able-bodied children to maneuver. The door opening accommodates a standard door 205cm x 70cm, and is completed with a 10 cm thick timber or RC lintel.

Outward opening doors reduce the floor area of the toilet compartments, and so reduces the quantity of materials need to complete the superstructure. However, outward opening doors are much more vulnerable to wind damage, and so the inward opening option is preferred.

In our design, the first cubicle is 1.5 metres wide, allowing more room for manoeuvre for a disabled child, if necessary accompanied by a care giver. At 90 cms, the door is wider as well for the same reasons.

Exterior walls and partitioning can be timber, masonry, burnt brick, stabilised compressed soil brick or concrete hollow block (CHB). The latter come in two sizes; 20x20x40 cm, and 15 x 20 x 40 cm. It is recommended that the smaller size is used for both exterior walls and partitions. 150 x 150 mm RC columns on each corner of the superstructure are desirable for stability, but are not essential. Wire ties in the back wall (every second course) are needed to secure the vent pipe.

The roof, the front sloping down the back, is supported by the block work, and internal timber trusses over each partition wall. Details are provided below.

As already mentioned, doors are an important component of most school toilets, essential to guarantee privacy and security for the user. Treated timber is preferred to steel. A standard 205mm x 70 mm door is recommended, with two or more hinges. The standard door frame measures 210cms high, resulting in a 40 mm air gap underneath the door for ventilation. The end cubicle should include a wider door, 90 cms rather than 70 cms wide (Figure 10), providing more room for a disabled user and caregiver.

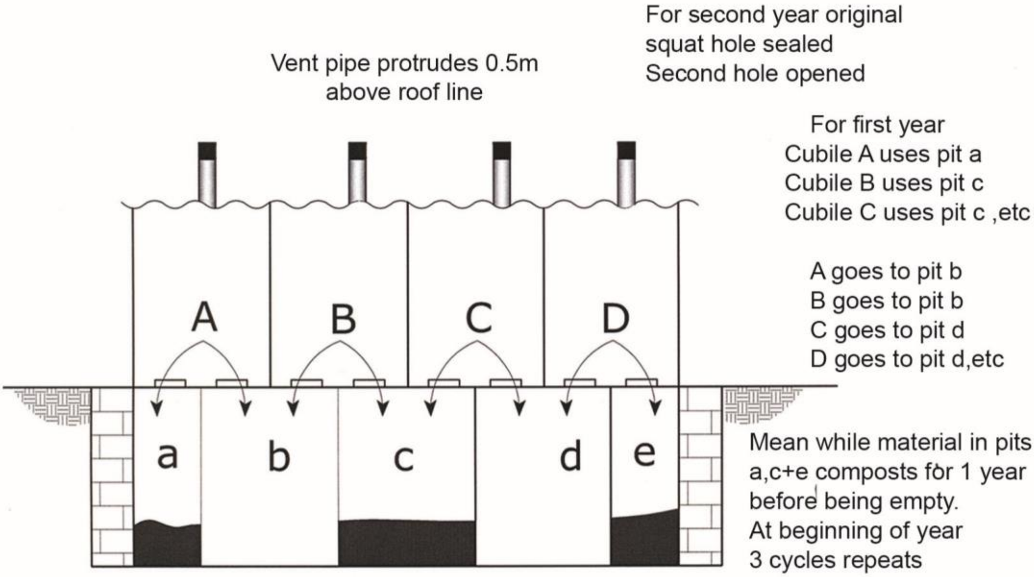


Figure 10 : Superstructure Walls and Doors

A privacy wall, 1.5 meters high is placed 1.4 metres in front of the toilet partitions. The privacy wall in the girl's toilet block is closed at the end of the structure. This provides more security for girls using the urinal, and more privacy for washing (Figure 11). The design of the wall can be made open block, saving blocks, affording limited visibility and making the exterior of the toilet more welcoming. The design and the height of the wall, needs to be finalized with the participation of students, however.

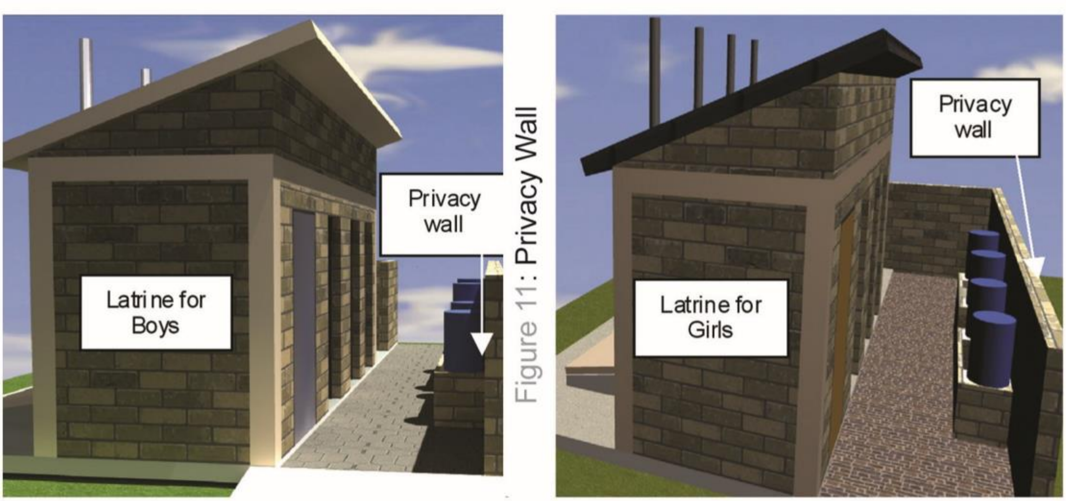


Figure 11: Privacy Wall

Roof and Vent Pipe

The roof, sloping down from front to back, is covered with galvanised Corrugated Iron Sheet (CIS). A minimum 32 guage Corrugated Iron Sheet (CIS) is recommended. Seasoned eucalyptus wood is recommended for the timber frame (see Figure 12), which fastened to the top of the partition walls with 4 mm tie bar. The roof is supported on block-work at each end of the toilet block and over the lintel. Three courses of block work extend from the lintel to the top of the frame above the door, raising the roofline by 70 cms. A 40 cm high, 80 cm wide gap provides additional ventilation and ensures that the toilet partitions are not too dark to discourage their use. The ventilation gap may be completed with a 40 mm square chicken mesh to keep birds out.

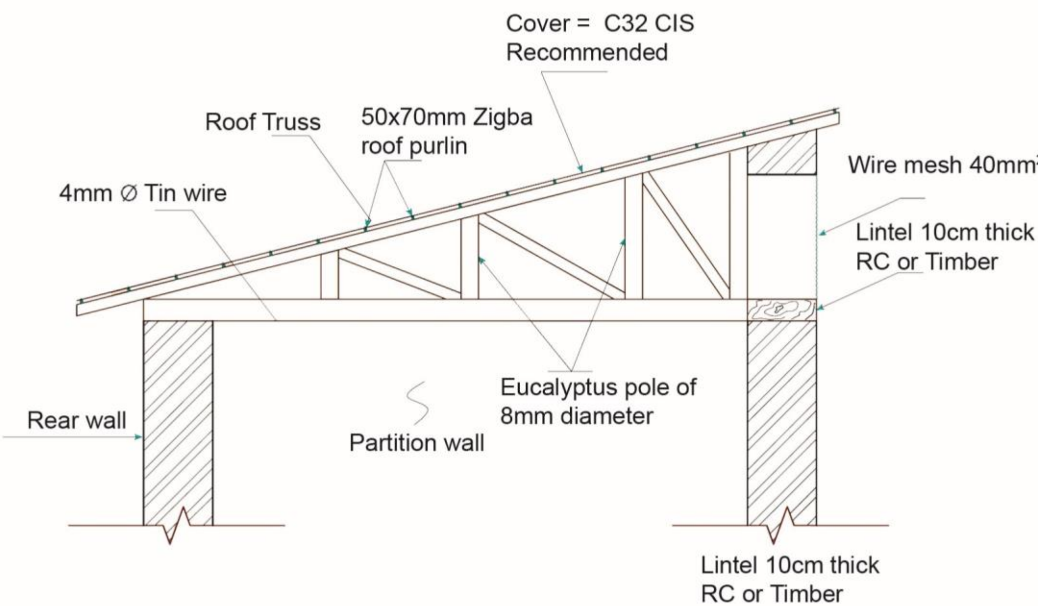
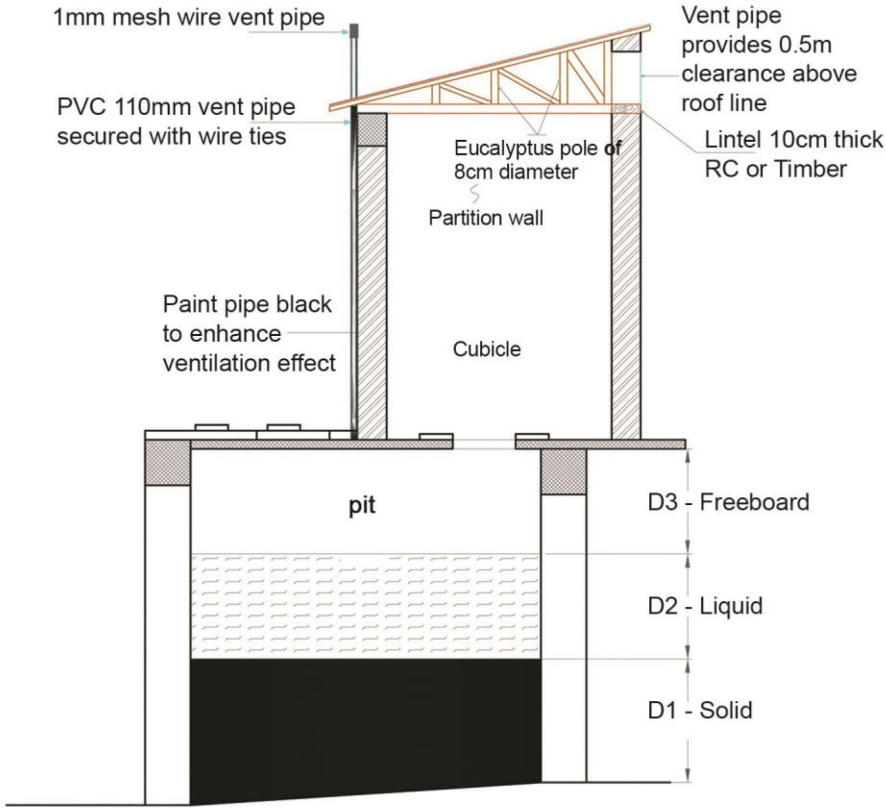


Figure 12 : Detail of Roof Truss

The 110 mm diameter 4 metre long PVC vent pipe – one for each partition - is critical to the operation of the toilet. A dark coloured or black- painted pipe is preferred, the heating effect enhancing the updraft. The pipe should be secured with wire ties to the back wall and grouted in place. A 1 mm galvanized wire mesh is secured at the top of the 4 m pipe to trap flies in the pit. The top 50cms of the pipe should protrude above the roof line to the maximize ventilation effect (Figure 13).



Note : Total pit Depth(D) = D1+D2+D3

Figure 13 : Detail of Vent Pipe

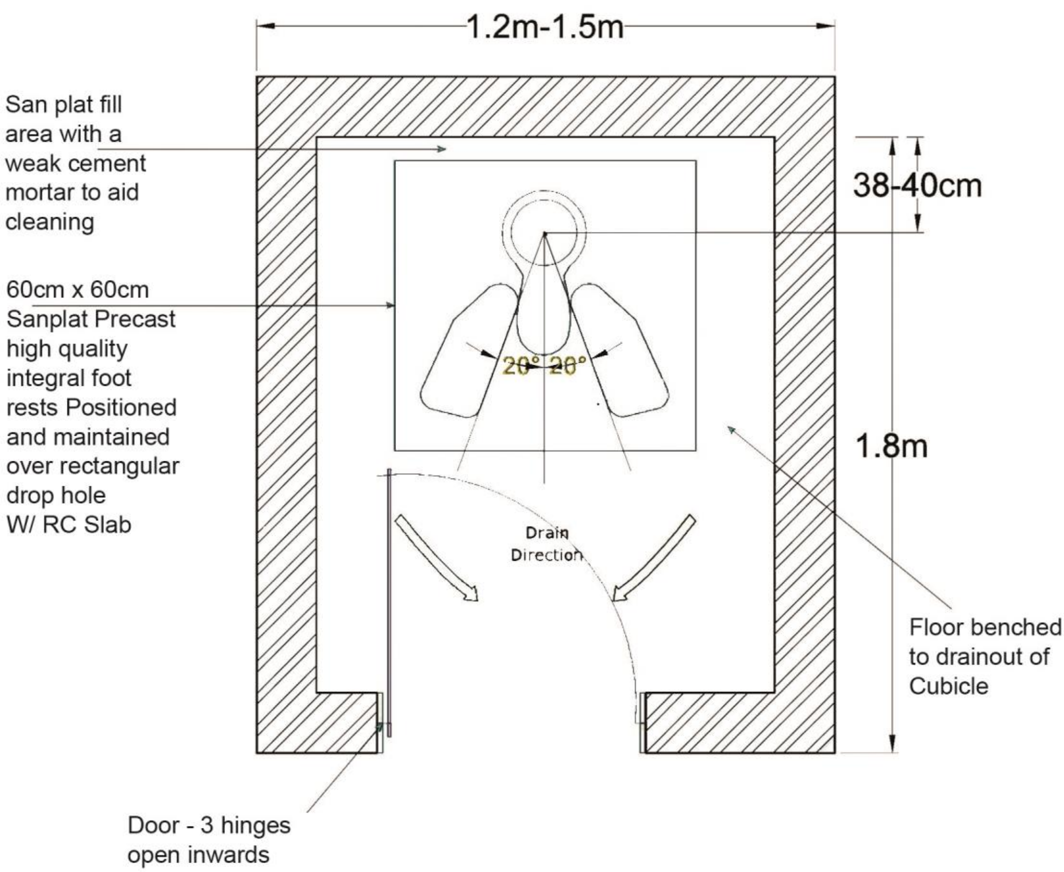
Interior and Squatting Plate

Many decent school toilets are let down, if not abandoned, because insufficient thought has gone into the interior of each partition. The most important aspect is the floor, and the squatting plate with foot rests. Often these seem to be designed for use by a adult rather than a child, and are next to impossible to clean without using tens of liters of precious water.

It is STRONGLY recommended (the first and only time this adjective is used in this manual) that the squatting plate used is precast using concrete and a off the shelf, high quality *sanplat* mould (designed for domestic use) with integrated footrests. The sanplat does not have to be larger than 60 x 60 cms, and should drain into the drop hole. It is possible to achieve a very smooth, easy to clean finish with such a mould and the right aggregate.

The sanplat is cemented over the rectangular drop hole cast into the concrete slab. The gap between the sanplat and back wall of the toilet cubicle is then filled with cement mortar, the surface being benched to drain into the sanplat's key-hole, and given a polished finish. This helps cleaning. If the budget allows, the interior walls of the cubicle should be plastered up to a height of one meter. The floor can then be finished with a polished cement screed, draining towards the toilet entrance (Figure 14).

Note : If door open outwards A = 1.2m



Note : If door open outwards A = 1.2m

Figure 14 : Detail of Vent Pipe

Section 6: Altering Twin Pit Toilet

The previous section focused on a remarkably simple, conventional 'deep pit' technology, with provision at the back of the toilet superstructure for emptying the pits every five years or so. The problem is that in a significant minority of cases, it is not practical to sink a pit by the required 3 metres or more. For example, after a metre or so of difficult excavation, one could already be striking hard rock. Alternatively, a high water table may be encountered. And collapsing sands may also make excavating a pit a risky proposition.

Alternatively, taking into account the following children friendly principle, the school authorities and or Parents Teachers Association (PTA) may want to make better and more regular use of composed faecal matter and urine to support agricultural production – generating food for the community, or income for the school, or both.

Whilst those more used to urban living may turn their noses up at this argument, it should be recalled that tens of millions of rural people, and thousands of farming communities across Asia depend on recycling human waste to enhance crop production – just as many farmers do in developed countries with larger urban populations.

Key Principles
WASH facilities and related practices should be designed to encourage children to understand their environment and conserve scarce resources, especially water resources. With the right technology and safe supervision, grey water, waste water and composted faecal matter from toilet pits can be reused to support agricultural production.

The basic alternating pit toilet, hardly a new idea, it based on a shallow vault to collect faeces and material used for anal cleansing. It should be full after only a year's use or so. At this stage, the pit contents are left to compost for a year. The drop hole is sealed and a second neighbouring hole is opened over a second pit next to the first, separated by a partition. Hence the tern alternating pit.

After a year of decomposition, the composted material, typically a dry, crumbly soil, is removed and used as a fertilizer or soil conditioner. Pathogenically it is safe from the perspective of bacteria and viruses, but precautions should still be taken to avoid direct handling just in case cysts from parasitic worms remain viable.

To minimize smell and problems of drainage from a relatively small pit, urinals should be used to the extent possible by girls as well as boys (Section 7), and care should be taken to avoid flooding the pit with water used for cleaning. Urine, waste water and grey water from hand washing is in fact channeled to a separate leach pit or infiltration trench in this design, just as it is in the design featured in Section 5.

It is relatively simple to modify the design of the leach pit and use the urine / water collected as a potent fertilizer. More detail of how to do this are to be included in the next edition of this manual, together with other eco-friendly designs. The basic alternating twin pit VIP concept in a school setting is shown in Figure 15.

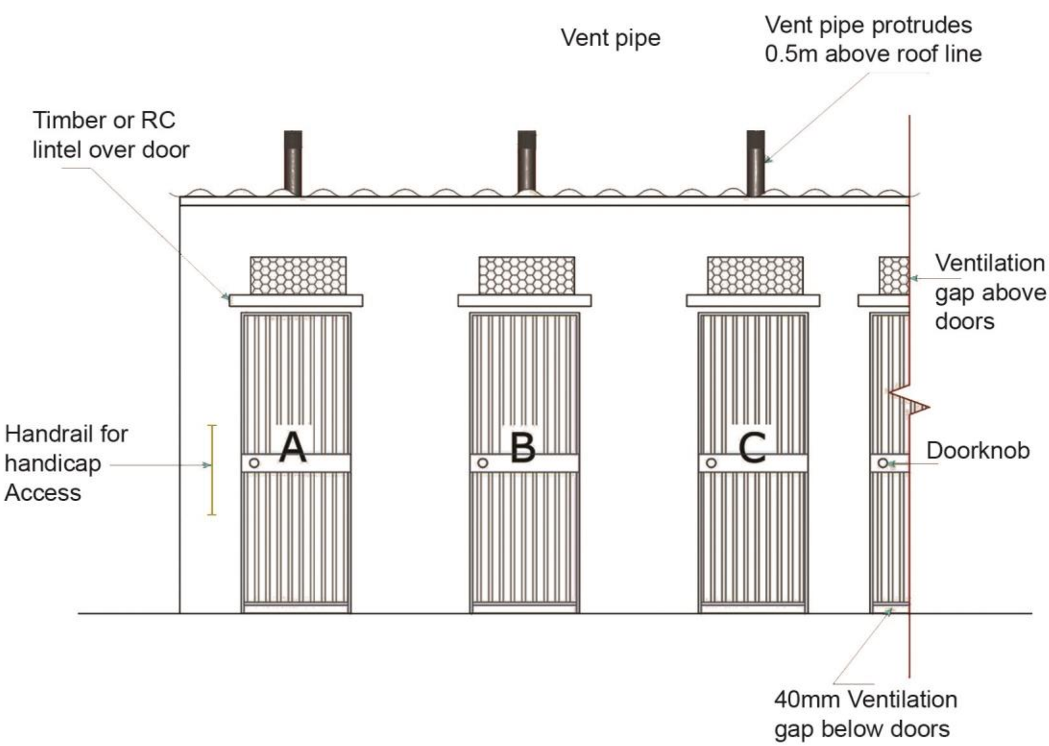


Figure 15 : Alternating VIP Design: Basic Operation

6.1 Sizing the Pit

Getting the dimensions of the pit right in an alternating VIP design is fundamental. Here again, the starting point is a number of rational assumptions based on global experience. These are set out below.

The basic assumptions used here are:

1. The toilet is designed for 50 students per toilet stand, with two stands sharing one pit at any one time
2. The pits are designed for a minimum 12 month fill time
3. The school is open for 200 days a year
4. The basic internal pit area under each stand is 1.1 metres wide, 2.6 metres long
5. The average volume of excreta amounts to 45 litres per child per year. This allows for (i) materials used for anal cleansing (ii) reduced aerobic decomposition over a limited one year period and (iii) the fact that the child will also go to the toilet at home, before or after school.
6. The average volume of fluid entering the toilet (urine and cleaning water) is 1 litre per child per day, of which half evaporates or percolates down through the bottom of the pit.
7. The infiltration rate of the soil is assumed as a minimum of 25 litres per metre squared (side wall area) per day – equivalent to a sandy loam soil. Soils with more clay will need connection to an additional soakway or infiltration trench

Based on these assumptions, the depth of pit can be calculated. The total pit depth required has to allow for (i) containment of accumulated solids, H1; (ii) the infiltration of liquid through side walls H2 and (iii) a reasonable free space (freeboard) beneath the toilet squatting plate, H3, 0.3 metres being used. The total pit depth H is the sum of H1, H2 and H3.

Box 6: Calculating Pit Depth

Solids

A. In one year, volume of accumulated sludge = 50 students x 2 x 45 l = 4,500 l

B. In one school year, volume = 4,500 x (200/365) = 2,500 l

C. Assumed pit area of 1.2 x 2.6 m = 3.12 m2

D. Resulting depth of sludge = H1 = 2500/3120 = 0.80 m

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C. Assumed pit area of 1.2 x 2.6 m = 3.12 m2

D. Resulting depth of sludge = H1 = 2500/3120 = 0.80 m

Liquids

A. In one day, amount of liquid entering the pit is 1 l per child 100 l of which 50% is lost by evaporation and deep percolation

E. Assumed infiltration rate of soil: 25 l / m2

F. Wall area need to infiltrate liquid = 2 m2

G. Additional depth of pit needed to infiltrate liquid (H2) = 2 / (1.2+1.2+2.6+2.6) = H2 = 0.26 m (half of this for a sandy soil or coarser materiel)

Freeboard

B. Additional safe space above solid and liquid below the slab: Minimum Freeboard (H3) = **0.3 m**

Total Depth of Pit (H) = 0.80 + 0.26+ 0.3 = 1.56m

Notes

This calculation is based on a fairly impermeable soil with a relatively low infiltration rate of 25 litres / meter 2 / day. If the soil type has a higher infiltration rate, the pit volume (depth) can be reduced. Alternatively, a drain pipe can be included in the design of the pit, falling to a separate infiltration trench.

The figure of 45 litres (annual accumulation rate per student) is much more than the equivalent figure of 15 litres per year used for the deep pit calculation. This is because the excreta have only one year to degrade / decompose, compared to five years or more in the deep pit design.

Finally, to ensure that the pit is filled efficiently, every 3 months, the pit access cover at the back of the pit should be removed and the contents raked back. Alternating Twin Pit VIPs have a greater need to periodic maintenance as a result, although the task is relatively simple to perform.

6.2 Detailed Design

The detailed design of the alternating VIP is provided in Section 12, a summary of the layout is shown on the next page. Other than the pit dimensions, many aspects of the design and construction are shared with the conventional deep pit design. The main difference is the layout of the floor of each toilet cubicle.

In the Alternating twin pit VIP design, each cubicle accommodates two drop holes, one being temporarily sealed with a 30 mm concrete tile, the other fitted with a prefabricated sanplat. The sanplats are shifted to cover the second set of pits once the first set of pits are full. Vent pipes are moved at the same time. The all important floor plan of a cubicle is shown in Figure 16 below.

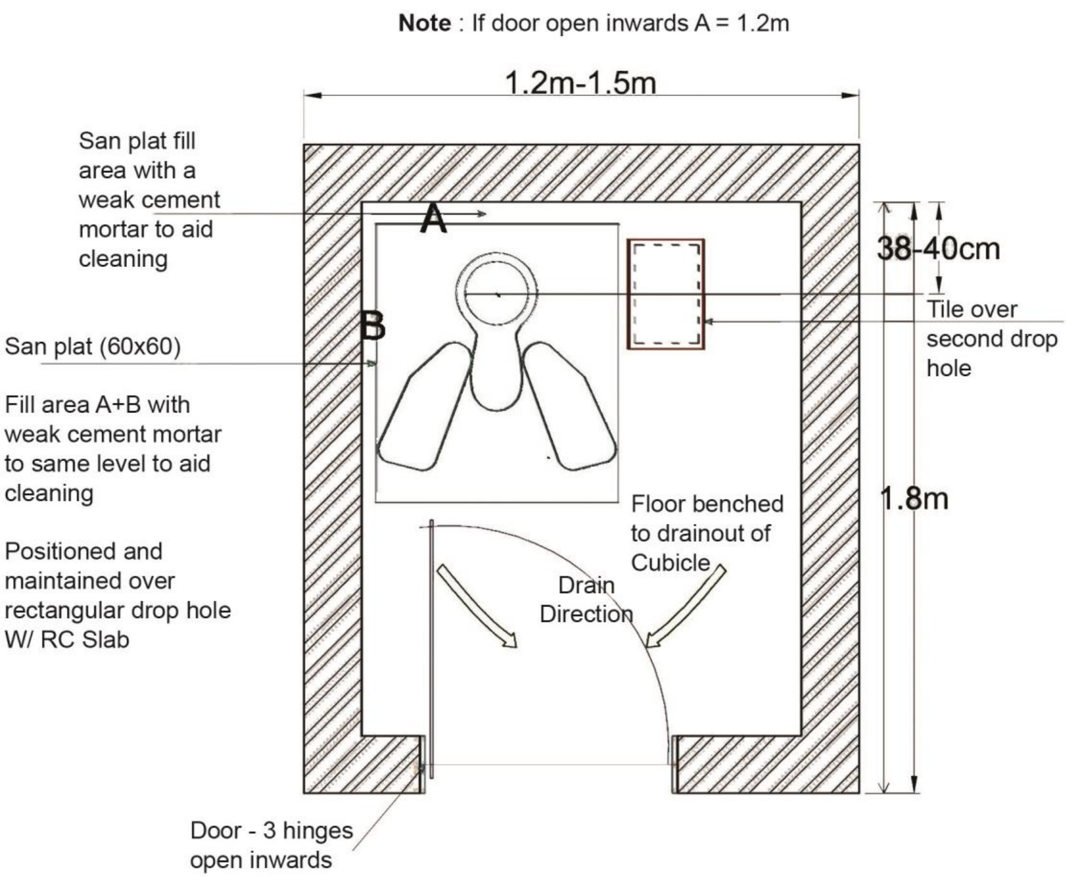


Figure 16 : Floor Layout – Alternating Twin Pit

Section 7: Urinals

7.1 Basics

If well designed sand cared for, urinals save both time and money, by reducing the pressure on toilet stands. If they are poorly designed and are not cared for, urinals can turn into the smelliest part of the toilet. This section describes the design and construction of urinals for girls and boys. In both cases the urinal is part of the 'standard' toilet superstructure described in section 5, with a physically separate soakage pit.

The dimensions of the girl's urinal are 3.05 metres long by 1.2 meters wide. With a urinal trough on one (long) side, the sloping floor design with precast footrests can accommodate up to five girls at a time. The boys 'trough and pipe' design is also 3.05 metres long by 1.5 metres wide, but the trough is on three sides and the urinal can therefore accommodate up to 9 boys at a time.

Urine is collected with the water used to clean the urinals and piped to a separate soakaway. This can be a separate pit, or a trench if the infiltration rate of the soil is lower than about 25 l/m2/day. Wastewater from the hand-washing stand (see next section) drains into the same pit. The basic designs are show in Figure 17 for girls and Figure 18 for boys. Detailed designs are presented in Section 12.

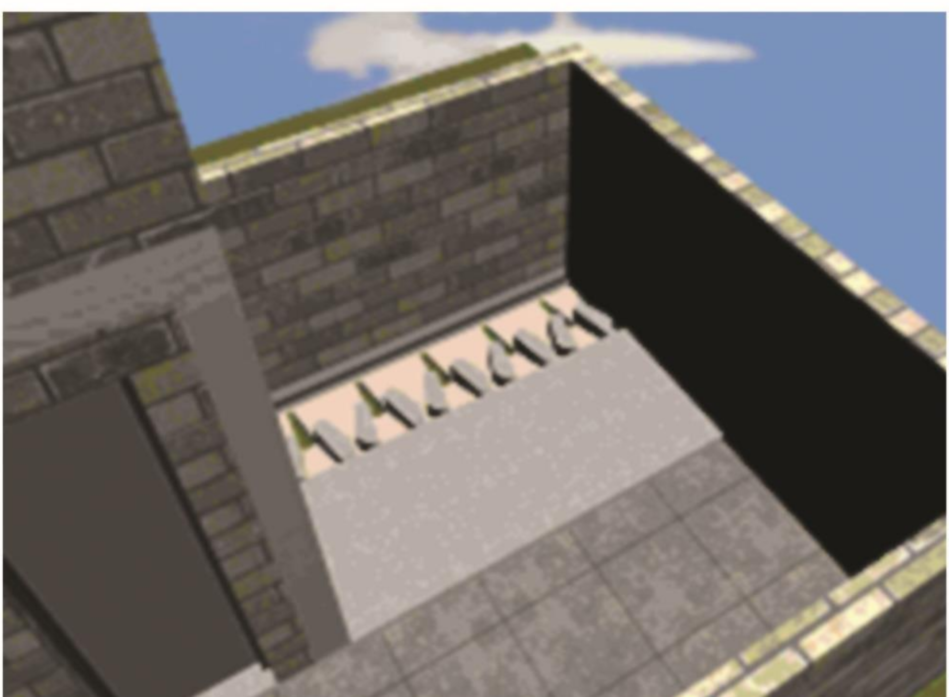
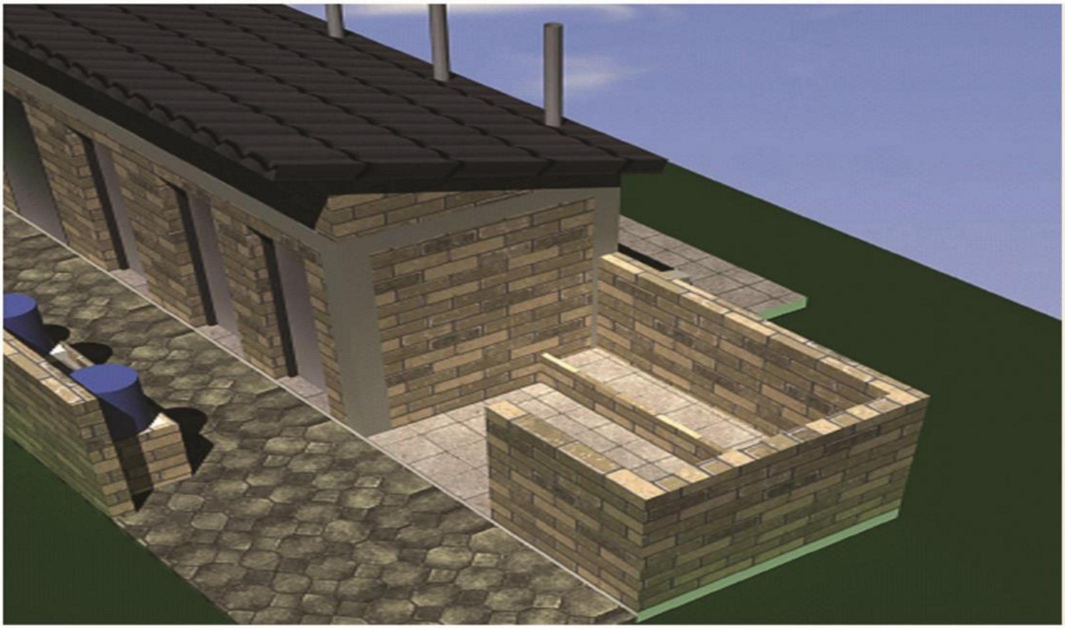
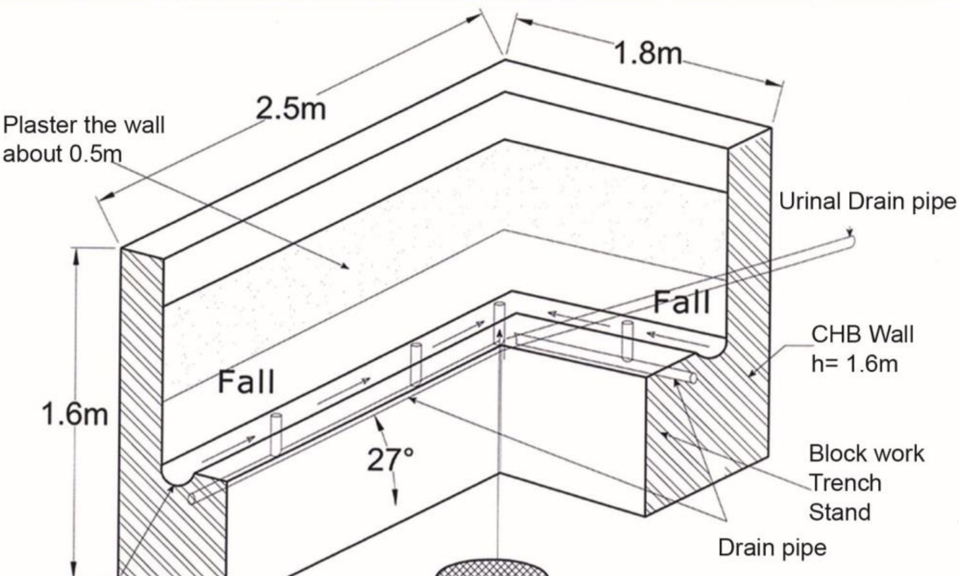


Fig 17 : Girls Urinal





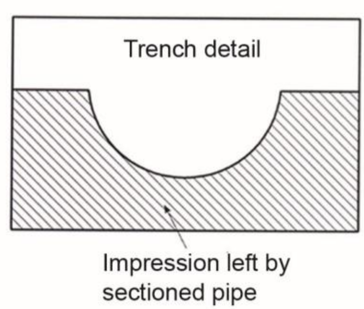


Fig 18 : Boys urinal

Section 8: Hand washing facilities

After using the toilet or urinal, students should wash their hands to avoid the possibility of getting sick (or making others sick) by faecal –oral contamination. Global lessons learnt and best practice shows that it is absolutely critical to provide hand-washing facilities – water and soap – at the toilet itself. Furthermore, separate and relatively private facilities are needed by girls, who may have to use these facilities to wash sanitary cloths if they happen to be having a period (mensurating).

The design included in this manual positions the handwashing facility against the inside privacy wall of the girls' and boys' toilet blocks. The hand washing stands are there in front of users when they come out of the toilet. Each facility is made up of a minimum of two stands (four are preferred), each comprising a 100 litre plastic drum and tap, drain and soap cage. The taps are at different heights to suit students of different ages. For girls, the privacy wall is designed to provide additional privacy for hand-washing and those using the urinal (see Figure 19 below, which shows a four stand open).

The drums could be filled by a water pipe from an elevated tank. More typically, they will need to be filled manually, and steps are also provided to facilitate this.

Grey water can be collected by a drain and piped to the soak-away – the same as the one used by the urinals (See Section 9). Alternatively, it can be reused as a valuable resource, for example, to water a vegetable garden (see Box 9 in Section 10).

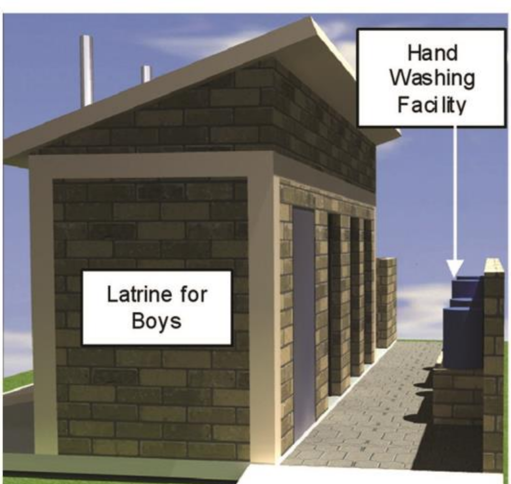


Fig 19. Latrines for boys (right) and girls showing Hand Washing Stands

Section 9: Waste Water Management

The concept of waste water management has been mentioned in several preceding sections, here this important issue gets the attention it deserves. If waste water is not properly managed, the school compound could end up contaminated with puddles of water, possibly contaminated, also providing mosquitoes that carry disease with a breeding site.

Whilst disposing of waste water efficiently and safely is important, we are also wasting a valuable resource. So, before deciding on how to dispose of waste water, one should first consider if and how it could be reused more productively (Box 7).

Box 7: Waste Water, Grey Water, or a Valuable Resource?

Waste water, or 'black water' refers to water discharged from toilets and urinals. This may contain very high levels of pathogens – and it smells pretty bad as well.

Grey water is untreated waste water that has not come into contact with high concentrations of faecal contaminants. In this case, grey water refers to water from hand washing stands, which may be slightly, but not highly contaminated.

The way we manage waste water and grey water is very important. If left to pool on the ground, it may present a health risk – not least by providing mosquitoes with a breeding ground, or attracting domestic animals into the school compound. Water combines with soil to make mud, which may be fun for some – but this can also put off users from entering the toilet or washing their hands.

The option described in this manual is one solution. Infiltrate water back into the ground. This may work in terms of reducing the health risk. But it is also wasting a valuable resource. If properly handled, grey water can be reused to for cleaning toilets and urinals, or for watering trees and plants - which can be sold by the school to augment its budget. Waste water can also be used in this way, although it needs more careful handling.

The concept of grey water reuse and recycling will be described in more detail in a second volume of the School WASH Guideline. This will also include the use of urine as an incredibly potent fertilizer, a broader range of composting toilets. Wait out for details.

an incredibly potent fertilizer, a broader range of composting toilets. Wait out for details.

Assuming the decision is made to dispose of waste water rather than reuse it, the following information must be considered.

The total volume of urine and waste water (from hand-washing stands, from rainwater and from cleaning the urinal may exceed 800 litres a day for a four stand sanitation block, designed to meet the needs of 400 students.

The following box takes one through the basic design of an infiltration trench. In this case, a trench is being used to drain liquid into the ground. Liquid drains through the sidewalls of the trench rather than the bottom, which rapidly silts up. The key factor that determines the length of the trench is the soils infiltration rate (I, here measure in litres per metre squared), which varies enormously depending on the type of soil. The more clay there is in the soil, the less liquid it can handle and the lower the value of I.

Infiltration rates for different soil types are tabulated below. For more detail on how to classify soil type and assess infiltration rate by physical inspection and the jar test, see Annex A.

Soil Type	Infiltration Rate I (l/m2)
Coarse to medium sand	>50
Fine sand, loamy soil	33
Sandy loam	25
Porous silty clay	10
Expansive clay	<10

Table 6: Infiltration Properties of Different Soil Types

Box 8: Designing a Soak Away

Soil infiltration rate: Estimated by inspection of soil type: 50 litres / metre^2 / day

Volume of liquid (urine, grey water, waste water combined) in litres / day to be drained: 2 litres per student per day: 800 litres

Side area of infiltration trench required = 800 / 50 = 16 m2

Wall area of trench = 8 m2 (for each side)

Depth of trench = 1.2 m (with 75cms infiltration zone)

Length of trench needed = 8 / 0.75 = 11.5 metres

Note that the end walls of the trench have not been included in determining its infiltration capacity. The area involved is relatively small as the trench need only be 60-75 cms wide. The bottom of the trench will soon silt up, reducing its infiltration capacity as well.

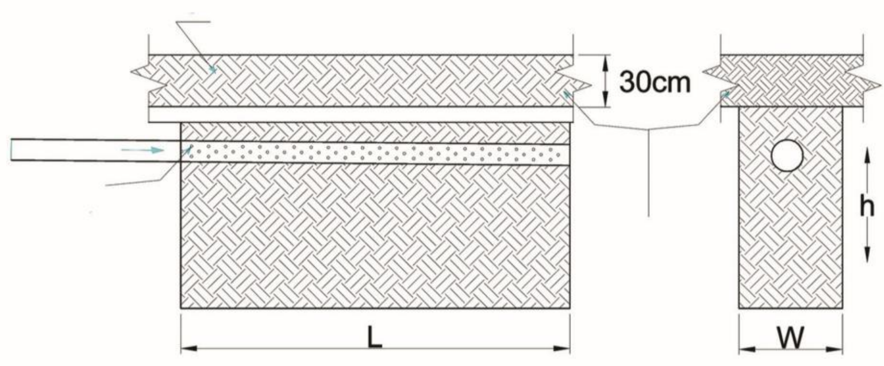
In this case, the top 45 cms of the 1.2 metre deep trench lie above the pipe leading from the urinal, leaving a 75 cms deep infiltration zone (see Figure X below).

If more infiltration area is needed, two or more parallel trenches and be built, spaced two metres apart.

The resulting design is shown below in Figure 20. A soak away based on a pit takes up less space, but is significantly deeper than a trench (and potentially more difficult to construct).

Using the same design parameters, a circular pit 1.2 metres in diameter would need to be dug to a depth of 4.7 metres to provide an infiltration area of 16 metres2, allowing for the same 45 cm deep freeboard. In practice, two pits each 2.4 metres deep may be easier to excavate.

Figure 20 : Soak away



Section 10: Water Supply

10.1 Introduction

This section is not intended to fully address all aspects of school water supply. It is however necessary to include some information on this subject, as water is needed both to clean toilets and urinals as well as for hand-washing. A toilet or urinal cannot function for more than a day or so without using water to clean it. At the same time, we should recognize that there is little point in supplying water for sanitation and hygiene unless water from drinking has also been provided.

After reviewing a number of basic options, a number of technologies receive more attention which are of particular importance in schools. These are rain water harvesting, force lift hand pumps and basic school drinking water fountain.

Just as the management of sanitation facilities in schools is very important, so to is the management of water in schools. Indeed, in some of the schools visited during the preparation of this manual, a system had been established by which children brought three litres of water into the school each morning, on rotation. These systems provided enough water for drinking, hygiene and cleaning.

Box 9: Water Demand in Schools

The fundamental question: How much water is needed? For a typical rural school with a VIP type toilet, we estimate that 1 litre is needed for drinking, 0.5 litres for hygiene (hand washing with soap) and 0.5 litres for cleaning both the toilet and urinal per student per day.

For a 4 stand toilet block and urinal (catering for 400 students), this equates to 200 litres for handwashing and 200 litres for cleaning. Inevitably, some water is wasted, and additional water may be needed for menstrual hygiene, so an average of 2 litres per student per day ONLY FOR HYGIENE AND TOILET CLEANING is appropriate. An additional 1 to 2 litres per student per day is needed for DRINKING. Even providing a total of 3 to 4 litres per student can be a great challenge for some schools.

Much more water is required for residential schools, for staff living on campus, and to operate flush toilets. The greater the water demand, the greater the amount of waste water and grey water that will need to be disposed of.

10.2 Technology Options

Whilst there are a wide range of water supply solutions applicable in schools, in most cases, relatively few will be feasible because of the school's specific location and elevation, the limited budget available for construction, and the limited budget available to pay for operation and maintenance (O&M).

To help pay for O&M, excess water from a school supply, or grey water from a hand-washing stand, may be used to water a cash crop grown in the school compound which is then sold. The funds raised can pay towards the upkeep of the water supply, for soap, and for a caretaker to ensure the upkeep of the school toilet. Whether this is a feasible option depends on the capacity of the water supply.

Finally, many schools are fully integrated with the local community. This may be an advantage in many respects, for example, it may be possible for the school to share water from a community water supply. The converse also holds true. A school water supply is likely to be used by the surrounding households, unless local agreement has been reached not to do this – that agreement being enforced through a robust water management system.

Water Carting

Here the 'technology' may be as simple as a donkey cart fitted with two 200l water drums. The main issues are in fact financial and institutional, relating to the management of the local water filling point, how a school is expected to pay for the water provided. How to ensure water safety when it comes from a remote supply is also an issue if the water is used for drinking.

One variation on this theme, already mentioned, is to agree with parents that older children bring a limited quantity of water to school each day, some of this going into hand washing containers. One challenge may be to ensure that all students have access to water containers of the right size, and that their families have reasonable access to safe water in the first place.

Rain Water Harvesting

Rain water harvesting, based on a roof catchment, is an obvious choice in a typical school setting – where one has access to a large roofed area. It is not likely to be a cost effective option in areas with low rain fall – less than 350 mm a year – and / or areas where there is a protracted dry period of three months or more, due to the storage volume required.

Water demand for a school of 500 students amounts to 1,000 litres every day. A reservoir designed to hold 40 school days supply (around two calendar months) would need to have a volume of 40,000 litres, making this a relatively expensive proposition. Two 20,000 litre tanks may be better (though more expensive) than one: If one tank or its roof catchment needs repair, the other can still provide some water. A ferro-cement design may be the most cost effective tank material, depending on the local availability and cost of construction materials and skilled labour.

The roof catchment and gutters need frequent maintenance, and the system should be fitted with a first flush system to reduce the risk of debris- and contamination – entering the tank.

Protected Well and Drilled Shallow Well

This is feasible provided that the school lies on top of a shallow aquifer. Both systems can be completed with a community hand pump such as an India Mark II or Afridev. The former can be adapted to pump water up from the collection chamber in the pump to an elevated typically roof mounted) tank, from which it falls under gravity to a drinking water fountain and hand washing stands. This sort of system requires additional and regular maintenance.

Piped Water Supply

In a significant minority of schools, it may be feasible to extend a pipeline from the local community into the school, typically feeding an elevated storage reservoir from which water is fed to a water fountain and hand-washing facility.

This option is very effective providing that (i) the capital cost if affordable – using correctly sized HDPE or PVC pipes helps reduced the costs compared to Galvanised steel; (ii) the system has capacity t meet water demand from the school (iii) the school can afford to pay for the water it uses, or the water supplier agrees to cross subsidise this cost from water sales to private users.

Box 10: Force Lift Pump

The Force Lift hand pump has already been mentioned as being particularly useful in an institutional setting such as a school or health post. Force lift pumps are relatively simple, and are based on a standard hand pump design such as the India Mark II, common in many rural areas in Ethiopia.

The standard pump lifts water up the riser pipe into a collection box, from where it discharges through an open spout .In the case of a Force Lift Pimp, the spout is not open but connected to a second riser pipe, connected to an elevated tank up to five meters higher than the hand pump itself. Water is pumped into the tank. The connection rod which connects the pump handle to the working parts (basically the piston and cylinder at the bottom of the riser pipe) passes through a seal (termed a 'Stuffing Box'), to prevent water leaking out. The seal needs regular adjustment every few weeks or so – a simple task for a trained caretaker – and occasional replacement.

Whilst more sophisticated alternatives to a Force Lift Pump are available, such as a solar pump, wind pump or even a roundabout type 'Roundabout' or 'Play Pump', all of these are significantly more expensive to buy and more difficult (and expensive) to maintain.

Young children may find it difficult to operate a hand pump, particularly a Force Lift Pump which requires more effort. This should be taken into account by the school authorities and teachers when establishing a pumping system.

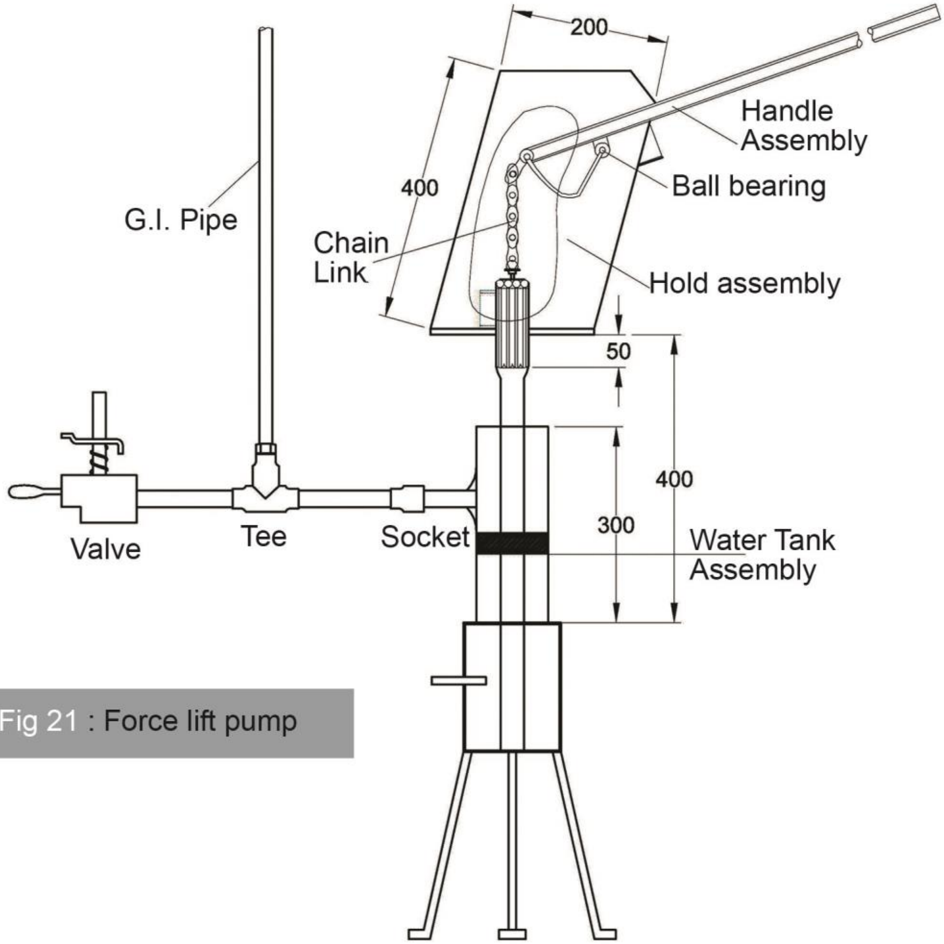


Fig 21 : Force lift pump

S.No.	Description	No.
1	Base Assembly	1
2	Barrel Assembly	1
3	Head Assembly	1
4	Bracket	1
5	Handle Assembly	1
6	Piston Assembly	1
7	Check Value Assembly	1
8	Hex Bolt M.12 X 45	8
9	Hex Nut M-12	14
10	Washer (to suit M-12)	7

10.3 Drinking Water Fountains

A well designed drinking water fountain, fed from an elevated tank, is a very important asset in any school. In general, girl and boy students can use the same fountain, provided that hand-washing facilities are provided in physically separate girls' and boys' toilets. Here again, the opinions of the students themselves should be taken into account.

The number of taps needed depends on the numbers of users. In general, one tap should be provided for every 100 students, with a minimum of two for smaller schools. The maximum number of taps that should be installed in a single fountain is six, to avoid crowding. If two or more fountains are needed, it is good practice to provide separate facilities for girls and boys and locate these taking into account their preferences.

The dimensions of the drinking fountains should take into consideration the age of the users. The height of the tap and the drainage water trough for different age groups vary. We recommend a 50 cm height for the trough for under nines, and a 70 cm height for over nines. In both cases, the tap is positioned 25 cm above the trough.

One design of a drinking fountain for school children that takes care of different age requirements is presented below. In this design, there are five taps in each side of the drinking fountain, and a total of ten children can be served at a time.

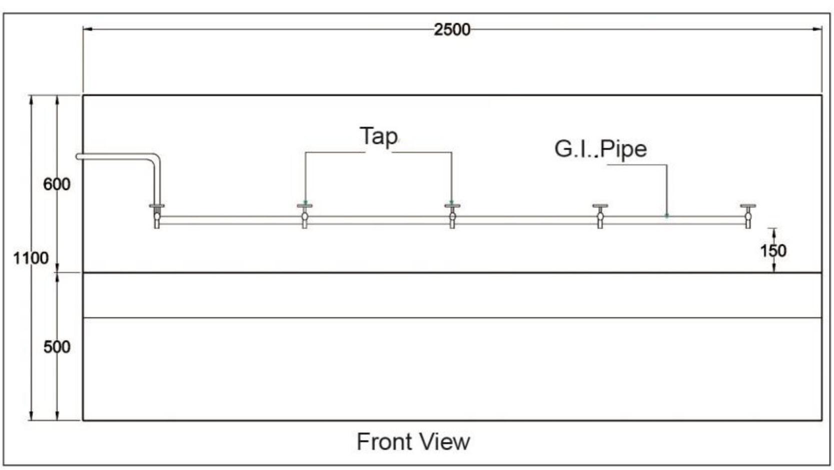


Fig 22 : Basic Design of Drinking Water Fountain

In terms of what type of tap to use, whilst there are self shutting taps on the market, these tend to be low quality, and difficult for a child to use when washing his or her hands. Instead, we recommend good quality half inch faucets. Even these will require routine maintenance. The fountain must also be connected to a drain pipe and soak pit or infiltration trench.

Section 11: Management of School WASH facilities

Whilst investing a great deal in the provision of WASH facilities in schools, it makes sense to invest in ensuring their proper use, upkeep and sustainability. Many aspects relating to management have indeed been mentioned in the preceding nine sections of this manual. Some key principles are reiterated below. These are merely a summary of the issues involved.

For more information, the reader is referred to separate guidelines for the management of water, sanitation and hygiene education in primary schools. This is being published shortly by the Ministry of Health, Ministry of Education, Ministry of Water Resources and UNICEF.

Box 11: Principles of Effective WASH Management in Schools

Management starts before Infrastructure: Roles and Responsibilities for school WASH management must be agreed before work starts on site; this agreement may take the form of a written declaration witnessed by the Kebele Administration

Participation is vital in the Management of sanitation facilities in schools – involving boy and girl students, teachers, the school principal / head teacher, school administration and PTA. Ensuring the participation of students to play an active role in the planning and upkeep of facilities is extremely important

Contributions in terms of cash, materials, labour, time and decision making from the local community and their representatives can engender a sense of ownership and shared responsibility for the maintenance of the facilities established

Oversight during construction is important to ensure that the facilities are correctly built – in the right place, using the right materials.

School management should extend to ensuring that students understand how to use sanitation facilities – avoiding the unintentional soiling of toilet compartments and unnecessary waste of water, for example.

Responsibilities for daily and weekly cleaning should be agreed. This may involve organizing students to clean toilets according to a roster, supervised by a teacher

Preventative maintenance reduces the risk of breakdown. A system to ensure regular checking and maintenance needs to be established, probably involving a contracted worker who needs to receive an adequate financial incentive

Maintenance extends to oganising the safe emptying of a full latrine pit and the safe disposal or use of the waste material; and ensuring that infrastructure and/or systems are in place to bring adequate quantities of water into the school

To ensure facilities are fully utilized and hygiene practices respected, a system needs to be established to pay for cleanrers, cleaning materials, spare parts and soap (even water). This needs to be agreed at the outset with all parents

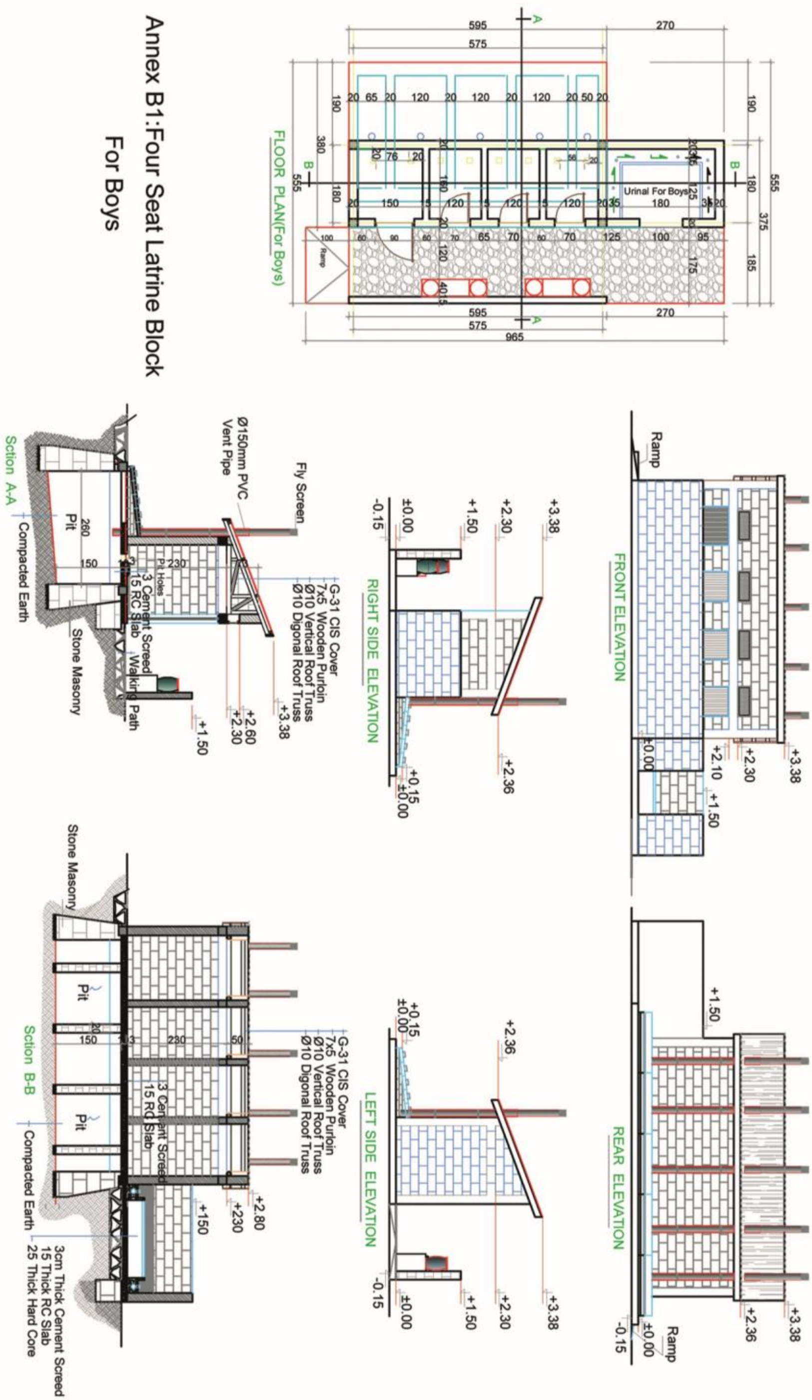
Latrine Type	Qty	No. of users (Students)	Cost (Birr)
2 seat (Teachers) with hand washing	1	200	**44,908.31**
4 Seat (Girls) with urinal and hand washing	1	400	**87,972.24**
4 Seat (Boys) with urinal and hand washing	1	400	**84,418.11**

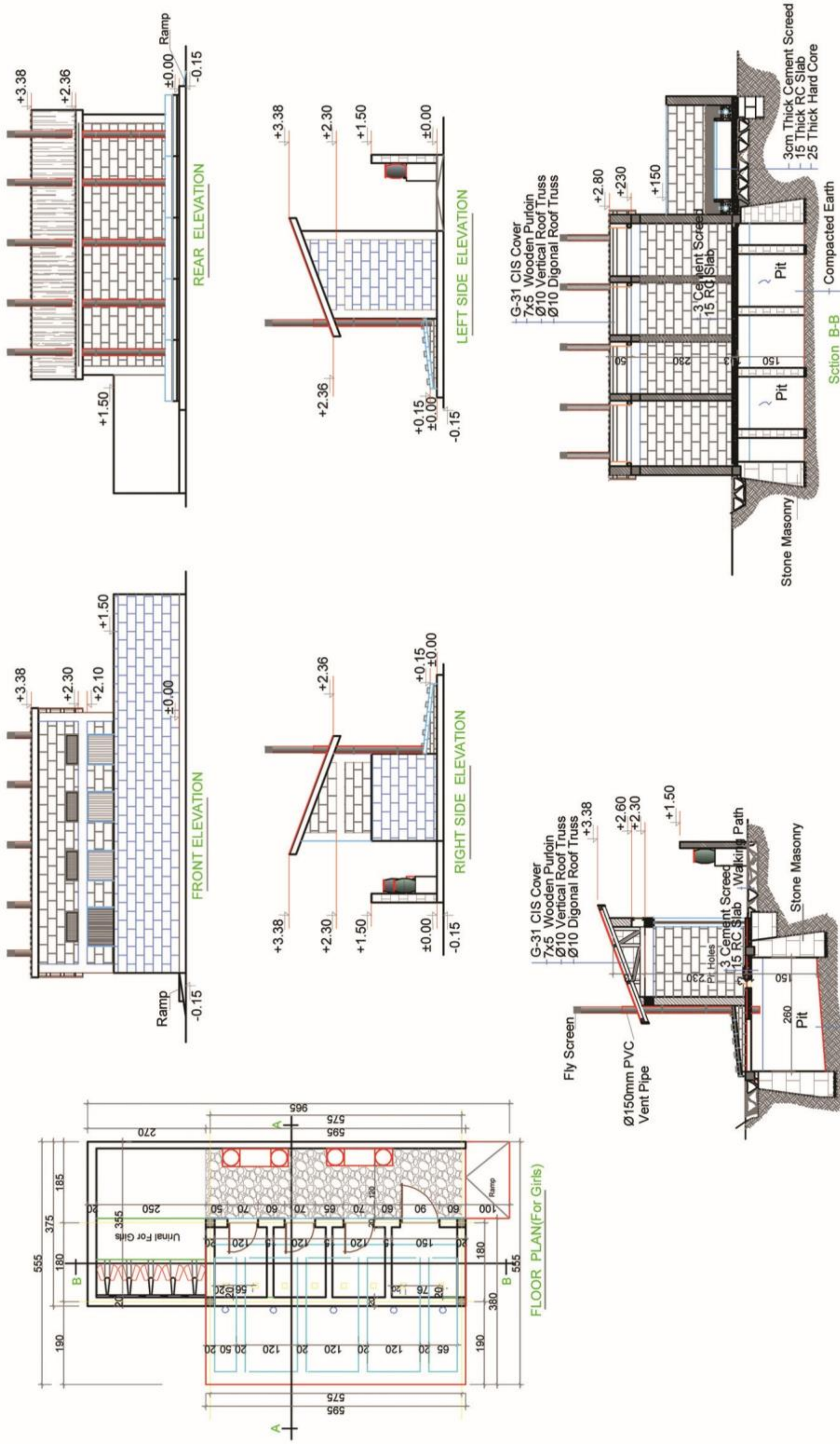
Table 7. Indicative cost breakdown (Birr) for each latrine type at 2010

Section 12: Detailed Designs and Bills of Quantities

Design and Architecture for Standard Minimum four seat Latrines for boys

Annex B1: Four Seat Latrine Block For Boys



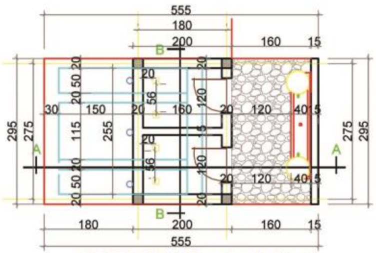


Annex B2:Four Seat Latrine Block

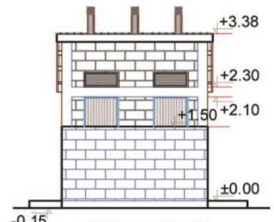
For Girls

Design and Architecture for Standard Minimum four seat Latrines for girls

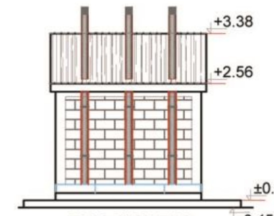
Annex B3:Two Seat Latrine Block For Teachers



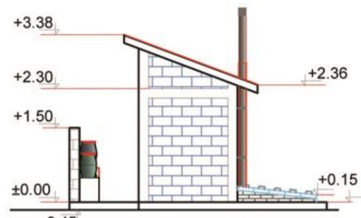
FLOOR PLAN(Two Seat Latrine)



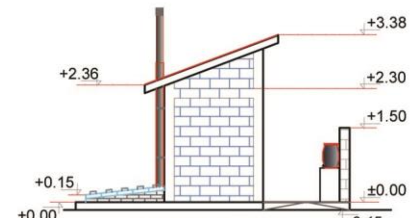
FRONT ELEVATION



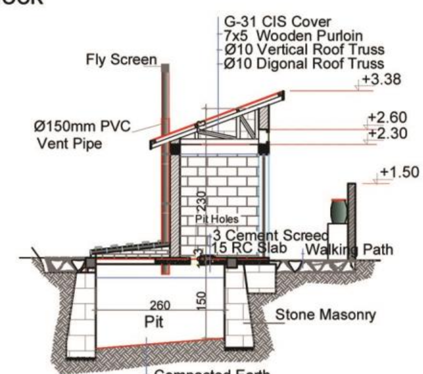
REAR ELEVATION



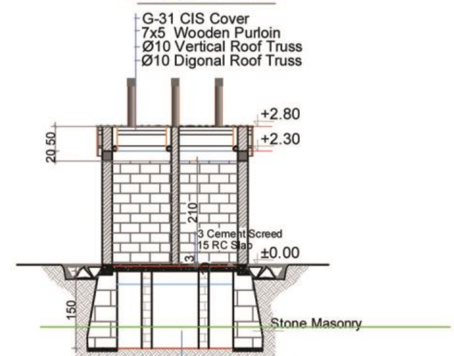
RIGHT SIDE ELEVATION



LEFT SIDE ELEVATION

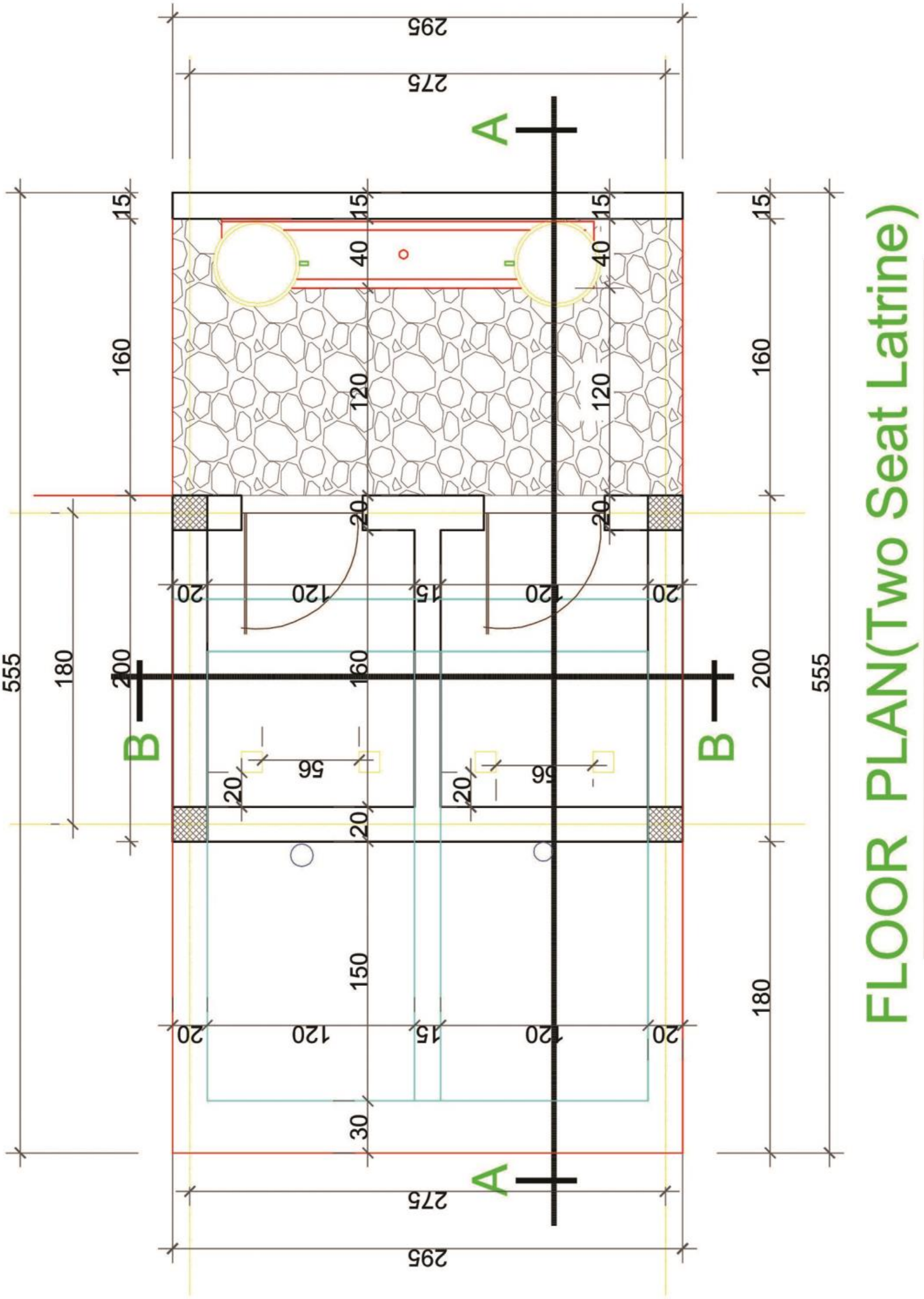


Sction A-A

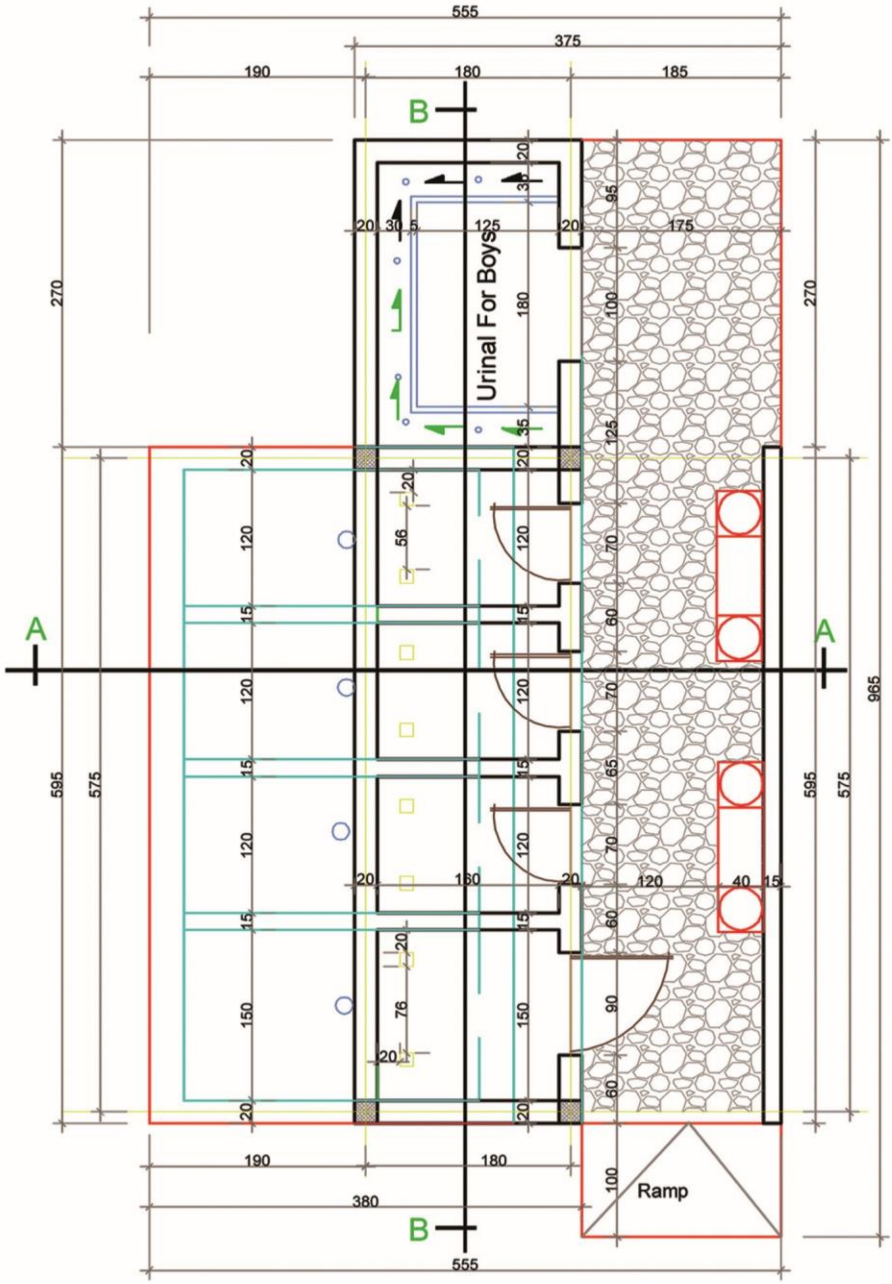


Sction B-B

Design and Architecture for Standard Minimum two seat Latrines

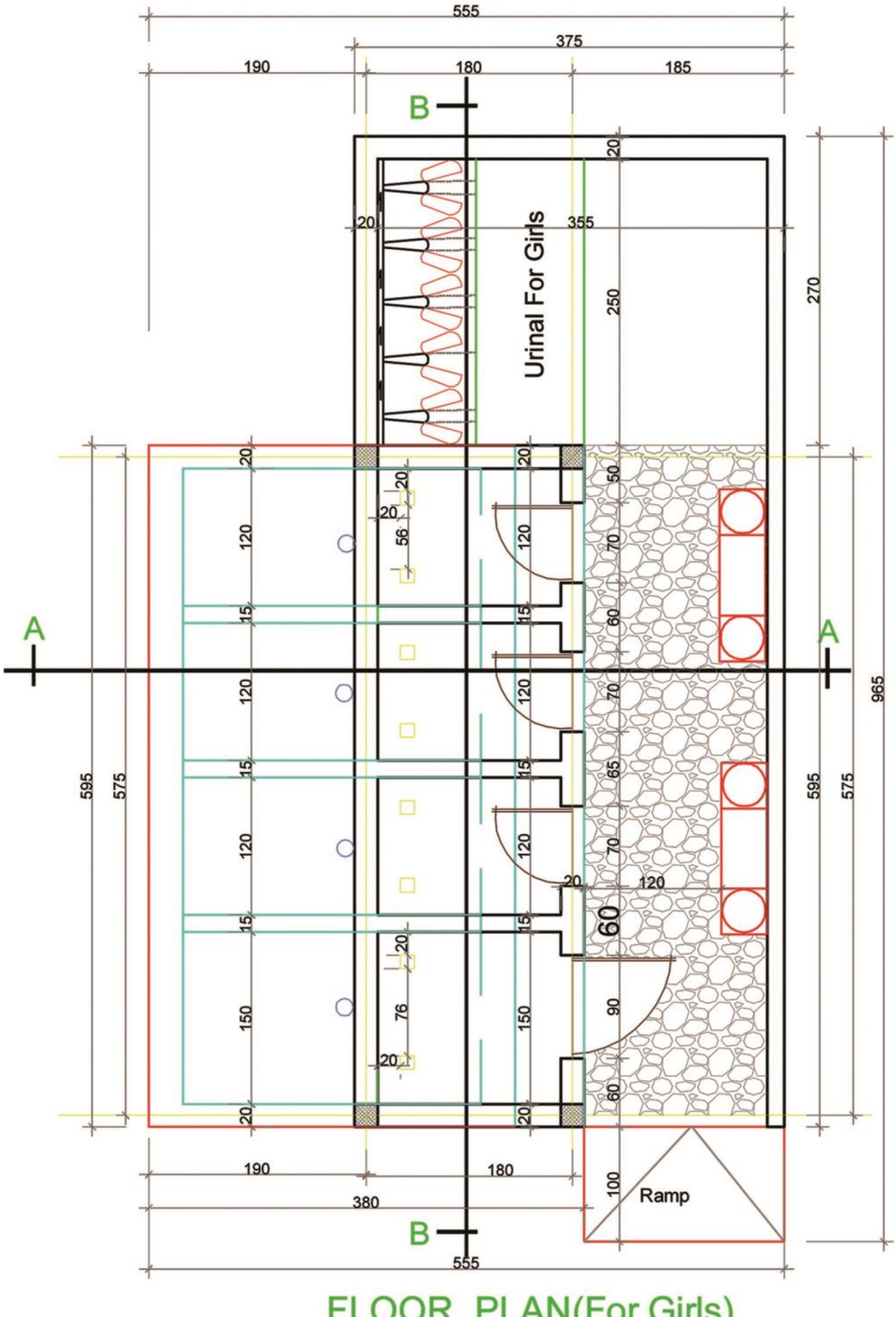


Floor Plan For Girls

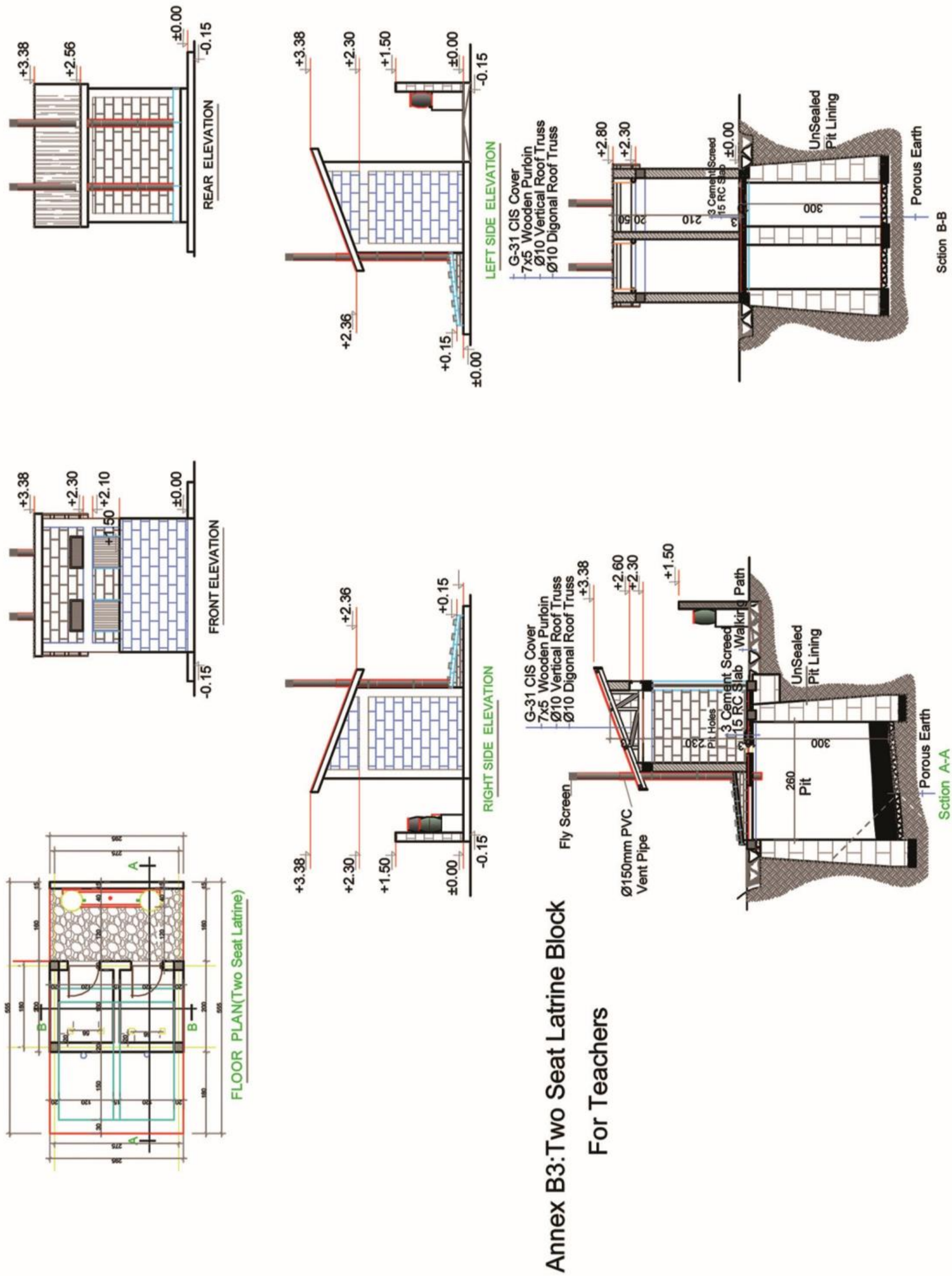


FLOOR PLAN(For Boys)

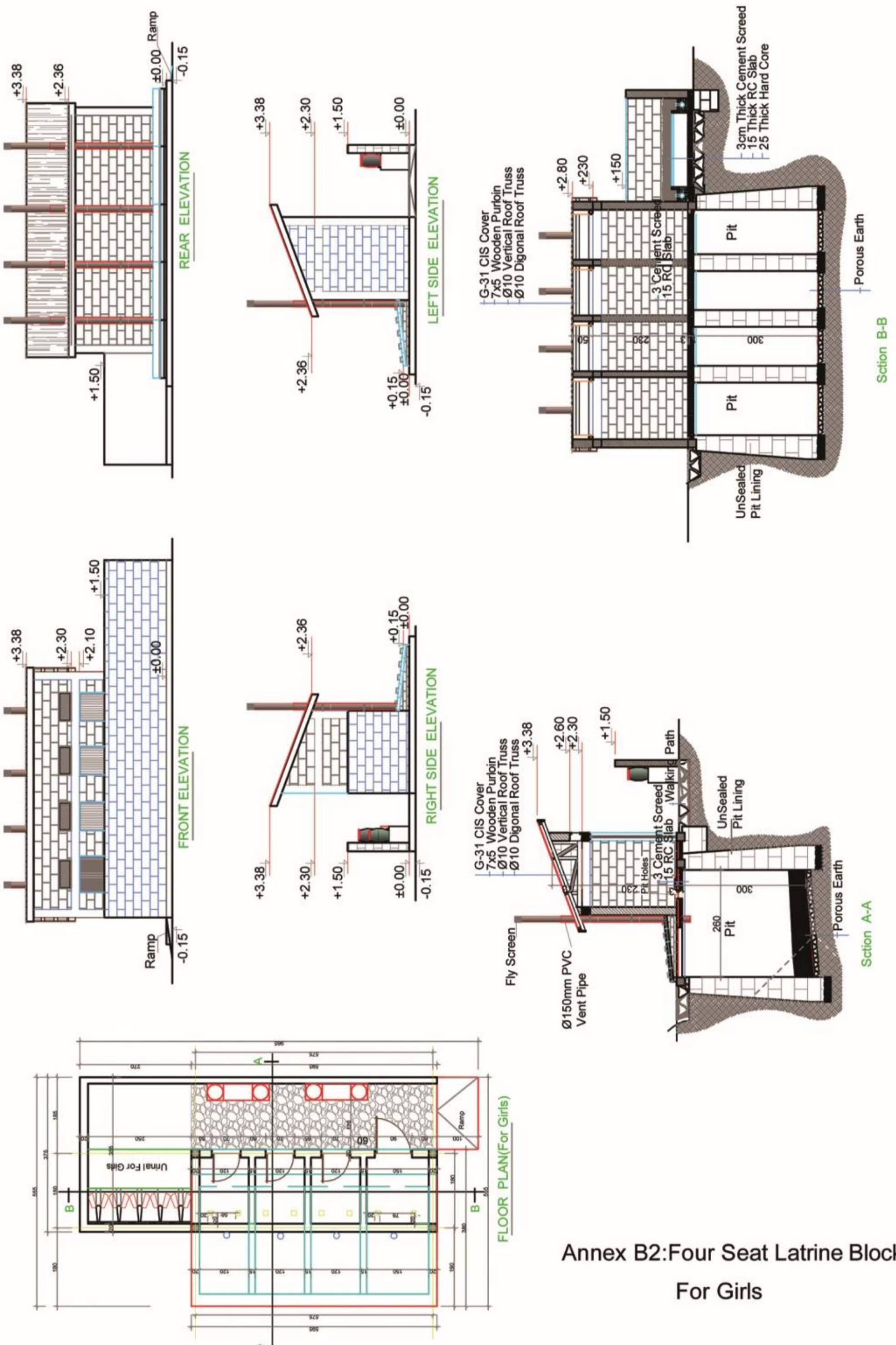
Annex B1:Four Seat Latrine Block For Boys



FLOOR PLAN(For Girls)



Two Seat Latrine Block For Girls



Two Seat Latrine Block For Teachers

Annex B2:Four Seat Latrine Block For Girls

Bill of Quantities for Designed VIP Latrines

Annex B: Table 1 - A 2 seat latrine for teachers

S.n	Description	Unit	Qty.	Unit Price	Total Price
	I. LATRINE BLOCK				
	A. Sub-Structure				
1	**Excavation & Earth Work**	m2	31.17		
1.1	Clear off the site to remove top soil to an average depth of 30 cm				
1.2	Bulk excavation to reduce level excavation to ordinary soil not exceeding 1.5m	m3	21.58		
1.3	Over 1.5m not exceeding 3.0 m	m3	20.24		
1.4	Back fill under hard core & around masonry with selected granular borrowed material from out side & well ram in layers not exceeding 20 cm thick until it attains a minimum of 95 % proctor density.	m3	4.29		
1.5	Cart away surplus excavated material & deposit at a distance not exceeding 1km from the site.	m3	46.87		
1.6	25cm thick basaltic or equivalent stone hardcore, well rolled, Consolidated & blinded with crushed stone	m2	11.87		
	Total to summary				
2	**Concrete Work**				
2.1	5cm thick lean concrete class C-5 , 150 kg cement / m3 concrete, under masonry foundation wall. a) under masonry	m2	15.96		
2.2	Reinforced concrete, C-25, 360 kg cement/m3 of concrete filled in to form work and vibrated around reinforcement measured separately. a) in grade beam	m3	0.74		
2.3	In 15 cm thick RC ground floor slab class C-20 with minimum cement content of 320 kg/m3 evenly spread	m2	10.92		
2.4	Provide cut and fix in position sawn zigba formwork or equivalent. a) for grade beam b) for ground slab c) support poles of 8mm diameter & 3m length	 m2 m2 No	 7.37 1.33 24		
2.5	Steel reinforcement according to drawing cut, bend & placed in position, unit price shall include cutting, bending & placing in position & tying wires. a) Φ 6mm b) Φ 10mm c) Φ 12mm	 kg kg kg	 21.87 125.50 68.98		
	Total to summary				

S.n	Description	Unit	Qty.	Unit Price	Total Price
3	**Masonry Work**				
3.1	500mm thick trachytic or equivalent stone masonry below ground level bedded in cement mortar (1:4) in full joints.	m^3	23.73		
	Total to summary				
3.2	20X20X40cm Solid Concrete Block Pit Partition Wall"class C" bedded in cement sand mortar 1:3 both side left for plastering	m^2	7.8		
	Total to summary				
	B. Super-Structure				
1	**Concrete Work**				
1.1	Reinforced concrete, C-25, 360 kg cement/m^3 of concrete filled in to form work and vibrated around reinforcement measured separately.				
	a) in elevation columns	m^3	0.37		
	b) in top tie beam	m^3	0.36		
1.2	Provide cut and fix in position sawn zigba formwork or equivalent.				
	a) to elevation columns	m^2	7.36		
	b) to top tie beam	m^2	5.46		
1.3	Steel reinforcement according to drawing cut, bend & placed in position, unit price shall include cutting, bending & placing in position.				
	a) Φ 6mm	Kg	15.18		
	a) Φ12mm	Kg	83.47		
	Total to summary				
2	**Concrete Block Work Above Grade Walls**				
2.1	20X20X40cm HCB Wall "class C" bedded in cement sand mortar 1:3 both side left for plastering	m^2	19.27		
2.2	15X20X40cm HCB Wall "class C" bedded in cement sand mortar 1:3 both side left for plastering	m^2	8.11		
3	**San Plat (60x60 cm^2) one for each toilet room**				
	Total to summary				

S.n	Description	Unit	Qty.	Unit Price	Total Price
4	**Roof Work**				
4.1	Roof cover in G32 CIS Nailed to 5x7cm battens as proposed by the Engineer.	m^2	8.63		
4.2	Supply and fix G-32 galvanized sheet metal gutter and down pipe a) Gutter 60cm devt. b) Down pipe 33cm devt	 ml ml	 3.8 2.8		
5	**Vent Pipe**				
	a) PVC vent pipe ϕ110 mm (each vent 4.2m length)	no	2		
	Total to summary				
6	**Carpentry Work**				
	All structure truss members shall be in seasoned eucalyptus wood and painted two coats of anti termite solution and shall be tight fixed with top tie beam with 6mm diameter plain bar.				
6.1	Diameter 8cm eucalyptus upper and lower chord	ml	5.94		
6.2	Diameter 6cm eucalyptus vertical and diagonal members	ml	2.76		
6.3	50x70mm zigba roof purlin	ml	12.6		
	Total to summary				
7	**Metal Work**				
	All metal doors are manufactured from locally produced LTZ seiko steel profile frames. All works should be cut and assembled to sizes and shapes of the door schedule upon submitting workshop drawing by the contractor. Unit price includes cylinder lock or similar, door stoppers and other necessary accessories for completing the work. All according to doors schedule and as specified.				
7.1	Type D2, size:- 70x210cm	No	2		
	Mesh wire	m2	1		
	Total to summary				
8	**Plastering and Pointing**				
8.1	Pointing to all Internal and External HCB wall surfaces with cement sand mortar 1:2	m^2	55.74		
8.2	Apply three coats of plastering to beam & columns surface	m^2	19.01		
8.3	Supply and made an average thickness of 5cm roughened Cement sand screed with 0.1 aggregate mix, price Includes chiseling of floor.	m^2	14.69		
8.4	Stone riprap foot path in front and around the latrine	m^2	15.95		
	Total to summary				

S.n	Description	Unit	Qty.	Unit Price	Total Price
	II. HAND WASH AREA				
1	**water trough masonry work**				
1.1	400 mm thick trachytic or equivalent stone masonry above ground level bedded in cement mortar (1:3) in full Joints.	m^3	0.424		
1.2	Apply three coats of plastering to External trough surface	m^2	2.16		
1.3	Supply & install a 200 lit fiber plastic ground water tank with an out let ½ ‘ pipe, price shall include fixing in position and complete the system with all its necessary Accessories to make the system workable.	No.	2		
	Total to summary				
	Grand Total				

Annex B: Table 2: A Four seat latrine for Girls

S.No	Description	Unit	Qty.	Unit Price	Total Price
	I. LATRINE BLOCK				
	A. Sub-Structure				
1	**Excavation & Earth Work**				
1.1	Clear off the site to remove top soil to an average depth of 30 cm	m^2	63.21		
1.2	Bulk excavation to reduce level excavation to ordinary soil not exceeding 1.5m	m^3	40.02		
1.3	Over 1.5m not exceeding 3.0 m	m^3	37.62		
1.4	Back fill around masonry with selected granular borrowed material from out side & well ram in layers not exceeding 20 cm thick until it attains a minimum of 95 % proctor density.	m^3	6.07		
1.5	Cart away surplus excavated material & deposit at a distance not exceeding 1km from the site.	m^3	90.53		
1.6	25cm thick basaltic or equivalent stone hardcore, well rolled, consolidated & blinded with crushed stone	m^2	22.96		
	Total to summary				
2	**Concrete Work**				
2.1	5cm thick lean concrete class C-5 , 150 kg cement / m3 concrete, under masonry foundation wall. a) under masonry	m^2	19.72		
2.2	Reinforced concrete, C-25, 360 kg cement/m3 of concrete filled in to form work and vibrated around reinforcement measured separately. a) in grade beam	m^3	1.20		
2.3	In 15 cm thick RC ground floor slab class C-20 with minimum cement content of 320 kg/m3 evenly spread	m^2	22.61		
2.4	Provide cut and fix in position sawn zigba formwork or equivalent. a) for grade beam b) for ground slab c) support poles of 8mm diameter & 3m length	 m^2 m^2 no	 18.86 25.54 30		
2.5	Steel reinforcement according to drawing cut, bend & placed in position, unit price shall include cutting, bending & placing in position & tying wires. a) Φ 6mm b) Φ 10mm c) Φ 12mm	 kg Kg Kg	 42.87 109.70 128.80		
	Total to summary				

S.n	Description	Unit	Qty.	Unit Price	Total Price
3	**Masonry Work**				
3.1	500mm thick trachytic or equivalent stone masonry below ground level bedded without cement mortar.	m^3	35.84		
3.2	The top 50 cm masonry bedded with cement mortar(1:3)	m^3	5		
	Total to summary				
3.2	20X20X40cm Solid Concrete Block Pit Partition Wall "class C" bedded in cement sand mortar 1:3 both side left for plastering	m^2	23.4		
	Total to summary				
	B. Super-Structure				
1	**Concrete Work**				
1.1	Reinforced concrete, C-25, 360 kg cement/m3 of concrete filled in to form work and vibrated around reinforcement measured separately.				
	a) In elevation columns	m^3	0.37		
	b) In top tie beam	m^3	0.46		
1.2	Provide cut and fix in position sawn zigba formwork or equivalent.				
	a) to elevation columns	m^2	14.72		
	b) to top tie beam	m^2	12.08		
1.3	Steel reinforcement according to drawing cut, bend & placed in position, unit price shall include cutting, bending & placing in position.				
	a) Φ 6mm	Kg	21.26		
	b) Φ12mm	Kg	107.63		
	Total to summary				
2	**Concrete Block Work Above Grade Walls**				
2.1	20X20X40cm HCB Wall "class B" bedded in cement sand mortar 1:3 both side left for plastering	m^2	30.70		
2.2	15X20X40cm HCB Wall "class B" bedded in cement sand mortar 1:3 both side left for plastering	m^2	19.97		
3	**San Plat (60x60 cm^2) one for each toilet room**	No	4		
	Total to summary				

Item No	Description	Unit	Qty.	Unit Price	Total Price
4	**Roof Work**				
4.1	Roof cover in G32 CIS Nailed to 5x7cm battens as proposed by the Engineer.	m^2	16.85		
4.2	Supply and fix G-32 galvanized sheet metal gutter and down pipe a) Gutter 60cm devt. b) Down pipe 33cm devt.	 ml ml	 6.8 2.8		
5	Vent Pipe a) PVC vent pipe 0 110 mm (each vent 4.2m length)	 no	 4		
	Total to summary				
6	**Carpentry Work**				
	All structure truss members shall be in seasoned eucalyptus wood and painted two coats of anti termite solution and shall be tight fixed with top tie beam with 6mm diameter plain bar.				
6.1	Diameter 8cm eucalyptus upper and lower chord	ml	17.82		
6.2	Diameter 6cm eucalyptus vertical and diagonal members	ml	8.28		
6.3	50x70mm zigba roof purlin	ml	24.6		
	Total to summary				
7	**Metal Work (Door)**				
	All metal doors are manufactured from locally produced LTZ seiko steel profile frames. All works should be cut and assembled to sizes and shapes of the door schedule upon submitting workshop drawing by the contractor. Unit price includes cylinder lock or similar, door stoppers and other necessary accessories for completing the work. All according to doors schedule and as specified.				
7.1	Type D1, size:- 90x210cm	No	1		
7.2	Type D2, size:- 70x210cm	No	3		
7.3	Door Lock	No	4		
	Total to summary				
8	**Plastering and Pointing**				
8.1	Pointing to all Internal and External HCB wall surfaces with cement sand mortar 1:2	m^2	93.37		
8.2	Apply three coats of plastering to beam & columns surface	m^2	38.14		
8.3	Average thickness of 5cm roughened cement sand screed with 0.1 aggregate mix, price includes chiseling of floor	m^2	28.44		
8.4	Stone riprap foot path in front and around the latrine	m^2	39.41		
	Total to summary				

S.n	Description	Unit	Qty.	Unit Price	Total Price
	II. URINAL BLOCK				
	A. Sub-Structure				
1	**Excavation & Earth Work**				
1.1	Clear off the site to remove top soil to an average depth of 30 cm	m^2	10.13		
1.2	Bulk excavation to reduce level excavation to ordinary soil not exceeding 1.5m	m^3	4.70		
1.3	Back fill under hard core & around masonry with selected granular borrowed material from out side & well ram in layers not exceeding 20 cm thick until it attains a minimum of 95 % proctor density.	m^3	2.51		
1.4	Cart away surplus excavated material & deposit at a distance not exceeding 1km from the site.	m^3	5.23		
1.5	25cm thick basaltic or equivalent stone hardcore, well rolled, consolidated & blinded with crushed stone	m^2	8.38		
	Total to summary				
2	**Concrete Work**				
2.1	5cm thick lean concrete class C-5 , 150 kg cement / m3 concrete, under masonry foundation wall. a) under masonry	m^2	4.38		
2.2	Reinforced concrete, C-25, 360 kg cement/m3 of concrete filled in to form work and vibrated around reinforcement measured separately. a) in grade beam	m^3	0.35		
2.3	Provide cut and fix in position sawn zigba formwork or equivalent. a) for grade beam	m^2	3.50		
2.4	Steel reinforcement according to drawing cut, bend & placed in position, unit price shall include cutting, bending & placing in position & tying wires. Φ 6mm Φ 12mm	 kg kg	 7.42 33.03		
	Total to summary				

Item No	Description	Unit	Qty.	Unit Price	Total Price
3	**Stone masonry**				
3.1	500mm thick trachytic or equivalent stone masonry ground level bedded in cement mortar (1:4) in full joints.	m^3	1.85		
3.2	Urinal trough masonry	m^3	0.7		
	Total to summary				
	B. Super-Structure				
1	**Concrete work**				
1.1	Reinforced concrete, C-25, 360 kg cement/m3 of concrete filled in to form work and vibrated around reinforcement measured separately. a) in elevation columns	m^3	0.18		
1.2	Provide cut and fix in position sawn zigba formwork or equivalent. a) to elevation columns	m^2	7.20		
1.3	Steel reinforcement according to drawing cut, bend & placed in position, unit price shall include cutting, bending & placing in position. a) Φ 6mm b) Φ12mm	Kg Kg	4.05 18.12		
	Total to summary				
2	**Concrete Block Work Above Grade Walls**				
2.1	20X20X40cm HCB Wall "class B" bedded in cement sand mortar 1:3 both side left for plastering	m^2	12.53		
	Total to summary				
3	**Finishing work**				
3.1	Apply three coats of plastering to internal wall surface	m^2	5.01		
3.2	Pointing to Internal and External HCB wall surfaces with cement sand mortar 1:2	m^2	20.04		
3.3	Apply three coats of plastering to beam & columns surface	m^2	5.90		
3.4	Plastering urinal trough	m^2	3.22		
3.5	Supply and made an average thickness of 5cm roughened Cement sand screed with 0.1 aggregate mix, price Includes chiseling of floor.	m^2	8.38		
	Total to summary				

Item No	Description	Unit	Qty.	Unit Price	Total Price
4	**Painting**				
4.1	Apply three coats of approved type oil paint to internal plastered wall surface H=1000	m^2	8.35		
	Total to summary				
	III. HAND WASHING FACILITY				
1	**Water trough masonry work**				
1.1	400 mm thick trachytic or equivalent stone masonry above ground level bedded in cement mortar (1:3) in full Joints.	m^3	0.992		
1.2	Apply three coats of plastering to External trough surface	m^2	5.68		
1.3	Supply & install a 25 lit fiber plastic ground water tank with an out let ½ ‘ pipe price shall include fixing in position and complete the system with all its necessary Accessories to make the system workable.	No.	4		
	Total to summary				
	Grand Total				

Annex c: Table 3 - A Four seat latrine for Boys

S. No	Description	Unit	Qty.	Unit Price	Total Price
	1. Latrine Block				
	A. Sub-Structure				
1	**Excavation & Earth Work**				
1.1	Clear off the site to remove top soil to an average depth of 30 cm	m^2	68.16		
1.2	Bulk excavation to reduce level excavation to ordinary soil not exceeding 1.5m	m^3	39.74		
1.3	Over 1.5m not exceeding 3.0 m	m^3	37.34		
1.4	Back fill under hard core & around masonary with selected granular borrowed material from out side & well ram in layers not exceeding 20 cm thick until it attains a minimum of 95 % proctor density.	m^3	6.04		
1.5	Cartaway surplus excavated material & deposit at a distance not exceeding 1km from the site.	m^3	91.47		
1.6	25cm thick basaltic or equivalent stone hardcore, well rolled, consolidated & blinded with crushed stone	m^2	26.07		
	Total to summary				
2	**Concrete Work**				
2.1	5cm thick lean concrete class C-5 , 150 kg cement / m3 concrete, under masonary foundation wall. a) under masonary	m^2	19.64		
2.2	Reinforced concrete, C-25, 360 kg cement/m3 of concrete filled in to form work and vibrated around reinforcement measured separately. in grade beam	m^3	1.20		
2.3	In 15 cm thick RC ground floor slab class C-20 with minimum cement content of 320 kg/m3 evenly spread	m^2	22.02		
2.4	Provide cut and fix in position sawn zigba forkwork a) or equivalent. b) for grade beam c) for ground slab support poles of 8mm diameter & 3m length	 m^2 m^2 no	 18.94 24.91 30		
2.5	Steel reinforcement according to drawing cut, bend & placed in position, unit price shall include cutting, bending & placing in position & tying wires. a) Φ 6mm b) Φ 10mm c) Φ 12mm	 kg kg kg	 42.87 109.70 128.80		
	Total to summary				

S.n	Description	Unit	Qty.	Unit Price	Total Price
3	**Masonry Work**				
3.1	500mm thick trachytic or equivalent stone masonary below ground level bedded without cement mortar.	m^3	33.59		
3.2	The top 50 cm masonry bedded with cement mortar (1:3)	m^3	5		
	Total to summary				
3.2	20X20X40cm Solid Concrete Block Pit Partition Wall "class C" bedded in cement sand mortar 1:3 both side	m^2	31.2		
	left for plastering				
	Total to summary				
	B. Super-Structure				
1	**Concrete Work**				
1.1	Reinforced concrete, C-25, 360 kg cement/m3 of concrete filled in to form work and vibrated around reinforcement measured separately.				
	In elevation columns	m3	0.37		
	In top tie beam	m^3	0.60		
1.2	Provide cut and fix in position sawn zigba forkwork or equivalent.				
	to elevation columns	m^2	14.72		
	to top tie beam	m^2	12.08		
1.3	Steel reinforcement according to drawing cut, bend & placed in position, unit price shall include cutting, bending & placing in position.				
	a) Φ 6mm	Kg	21.26		
	b) Φ12mm	Kg	107.63		
	Total to summary				
2	**Concrete Block Work Above Grade Walls**				
2.1	20X20X40cm HCB Wall "class C" bedded in cement sand mortar 1:3 both side left for plastering	m^2	30.70		
2.2	15X20X40cm HCB Wall "class C" bedded in cement sand mortar 1:3 both side left for plastering	m^2	19.97		
3	**San Plat (60x60 cm^2) one for each toilet room**	No	4		
	Total to summary				

S.n	Description	Unit	Qty.	Unit Price	Total Price
4	**Roof Work**				
4.1	Roof cover in G32 CIS Nailed to 5x7cm battens as proposed by the Engineer.	m^2	16.85		
4.2	Supply and fix G-32 galvanized sheet metal gutter and down pipe Gutter 60cm development Down pipe 33cm devevelopment	 ml ml	 6.8 2.8		
5	**Vent Pipe**				
	a) PVC vent pipe 0 110 mm (each vent 4.2m length)	no	4		
	Total to summary				
6	**Carpentry Work**				
	All structure truss members shall be in seasoned eucalyptus wood and painted two coats os anti termite solution and shall be tight fixed with top tie beam with 6mm diameter plain bar.				
6.1	Diameter 8cm eucalyptus upper and lower chord	ml	17.82		
6.2	Diameter6cm eucalyptus vertical and diagonal members	ml	8.28		
6.3	50 x 70mm zigba roof purlin	ml	24.6		
	Total to summary				
7	**Metal Work**				
	All metal doors are manufactured from locally produced LTZ seiko steel profile frames. All works should be cut and assembled to sizes and shapes of the door schedule upon submitting workshop drawing by the contractor. Unit price includes cylinder lock or similar, door stoppers and other necessary accessories for completing the work. All according to doors schedule and as specified.				
7.1	Type D1, size:- 90x210cm	No	1		
7.2	Type D2, size:- 70x210cm	No	3		
7.3	Door Lock	No	4		
	Total to summary				
8	**Plastering and Pointing**				
8.1	Pointing to all Internal and External HCB wall surfaces with cement sand mortar 1:2	m^2	93.37		
8.2	Apply three coats of plastering to beam & columns	m^2	36		
8.3	surface Supply and made an average thickness of 5cm roughened Cement sand screed with 0.1 aggregate mix, price Includes chiseling of floor.	m^2	32.01		
8.4	Stone riprap foot path in front and around the latrine	m^2	21.85		
	Total to summary				

S.n	Description	Unit	Qty.	Unit Price	Total Price
	II. Urinal Block				
	A. Sub-Structure				
1	**Excavation & Earth Work**				
1.1	Clear off the site to remove top soil to an average depth of 30 cm	m^2	6.08		
1.2	Bulk excavation to reduce level excavation to ordinary soil not exceeding 1.5m	m^3	3.70		
1.3	Back fill under hard core & around masonary with selected granular borrowed material from out side & well ram in layers not exceeding 20 cm thick until it attains a minimum of 95 % proctor density.	m^3	1.20		
1.4	Cartaway surplus excavated material & deposit at a distance not exceeding 1km from the site.	m^3	4.32		
1.5	25cm thick basaltic or equivalent stone hardcore, well rolled, consolidated & blinded with crushed stone	m^2	4.00		
	Total to summary				
2	**Concrete Work**				
2.1	5cm thick lean concrete class C-5 , 150 kg cement / m3 concrete, under masonary foundation wall. a) under masonary	m^2	3.50		
2.2	Reinforced concrete, C-25, 360 kg cement/m3 of concrete filled in to form work and vibrated around reinforcement measured separately. a) in grade beam	m^3	0.28		
2.3	Provide cut and fix in position sawn zigba forkwork or equivalent. a) for grade beam	m^2	2.80		
2.4	Steel reinforcement according to drawing cut, bend & placed in position, unit price shall include cutting, bending & placing in position & tying wires. a) Φ 6mm b) Φ 12mm	 kg kg	 6.07 26.82		
	Total to summary				

S.n	Description	Unit	Qty.	Unit Price	Total Price
3	**Stone masonry**				
3.1	500mm thick trachytic or equivalent stone masonry below ground level bedded in cement mortar (1:4) in full joints.	m^3	1.32		
3.2	Urinal trough masonry work	m^3	0.553		
	Total to summary				
	B. Super-Structure				
1	**Concrete work**				
1.1	Reinforced concrete, C-25, 360 kg cement/m3 of concrete filled in to form work and vibrated around reinforcement measured separately. a) in elevation columns	m^3	0.12		
1.2	Provide cut and fix in position sawn zigba formwork or equivalent. a) to elevation columns	m^2	4.80		
1.3	Steel reinforcement according to drawing cut, bend & placed in position, unit price shall include cutting, bending & placing in position. a) Φ 6mm b) Φ12mm	Kg Kg	2.70 12.08		
	Total to summary				
2	**Concrete Block Work Above Grade Walls**				
2.1	20X20X40cm HCB Wall "class B" bedded in cement sand mortar 1:3 both side left for plastering	m^2	8.10		
	Total to summary				
3	**Finishing work**				
3.1	Apply three coats of plastering to internal wall surface	m^2	3.24		
3.2	Pointing to Internal and External HCB wall surfaces with cement sand mortar 1:2	m^2	12.96		
3.3	Apply three coats of plastering to beam & columns surface	m^2	5.20		
3.4	Plastering urinal trough	m^2	3.22		
3.5	Supply and made an average thickness of 5cm roughened Cement sand screed with 0.1 aggregate mix, price Includes chiseling of floor.	m^2	4.00		
	Total to summary				

S.n	Description	Unit	Qty.	Unit Price	Total Price
4	**Painting**				
4.1	Apply three coats of approved type oil paint to internal plastered wall surface H=1000	m^2	5.40	22	118.8
	Total to summary				**118.8**
	III. Hand wash area				
1	**water trough masonry work**				
1.1	400 mm thick trachytic or equivalent stone masonry above ground level bedded in cement mortar (1:3) in full Joints.	m^3	0.992	545	540.64
1.2	Apply three coats of plastering to External trough surface	m^2	5.68	66	374.88
1.3	Supply & install a 25 lit fiber plastic ground water tank with an out let ½ ‘ pipe price shall include fixing in position and complete the system with all its necessary Accessories to make the system workable.	No.	4	100	400
	Total to summary				1315.52
	GRAND TOTAL				89,370.45

Section 13: References and Additional Information

Cairncross, Sandy, and Richard Feachem, 1999. Environmental Health Engineering in the tropics. An introductory text. Second Edition.

Density of materials. http/: WWW. SI metric.co.uk

FDRE. Ministry of Health. 2005. National Hygiene and "on-site" Sanitation Protocol.

Gotaas, B. H. 1956. Sanitary Disposal and Reclamation of Organic Wastes, World Health Organization.

WHO. 2005. Water, Sanitation and Hygiene. CD-ROM

UNICEF and Government of Malawi. 2005. School Water Sanitation and Hygiene Education: A manual for planning, construction and supervision of facilities. Malawi SWSHE.

Moorijman, A. Caroline Van den Berg, Lene Odum ? Toolkit on Hygiene Sanitation and Water in Schools. Publication of UNICEF and Water and Sanitation Program of the World Bank.

Water supply and sanitation facilities in schools, coupled with the promotion of hygiene, have a great influence on the quality of education received by school children, especially girls.

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የትምህርት ሚኒስቴር
The Federal Democratic Republic of Ethiopia
Ministry of Education

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Design and Construction Manual
For Sanitary Facilities in Primary Schools in Ethiopia

The Federal Democratic Republic of Ethiopia
Ministry of Education, Health and Water Resources