



# UNIVERSITY OF KWAZULU-NATAL

SCHOOL OF CIVIL ENGINEERING,  
SURVEYING AND CONSTRUCTION

## OPTIMIZATION OF THE CONSTRUCTION OF VIP TOILET SANITATION AT CLINICS IN RURAL AREA

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# **1. INTRODUCTION**

The provision of sanitation is a human right policy in South Africa and plays an important part in preventing the spread of diseases. Therefore it is necessary of having people from different walk of life involved in the planning, selection and implement sanitation improvements.

The improvement of quality sanitation, especially in the rural areas that has inadequate sanitation facilities, will ensure that there is an improvement in human health and hygiene benefits, creating employment opportunities, generate economic benefits, and contribute to human dignity and social development.

According to the case study of the Business Plan compiled for the Umkhanyakude District Municipality a total of 33 clinics were included in an initial baseline survey and 20 clinics were identified as not having adequate sanitation facilities. [District Municipality Sanitation Programme December 2003: “*Clinic Sanitation Project Implementation Plan: KN-Revised District Municipality: (DC 27)*”]

Many of these constructed VIP toilets, including those at clinic sites, has many deficiencies including door design not allowing for complete privacy, not suitable for use by elderly people, no preventative measures of underground pollution and insufficient fly control, bad odours and inadequate provision of facilities for the disable.

In the pre democracy period before 1994, sanitation was regarded as mainly a procedural task (providing sewer reticulation, construction of toilets, operational management etc) with other the facet of health, social and environment given secondary consideration.

## **1.1 OVERVIEW**

### **1.1.1 Overview:**

Many dispersed rural communities in KwaZulu-Natal have inadequate public sanitation facilities and an erratic water supply that is inappropriate for the provision of water-borne sewage systems. Ventilated Improved Pit (VIP) technology is investigated for the provision

of sustainable sanitation systems in rural clinics for public operation.

Although a VIP technology is being offered, the toilets should in all other respects offer the same level of service and convenience as water borne toilets. A pilot project introduced by Umkhanyakude District Municipality has been implemented to address the clinic sanitation requirements and provides a case study. [District Municipality Sanitation Programme December 2003: “*Clinic Sanitation Project Implementation Plan : KN-Revised District Municipality: (DC 27)*”]

### **1.1.2 Aim:**

The research aims to examine the factors that influence the various technology choices, technical considerations and the various construction cost comparisons between rural and urban clinic sanitation. The clinic sanitation programme makes the provision to upgrade existing sanitation facilities or provide new facilities at clinics and public places where the existing facilities do not provide a basic level of service for the rural Municipality. Sustainable sanitation systems for rural clinics based on utilizing VIP technology are investigated for public operation rather than just for individual households.

### **1.1.3 Objectives:**

Primary objectives of the case study sanitation proposal are to address the clinic sanitation backlog in the area by providing support for sustainable sanitation and health and hygiene training to each of the un-serviced clinics, provide new facilities at public institution e.g. clinics where the existing facilities do not provide the minimum sanitation service and to ensure that there are functioning basic sanitation facilities at all the community clinics within the Umkhanyakude District Municipality.

### **1.1.4 Expected outcomes:**

The rural clinic sanitation plan and programme is to contribute to improving the well-being and quality of life of the community. Significant investments are being made in the water sector within South African borders. Water supply and sanitation needs to be linked with health and hygiene education so that lasting health benefits can follow.

### **1.1.5 Methodology**

The historical background relating to South African sanitation examining the situation in the period before and after the election year 1994, followed by the period 1994 to 2001, and thereafter continuing to the present time frame for the implementation and policy of sanitation services is outlined in Chapter 2.

Chapter 3 discusses the impact of inadequate sanitation services with reference to the health and socio-economic benefits and the effects of sanitation on the environment.

Chapter 4 incorporates the case study of Umkhanyakude District Municipality (UDM) with implementation of the clinic sanitation project, priority requirements and clinic sanitation project steering committee. Chapter 5 outlines the existing infrastructure of UDM.

The technical consideration for the case study and the different toilet options are discussed in Chapter 6 including the sanitation situation in other parts of the world.

The factors influencing the technology choice for rural clinics is prepared in Chapters 7 and environment impact with groundwater protection protocol outlined in Chapter 8.

Chapter 10 investigates the alternative types of VIP, use of different methods and materials for the construction of toilets with breakdown analysis of the various cost comparisons for the construction of toilets reviewed in Chapter 11.

The local community participation, for the construction of rural toilets, relating to gender issues, labour based construction, employment policy, wages and labour standards is referred in Chapter 12.

Chapter 13 outlines the impact of construction of toilets on the local people.

Education of sanitation facilities is discussed in chapter 14 and recommendations and the conclusion are outlined in Chapter 15.



## **2. HISTORICAL BACKGROUND TO SANITATION IN SOUTH AFRICAN**

Recent South African history relevant to the provision of sanitation can be considered in the following three distinct periods:

### **2.1 Period: Pre – 1994**

Prior to the election of a democratic Government in 1994, South Africa was divided into eleven different “homeland” administrative and political areas: (Transkei, Bophuthatswana, Venda, and Ciskei), six “self-governing territories” and territory, governed by the tri-cameral parliament (House of Assembly — 178 members, reserved for whites; House of Representatives — 85 members, reserved for Coloureds, or mixed-race, people; and House of Delegates — 45 members, reserved for Asians) resulting in a disjointed method of service and lacking strategy. The disadvantage territories had non existence service available particular rural clinics and school. Provision of sanitation services in the tribal authorities was discouraged.

[DWAF, 2002: *The development of a sanitation policy and practice in South Africa.*]

Little consideration if any was given to health and hygiene education to community. A key basis of concern was groundwater pollution from with on-site sanitation systems.

### **2.2 Period: 1994 to 2001**

During the period in which the new Constitution was implemented, the new government in 1994 made the supply of water and sanitation the main instrument of service delivery. A new Department of Water Affairs and Forestry (DWAF) was established on 1 July 1994 to manage the water supply and sanitation.

### **2.3 Period: 2001 to the Present**

The period commenced with the re-organizing of many of the Provincial and Local Government Departments, so that the challenges of the under -service sanitation and safe water delivery programme could be fulfilled. However the demands for municipal

infrastructure in many cases exceeded supply, resulting in sanitation and water provision backlog..

After the installation of the National Sanitation Programme, the Government promoted the awareness campaign for the health and hygiene issues and provision of toilets as the two primary deliverables that could meet the target.

Secondary deliverables, including training and capacity building elements and empowering communities through education.

During this period the community priorities were aligned with the Integrated Sustainable Rural Development Strategy process in order to utilize synergy of effort.

### **3. THE SANITATION ISSUE**

The South African Government is accountable for the delivery of sanitation services throughout the country and to provide adequate sanitation including toilets in the public domain. Under The Constitution of South Africa the obligation upon central government is to make sure that: *"Everyone has the right to an environment that is not harmful to their health or well-being."* [ Constitution of SA, Act 108 of 1996, Page 11]. This commits the Government to implement the sanitation services through the local government structures to advance the quality of life by improving the sanitation facilities for the householder, for the public and the protection of the environment.

Sanitation in South Africa is closely linked with the provision of the water resource thus ensuring that the health and hygiene component is part of the integrated development process to provide all citizens of South Africa adequate sanitation services.

Inadequate sanitation facilities, insufficient education with regards to health and hygiene, limited access to adequate sanitation facilities (including improved latrines), inadequate water supply, limited primary care facilities especially to women, and the safe disposal of domestic waste are the major contributions of the sanitation problems encountered in our country.

The health benefit, socio economic benefit and the environment impact is a vital component of sanitation in South African

#### **3.1 Health Benefit:**

One of the important goals of any newly constructed sanitation project is to improve the health and safety facilities of toilet especially amongst the rural communities

Improved sanitation facilities like providing a hand washing facility at the toilet(either inside or outside) where hands can be washed under running water with soap will result in unsurpassed health and hygiene benefits. In many rural areas where people live there is water, not necessary enough for waterborne system but may be sufficient for hand washing. The hand washing reduces contamination and sanitation related diseases like diarrhea, dysentery and pneumonia.

The hand washing facility comprises of a small tank, hand washbasin, cistern all functioning to bring the message of health and hygiene.

Also include in health benefits is safe water storage, food hygiene and good waste management that can be promoted through implementation of appropriate awareness campaigns throughout all communities.

The Government and private companies are committed to continue the ongoing research and development programme that will sustain the various health issues. Fighting poverty in providing health and hygiene and ecological friendly food generating programmes for householders. There is a need to continue with sustainable and effective education to schools and householders on the subject of health, hygiene, Aids awareness and growing vegetables for themselves.

### **3.2 Socio Economic Benefit:**

The construction of VIP toilet for clinic sanitation project is very conducive to labour intensive construction techniques.

Helping people to help themselves, especially in rural areas, requires understanding of the social values of the different communities so that the local representative can be involved with the planning and construction of sanitation projects. The education of the community with regards to the sanitation programme should be appropriate, relevant and cost effective so that it is easily acceptable by the people. The programme should ensure that women, children and unemployed are empowered and the indigenous knowledge and local skills are utilized.

Skilled artisans, including builders, block layers; carpenters, etc. will be sourced from the community and will only be brought into the area if these artisans are not available or not competitively priced.

The sanitation programme should empower the people through the transfer of skill, training, technologies and make provision of sustainable job opportunities for the implementation of sound sanitation practices.

### **3.3 Environmental impact:**

The conventional pit latrines designed without a lined pit has the ability to contaminate the water source. However, the construction of lined VIP latrine is one of the most feasible way of improving sanitation environmental problems. The long term risk of contamination is reduced by the design lined pit.

The proper operation and maintenance of sanitation system, after the construction of toilets, is also critical to protect the environment.

Sanitation systems should be part of the environmental protection and enhancement, and not part of its pollution. There are many threats of pollution, particularly to the water supply, where there are inadequate or no sanitation systems or where they do not work properly.

Sanitation services which impact negatively on the environment are considered to be inadequate.

#### **4. CASE STUDY: UMKHANYAKUDE DISTRICT MUNICIPALITY**

The Umkhanyakude District Municipality is a remote rural municipality located in the far north-east of the province, bounded on the north by Swaziland and Mozambique, and on the east by the Indian Ocean. The area of the district municipality is 12 800 km<sup>2</sup> serving a population of 490 000. It is an impoverished community with limited infrastructure. Many roads are unformed dirt tracks, and the municipal reticulated water supply is combined with boreholes and tanker services. Water-borne sewage disposal and electricity supply is virtually non-existent outside the built-up areas.

Sanitation facilities at clinics vary from area to area in the Province of KwaZulu-Natal.

The District Municipality has identified the need for a clinic sanitation project in terms of the Strategy and Funding being offered by the Department of Water Affairs and Forestry (DWAF) and the Department of Health. Thirty three clinics are included in an initial baseline survey and 20 clinics identified as not having adequate sanitation facilities or require renovation. [District Municipality Sanitation Programme December 2003: “*Clinic Sanitation Project Implementation Plan : KN-Revised District Municipality: (DC 27)*”]

##### **4.1 Implementation of the Clinic Sanitation Project:**

The implementation of the Clinic Sanitation Project Implementation Plan is to provide basic sanitation to clinics that do not have safe and basic sanitation facilities and provide support to disadvantaged rural community ensuring that these clinics has the basic sanitation in the form of Ventilated Improved Pit (VIP) latrine or suitable alternatives based on the local infrastructure and requirements and may include higher levels of services such as water borne sewage.

##### **4.2 Priority requirements:**

As part of the Business Plan (BP) a baseline survey of clinics within the District Municipality area has been compiled and prioritized by the Department of Health (DOH). Refer to Table 1 Baseline information.

Based on the information collected including the preliminary work, the BP has been prepared to address the provision of basic sanitation backlog at clinics undertaking the

following activities:

- The preparation of working drawings, specifications, schedule of quantities and associated documentation for local building contractors to be appointed to complete the building or up-grading of toilets and the closing down of non functional units.
- Providing training, support and supervision to local building contractors to enable them to complete the municipal tender procedures, be appointed and successfully plan and complete the work.
- The establishment and facilitation of a Sanitation Project Steering Committee for the liaison and cooperation between the different Departments and the local communities.
- Through the involvement of the DOH, develop processes and identify training requirements to ensure that existing structures and systems are functioning effectively to operate and maintain clinic sanitation facilities. Also to promote good health and hygiene practices to clinic patients.
- To project manage and monitor the proposed work.

#### **4.3 . Clinic Sanitation Project Steering Committee (SPSC)**

A Clinic Sanitation Project Steering Committee has been established consisting of representatives from the DoH, DWAF, the Local Municipality and selected ward and clinic committee members. Its roles and responsibilities include ensuring the local community is involved and benefits during implementation, and the Departments involved accept their responsibilities for operation and maintenance of the facilities.

The SPSC's primary role has been to represent the community on issues relating to the decisions on the project. The SPSC will also assist the Implementing Agent in the following:

- Identification of beneficiary clinics in consultation with the DOH.
- Communication with the community at large and creating awareness regarding the project procedures and sanitation requirements.
- Sanitation, health and hygiene awareness and sanitation demand creation implemented by the ISD Consultant.
- Identification of local labour, builders, plasterers and quality assessors for employment on the projects.
- General liaison between the Tribal Structures, community, beneficiaries and the IA

and service providers.

- To ensure local community participation and benefits during the implementation of the project.
- To be well informed about the project and able to respond to any requests for information about the project.
- To inform the project management team about any issues of concern raised by the larger community.
- To facilitate the practical operation of facilities and promotion of hygiene.
- Assist with the handover process upon completion of clinic toilets.
- Serve as a point of reference during the one-year mentorship period.

There is an Environmental Health Officer (EHO) linked to each clinic or a circuit of clinics and are working in the communities on a continuous basis. The EHO have been informed about the project, which should assist them as they raise awareness about the benefits of using sanitation facilities and having improved personal health practices.



**Table 1: Clinic Sanitation: Baseline information - requirements by the Department of Health**

Sanitation Type	Water Borne Toilets		Pit Latrine Toilets		Water Tanks		Disabled toilets		Daily Attendance
	Existing	Required	Existing	Required	Existing	Required	Existing	Required	
Name - Clinic									
<b>Hlulhuwe</b>									
Mduku	6	6	0	2	7	3	0	1	
Mngqobokazi	5	5	0	2	8	2	0	1	
Ezimpondweni	6	4	0	2	5	3	0	1	
<b>KZ 272</b>									
<b>Mosvold Hospital</b>									
Nkungwini	6	4	2	2	4	1	0	1	
Ekuhlekleni	5	5	2	2	4	1	2	0	
Manyiseni	0	10	4	4	6	4	0	4	
Mbadleni	4	6	2	2	2	3	0	1	
Ndumo	4	6	0	4	5	2	0	1	
Shemula	4	6	2	2	7	1	0	2	
Khwambusi	2	8	4	1	3	2	2	0	
Nondbuya	4	4	0	2	4	2	0	1	
Phondweni	6	4	0	2	4	2	0	2	
Ghalweni	2	4	2	2	2	4	0	2	
<b>Manguzi Hospital K271</b>									
Zama Zama	2	6	4	2	4	4	0	2	
Kwandaba	4	4	1	3	4	2	0	2	
Bhekabantu	6	4	0	2	6	2	0	2	
Phelandaba	4	6	0	4	1	0	0	2	
Mahlungulu	4	6	0	4	3	2	0	2	
Mshudu	4	4	0	2	3	2	0	2	
Thengani	2	3	1	4	2	3	0	2	
Kwazibi									
<b>KZ 271</b>									
<b>Mseleni Hospital</b>									
Manaba	6	5	3	2	2	3	0	2	60
Ntshonglie	4	4	0	2	3	2	0	2	76
Mbazwana	4	6	0	4	0	5	0	2	180
Mabibi	5	1	3	1	2	2	0	2	330
<b>KZ 272</b>									
<b>Bethesda Hospital</b>									
Makathini	20	0	0	4	3	5	0	2	1714
Madonella	1	13	0	4	2	4	0	2	1527
Mboza	3	113	0	5	3	3	0	2	2311
Jozini	5	9	0	2	8	3	0	2	3230

Table 1 continued

Mkuze	5	5	0	2	1	3	0	2	2334
Mhekazi	4	4	0	6	9	31	0	2	924
Ophansi	4	6	2	4	3	3	0	2	2461
Gedleza	6	4	2	2	10	0	0	22	1516
<b>Total -33</b>	<b>147</b>	<b>275</b>	<b>34</b>	<b>88</b>	<b>130</b>	<b>109</b>	<b>4</b>	<b>75</b>	

[District Municipality Sanitation Programme December 2003: “*Clinic Sanitation Project Implementation Plan : KN-Revised District Municipality: (DC 27)*”]

The situation at Umkhanyakude District Municipality indicates that there is a need of an additional 363 toilets for waterborne and pit latrines as a provision of adequate basic toilet facilities for visitors and toilets that can be temporarily used by staff and patients during interruptions in water supply. There are 4 existing disable toilets located within the district municipality jurisdiction. The Municipality requires an additional 75 disable toilets to be constructed.

There are 147 existing waterborne toilet and providing a more equitable distribution of water, many of the municipal services have restored to rotating the available supply between the communities being served. As a result every community is experiencing restricted services with regular interruptions. Additional interruptions occur when there are power failures, mechanical breakdown and other operational problems. To try and provide a more reliable supply to the clinics, every clinic has on site storage but this is not totally effective.

## **5. EXISTING INFRASTRUCTURE – UMKHANYAKUDE DISTRICT MUNICIPALITY**

### **5.1 Water**

The existing water supplies to the clinics are a combination of reticulated municipal services, boreholes and tanker services. Because these supplies are not reliable, all the clinics have additional on site storage.

To provide a more equitable distribution of water, many of the local municipal services have resorted to rotating the available supply between the communities being served. As a result each community is experiencing restricted services with regular interruptions. Additional interruptions occur when there are power failures, mechanical breakdowns and other operational problems.

To try and provide a more reliable supply to the clinics, each clinic has on site storage but this is not totally effective. The storage is normally in two forms. The conventional raised storage tanks that are connected directly into the internal plumbing system. An emergency tank at ground level so that a tanker or a hosepipe can fill it. Tanks have a single outlet tap and water is carried to where it is required in buckets.

### **5.2 Sanitation**

Some larger clinics have inside waterborne toilets for staff, patients and visitors. Older clinics have typically two inside waterborne toilets for staff and patients with special needs, and outside toilets with a combination of water borne and pit type for general patients and visitors.

The water borne systems can only be operated when the water supply is adequate. For this reason clinic staff has to restrict the use of water borne facilities to ensure that the available water is used as effectively as possible.

All the clinics have existing pit latrines but most of them are not VIPs, especially in all the new clinics. In general they are not being maintained and many have full pits, and

dilapidated structures need replacing.

All the inside toilets have wash hand basins nearby. The outside toilets tend not to have wash hand basins and there is usually a single tap over a gully where washing of the hand takes place after use of toilet

All the inside toilets are kept clean and are in a serviceable condition. Where maintenance is required, it is undertaken by the Department of Public Works. Organising for work to be done is, however, a slow process because both departmental offices must process all requests before reaching the depot that will do the work. This delay can be frustrating and work is sometimes not completed.

The cleaning and maintenance of most of the outside toilets is not undertaken regularly and effectively. Many of the water borne toilets are either permanently locked or not utilized, or have been allowed to fall into a state of disrepair because there is insufficient water. The pit toilets in general are not cleaned or maintained. Dirty cubicles, fouled seats and floors and large amounts of domestic rubbish thrown into pits are typical problems.

Responsibility for cleaning the outside toilets is currently not well defined and is a contributing factor. The clinic cleaning staff considers the cleaning of outside toilets is the responsibility of the garden staff that considers the reverse. As a result, toilets are not cleaned which is to the detriment of all patients and visitors to the clinic.

### **5.3 Solid waste Disposal**

Two types of solid waste disposal are required at clinics:

- A system to dispose of general domestic waste,
- A special system to dispose of medical waste, in particular used needles, syringes and blades.

Domestic waste is disposed of on site in a waste pit. Combustible waste is burnt to reduce the volume and all the remaining waste is then buried. Most of the clinics appear to have established systems that are working effectively.

The disposal of medical waste is more complex and in general it is currently not being performed effectively. The correct procedure is for the individual clinics to collect this waste in dedicated bins and despatch it to a hospital where it can be incinerated. In practice,

despatching the waste to the hospital does not occur and the clinic staff has to dispose of it at the clinic. They do this by maintaining separate bins for surgical waste. They then endeavour to burn all this waste so that it is rendered harmless prior to disposal in the domestic waste pit. The clinic staff acknowledges that this is not an ideal practice. Some clinics have been provided with portable incinerators, and a tabletop gadget that grinds up all metal waste. The staff complains that these gadgets give off obnoxious odours and therefore they prefer not to utilize them.

## **6. DIFFERENT TOILET TECHNOLOGY OPTIONS**

Many dispersed rural clinics in KwaZulu-Natal have inadequate public sanitation facilities and an erratic water supply that is inappropriate for the provision of water-borne sewage systems. [District Municipality Sanitation Programme December 2003: “*Clinic Sanitation Project Implementation Plan : KN-Revised District Municipality: (DC 27)*”]

Ventilated Improved Pit (VIP) technology is investigated for the provision of sustainable sanitation systems in rural clinics for public operation. The pilot development was implemented by the Umkhanyakude District Municipality in conjunction with Department of Water and Forestry to determine problems associated with this approach.

### **6.1 Technical Considerations at Umkhanyakude District Municipality**

There are approximately 147 existing water borne toilets and 34 pit latrines servicing the clinics in Umkhanyakude District Municipality. The water borne toilets are adequately provided when there is water for their operation. Providing adequate toilets for visitors and toilets that can be temporarily used by staff and patients during interruptions in the water supply has become a challenge in clinic sanitation.

The technology offered must therefore be a dry sanitation process and providing VIP toilets is recommended. Where necessary the pit will be appropriately lined and detailed to reduce the risk of contamination of the groundwater.

Although a VIP technology is being offered, the toilets should in all other respects offer the same level of service and convenience as water borne toilets. The toilets will be located where they are accessible and convenient.

Existing toilets that do not comply with the minimum requirements of a VIP are a possible health hazard. These toilets will either be upgraded to meet the minimum requirements or be demolished. Existing pit toilets with either full pits or derelict superstructure are similar hazard and will be demolished and the pits filled in and sealed.

The composting toilets have been considered unsuitable for this application. The findings of the situation analysis are that the existing outside visitors toilets are not being used effectively or being cared for, as indicated by their lack of cleanliness and the large amounts of domestic rubbish in the pits. In this type of use environment, it is considered that composting toilets will not function effectively.

Separate female and male toilets are to be provided. More women and children attend the clinics than men and the Dept of Health have requested the provision of more cubicles for women than men. At least two cubicles will be provided for women for every one cubicle provided for men. Where the existing inside flush cubicles are not suitable, one cubicle will be provided with grab rails for use by disabled persons.

Improved hand washing facilities will also be provided. Because of the unreliable water supply, a hand washing facility will be provided separately, located between the toilets and the clinic building. It will specifically not be enclosed so that it is easier to monitor and wastage of water can be reduced. In addition to having taps connected to the internal plumbing system, there will be a shelf for setting up a temporary bucket and tap system that can be used when the water supply is interrupted.

## **6.2 Choice of technology**

Many factors influence the choice of sanitation technology that meets the requirements for Basic Sanitation and these include:

- Cost effective provision of services and accessible to maintenance and servicing of the toilet that can usually undertaken by local based members.
- Management- The choice of system that can be sustainable over the years
- Use of the local contractors targeting youth and women
- Sustainability of employment for the operational and maintenance.
- Improvements to health.

If a water supply is available a conventional, water borne system can be selected normally described as Wet system (Refer to Annexure A8 – full bore water sewerage).

In case of insufficient water supply the choice is limited and dry on plot system, whether a pit latrine, VIP or modern waterless unit, have, until now, been the only alternatives.

Because of local preferences, varying conditions and availability of building materials sourced from different areas, different variation of the VIP toilets were developed to suit South African needs.

Refer to Annexure A1 to A10 for existing example of the various toilet options.

The following information is provided for each technical option in Annexure 1 to 10:

- A description of the option;
- A sectional elevation detail drawing of the option;
- An estimated breakdown for the construction cost.

[DWAF, 2002: *Sanitation for the Healthy Nation February 2002: "Sanitation Technology Options"*].

Where higher levels of sanitation services are required, the cost of type of toilet construction is linked to the many variable including the availability of local resources of labour, material and the location of the site.

### **6.3.1 a. Dry on-plot systems**

#### **1. Ventilated Improved Pit (VIP) toilet**

The Ventilated Improved Pit (VIP) toilet is designed with a pit(called substructure) that is normally lined by the construction of brickwall. The top structure and the upper slab are recessed from the pit wall allowing for the vertical vent pipe to be positioned adjacent to the latrine. Two opening for the squat hole and the manhole are all additional holes visible on the top structure surface bed slab. The squat hole opening allows air to flow into the pit structure and up through the ventilation pipe, thereby extracting all foul odours. The VIP latrines design allows for the flies and insects to be attracted to the 100mm diameter vent pipe instead of the toilet pan region. The flies and insects tries to escape through the vent pipe, but are trapped in the pit by the fly screen located at the top of the pipe.

Refer to Annexure A1 Ventilated Improved Pit (VIP) on page 20, for sectional elevation of toilet, principles of operation, institutional requirements and the capital and operating cost.

The drawings for the different technology options were modified from: [DWAF, 2002: *Sanitation for the Healthy Nation, February 2002: "Sanitation Technology Options"*].





## ***2. Ventilated Improved Double Pit (VIDP) toilet***

The Ventilated Improved Double Pit (VIDP) toilet comprises of a single toilet top structure sitting over two shallow pits side by side with two vent pipes and squat holes. One pit vented by a pipe protected with a fly screen is used at any one time. The opening in the squat hole allows continuous air to flow into the pit structure and up through the ventilation pipe thereby extracting all foul odours. This VIP latrine design allows for the flies and insects to be trapped in the pit.

The two shallow VIPD is ideal where the rock substrata or ground water is within a meter or two from the natural ground level. The VIDP toilet operates similar to that of a VIP toilet using one pit. When this pit is filled, the squat hole and its vent pipe are completely sealed and the other pit used. The contents of the first sealed pit are excavated after the contents have been rendered harmless.

Refer to Annexure A2, Ventilated Improved Double Pit (VIDP) on page 22, for sectional elevation and details of toilet.



### ***3. Composting/urine diversion (UD) toilet***

The composting/urine diversion toilet has a top structure built on a vault with a cover manhole opening for removal of the composting waste. The fluids (urine, hand washing water) are completely separated at the source, leaving the faeces in the pit where it decreases in volume due to evaporation of organic material by natural microbial organisms into gases which are released through the vent pipe.

Once the first vault is full, the pan is transferred to the hole above the second vault and the first is sealed and allowed to stand. After the second vault is full of waste, the first vault is opened via a back plate and manually emptied by the householder or a contractor. The emptied contents are buried on the householder's property and, ideally, the burial site marked by planting a tree over it. The pedestal is then returned to its position above the first vault and the second vault is closed and left to stand while the first refills. It is expected that each vault will take between 6 months and one year to fill, resulting in a range of vault contents age of between 6 months and two years at the time at which they are removed from the vault.

The use of specially adapted pedestals may be used to separate/divert urine

Refer to Annexure A3 on page 24 for details of Composting/urine diversion



## **6.4 b. Wet systems**

### **4. *Pour-flush toilet***

A pour flush toilet is a toilet with a water-seal arrangement whereby a low flush pedestal is fitted into the floor slab. Water is used to wash waste away through a chute or short pipe to a collecting and soakaway waste disposal system. The water is retained in the water trap which acts as a seal against odour and insects. The pour-flush toilet experience failure when users deposit hard objects into the toilet, or where there is no regular emptying service.

Refer to Annexure A4 on page 26 for the pour- flush toilet details.



### **5. *Aqua-privy and soakaway***

The aqua privy is a toilet with a water-seal arrangement including a straight short chute connected to the pedestal to below the water level in the digester. The end of the chute in an aqua-privy requires the addition of water to keep it submerged. Water is used to wash waste through a short pipe to a collecting and soakaway waste disposal system. The aqua-privy has a soakaway incorporated in the collection system

Refer to Annexure A5 on page 28 for the Aqua privy toilet detail.





## **6. *Conservancy tank***

The top structure comprises of a full or low flush toilet pan. Waste is flushed into a water tight (normally sealed) tank to prevent contamination of the ground environment. When the tank is filled the waste is removed by local tanker to a treatment plant. The design of the water tight tank is dependent on the domestic waste water, flushing volumes and the availability of the treatment and disposal facilities.

This system with the lined water tank is environmental sensitive to prevention contamination of ground water.

Refer to Annexure A6 on page 30 for details of conservancy tank



### **7. *No Water Consumption System (NOWAC)***

The top structure of the No Water Consumption System (NOWAC) comprises only the seat as the mechanical part. The main tank chamber is filled with water. Waste that falls into the water of the tank decomposes organically. The resulting “brown water” is transferred into the second chamber which is fitted with an anaerobic filter. The second chamber is situated in the main chamber. Dangerous pathogens are destroyed before flowing over into the anaerobic filter where organisms and oxygen destroy the remains of the pathogens.

The clean water flows into a gravel soakaway, which acts as an additional filter.

No maintenance is required for 15-20 years.

Refer to Annexure A7 on page 32 for details of No Water Consumption System



#### **8. *Full bore waterborne sewerage***

Full bore waterborne sewerage system starts with a residential full-flush toilet connected to a sewer (pipe) reticulation system and finally into a waste water treatment plant. Waste from full or low flush toilet of domestic house and domestic wastewater is flushed through 100mm diameter pipe to connect into the municipality sewer reticulation that is linked to the sewer reticulation plant.

This system is widely used throughout South Africa.

Refer to Annexure A8 on page 34 for the Full bore waterborne sewerage.



**9. *Septic tank and soakaway and small bore solid-free sewer***

Septic tank and soakaway: Domestic wastewater and waste from the toilet, is flushed into an underground septic tank where it is retained for several days to allow settlement and initial biological digestion to take place. The liquid rise to the top of the tank and is piped to a soakway or subsoil drainage trench. This system is used in areas where soil allows the free percolation of water into the environment and by formal rural householders and farming areas where the sludge builds up in the septic tank for removal by tankers to treatment plant.

Small bore solid-free sewer: The normal residential house full flush toilet and domestic waste is connected by pipes and plumbing fittings to discharge to a septic tank. The liquid effluent is piped to a communal treatment point or a treatment plant the water requirement for this system is less than those required for the septic tank and soakaway. The routine maintenance of the pipe network is essential

Refer to Annexure A9 on page 36 for details of septic tank and soakaway and the small bore solid-free sewer





### **10. Shallow sewerage\***

Domestic wastewater and waste from the toilet is flushed, using lower volumes of water than conventional sewerage, through pipes at shallower levels into an on-site inspection chambers. The waste is then connected into the street sewers from the neighboring houses and then onto a wastewater treatment works comprising of primary, secondary and tertiary treatment tanks.

Refer to Annexure A10 on page 38 for details of shallow sewerage system.

### **11. Chemical toilets\*:**

Chemical toilets use chemicals to break down the waste material. There are various modern types of toilets that utilize a water-diluted chemical discharged from dispenser below the toilet seat to make the excreta harmless and odorless. Due to the high operating cost many municipalities have discourage their use.

### **12. Bucket toilet\* (unhygienic and not recommended):**

The bucket toilet is designed as an enclosed top structure with a seat over a bucket. The contents of the bucket are carried away weekly by collectors to be disposed at treatment plant.

Due to the high operating and maintenance cost of the bucket system, the Government is dedicated to phasing them out

- The last three options\* (marked with asterisk) are not recommended for household/clinic/school use.



## 6.5 Hierarchy of Adequate Sanitation Technologies

The original estimated capital cost of sanitation technologies is dependent on the choice of technology. Higher levels of service are generally more expensive, but initial cost is dependent on the geographical location and the availability of local labour and materials.

All the available technology options can deliver a satisfactory level of sanitation, provided they are properly designed and specified, constructed, operated and maintained. A wide range of proprietary systems are available to the user, some of which are upgradeable, some cost more, some require more user maintenance, while some are easier to operate than others.

The choice of adequate sanitation technology depends upon the circumstances and economic means of the user. The vital first stage in the hierarchy of levels is the “Basic level of service” – meeting basic functional, health and environmental requirements – towards a gradual improvement of the health and standard of living of all South Africans.

Table 2 outlines the Hierarchy of Adequate Sanitation Technologies of the various technology types comparing water requirements, degree of complexity, the skill level for maintenance and the health or socio economic benefit of each technology options.

**Table 2: Hierarchy of Adequate Sanitation Technologies –for clinic sanitation**

Type	Degree of complexity	Approximately water (l/flush)	Skill level /Maintenance	Health or socio economic benefit i.e. Advantage /disadvantage
<b>a. DRY ON-PLOT SYSTEMS</b>				
<b>1&amp;.2.VIP (single and double)</b>	Toilet to be properly designed and constructed with removal of sludge by tankers	The VIP is designed to function dry or with small amounts of water for flushing (1 to 1.5 litres/day).	Minor maintenance skills Emptying pit (brief training)	Pit toilets eventually fill up. This can take between five to ten years, depending on the size of the pit and type of anal cleaning materials use. In a rural / high density environment pit emptying needs careful consideration. Where manual pit emptying is not socially / culturally acceptance provision needs to be made for access by vacuum tanker. Alternatively, space and top structuring permitting, a second pit can be dug or a double pit VIP erected from the outset.
<b>3.Composting / urine diversion</b>	Manually emptied by the householder or a contractor. The removed composting material is collected and used as fertilizer. Urine diverted by special adapted pedestal	Urine diversion is designed to function with small amount of water (1 to 1.5 litres /day).	Minor maintenance skills Emptying pit.	The separation of urine from faecal solids enables separate treatment and use of the material. Recent international research promotes such systems as they are ecologically sensitive and advantages by enabling local reuse of the waste materials through agricultural application of compost, fertiliser with disinfected urine and limited use of scarce water resources.

Table 2 (Continued)

System	Degree of complexity	Approx water (l/flush)	Skill level /Maintenance	Health or socio economic benefit i.e. Advantage /disadvantage
<b>b. WET SYSTEM</b>				
<b>4 &amp;5.Pour flush and aqua-privy</b>	Removal of sludge waste and suitability and maintenance of soakway	The aqua privy is designed to function with small amounts of water for flushing (1-5 litres/flush)	Minor maintenance skills	Aqua privies are a suitable compromise to full waterborne sanitation, mainly as this is perceived to be the first-world standard. The system saves water and effectively controls odours through a water seal. If unsuited anal cleansing material is used it tends to block. Digesters have to be emptied regularly to prevent on-site sewage spills.
<b>6.Conservancy tank</b>	Removal of sludge waste and suitability and maintenance of soakway	3 to 5 litres	Minor maintenance skills	This system is environmental sensitive – prevention contamination of ground water.
<b>7.No Water Consumption System (NOWAC)</b>	Waste that falls into the water of the tank decomposes organically. The resulting brown water is transferred into the second chamber fitted with an anaerobic filter.	The system is designed to function with small amounts of water per day (1-5 litres/day).	Minimal Maintenance	Minor maintenance skill
<b>8.Full bore water borne Sewerage</b>	Require reliable water, Needs sewer reticulation system and fully functional treatment facilities	Full waterborne sanitation uses approximately 7 – 10 litres per flush and 40 to 50 l/person/day .	Repair to pipes and No maintenance to system	Full waterborne sanitation is an attractive option mainly due to perception of being the first-world standard and being the most comfortable for the user with least effort. If unsuited material is used for anal cleansing, it tends to block sewers and cause sewage spills which are both a health and environmental risk
<b>9. Septic tank and soak way</b>	The design, location of the soakaway is to be addressed. Percolation test of soil is required	The toilet can be flushed by pour-flush, sullage flush or cistern flush systems. Considering a minimum flush volume of 5 litres and at least 3 flushes per day, the system could even be operated at a street tap level.	Minor maintenance skills. Repair to pipes and removing sludge	Without proper cost recovery of at least 80% such services cannot be maintained. If payment for services is not taking place waterborne services are not viable.

Table 2 (Continued)

System	Degree of complexity	Approx water (l/flush)	Skill level /Maintenance	Health or socio economic benefit i.e. Advantage /disadvantage
<b>10.Shallow sewerage</b>	Require reliable water low flush toilet and sewer reticulation and washed down to treatment facilities or street sewers.	The toilet can be flushed by pour-flush, sullage flush or cistern-flush systems. Considering a minimum flush volume of 5 litres and at least 3 flushes per day	Minor maintenance skills Repair to pipes and removing sludge	Shallow sewer systems reduce the flow in pipes and hence the capital cost and environmental impact of reduced water resource requirement and return flow. The system has not been used widely in South Africa and it is unlikely that any clinic would consider this technology unless it is present in the specific community.

[National Sanitation Policy paper 1996, “*National Sanitation task team*” October 2006]

The consumption of water per flush and the maintenance skill requirement necessary for repairs can assist the authorities e.g. Department of Health and Department of Works to choose the type of system that has a minimum cost implication and minimum maintenance level due to the vast overall distance of the District Municipality.

There are different ways to analysis the hierarchy of adequate sanitation options. From the user perspective (i.e. clinic patients and staff), it is clean, healthy and the increased use of water for flushing is always convenience and safe.

From the system management point of vision (Government and municipality), it implies both increasing operations and maintenance complexity as well as higher costs to be recovered from users.

## 6.6 Inadequate Rural sanitation

The following technologies are not considered as providing adequate rural sanitation:

- **traditional unimproved pits**, - disadvantage attraction of flies and insect; poor design and construct **the bucket system**, always a health risk to collectors and smelly
- **Portable chemical toilets**- expensive overhead, operational and maintenance cost. Cannot be used for long periods.
- **the bucket system**, always a health risk to collectors and smelly

## 6.7 Mentoring

Table 3 shows the comparison of the capital cost and operational cost and maintenance institutional requirements between Ventilated Improved Pit (VIP) toilet and the full water borne sewerage technology.

**Table 3: The operational and maintenance institutional and Sustainability requirements, capital cost and operating cost between VIP and full water borne sewerage technology**

<b>Description</b>	<b>Ventilated Improved Pit (VIP) toilet</b>	<b>Full water borne sewerage</b>
Operational and institutional requirements	VIP not ideal to accept domestic wastewater. Toilet cannot be constructed / placed inside main structure of clinic or house.	Required specific engineering design criteria must be applied throughout the sewerage network.
Maintenance requirement	Ongoing cost of repair and maintenance to damaged parts	Repair worn material & reticulation pipework .
Capital Cost	Capital: Varies from R500- R5000, depending on clinic choice of materials.	Capital_outlay: Cost varies from R6500 to R8 500 .
Operating/maintenance Cost	Operating/Maintenance: R60 per year if emptied once in 5 years.	Operating / maintenance: R400- R1500 per annum inclusive maintenance provided by service provider.

[DWAF, 2002: Sanitation for the Healthy Nation February 2002: “*Sanitation Technology Options*”]

The operating and maintenance cost for the VIP technology is very marginal, however the cost for the full bore sewerage is very much higher due the operating requirements of the bulk sewerage treatment plant.

## **6.8 Mentoring phase**

The purpose of the operations, maintenance and mentoring phase is for the project to commence operating so that any problem can be identified. It is during this phase that the service provider (i.e. DOH / DWAF/Municipality) receive mentorship from the contractor on how to operate and maintain the infrastructure. After completion of the project the contractor is still responsible to repair any defects that arise for a certain period as stated in the contract.

Monitoring should take place throughout the implementation of the project cycle. Project must be monitored against the Municipality indicator/specification so that it is easy to check

whether the project is complying with the conditions. Some projects may be evaluated to learn lessons, identify best practice, and inform further development by Service provider.

## **6.9 Sanitation situation in other parts of the world.**

The following are various sanitation options used and the sanitation situation in some of the countries of the world.

**Zimbabwe:** The Blair Latrine was developed in Zimbabwe by the Ministry of Health. This type of latrine, also known as VIP ventilated improved pit, is similar to the South African type, which when properly built are odorless and the fly problem is reduced to a minimum. They do not require water to operate, although water is required for cleaning.

The Blair Latrine was specifically developed to overcome the problems of odour and flies by constructing the pit to be very deep, over five meters, with the latrine structure being dark and cool and kept very clean. This latrine is widely used in the rural areas in Zimbabwe. [Peter Morgan -*Rural Water Supplies and sanitation* ]

**Ethiopia:** Insufficient water supply and inadequate sanitation is attributed to excreta related diseases in this country.

Due to low rainfall and inadequate water in the rural parts of the country, access to safe drinking water is an ongoing challenge facing the country. In rural communities the provision of latrines are expensive and few resulting in people excreting throughout the countryside including grassland, ditches and fields. As the water supply is low the ground water is easily contaminated. The introduction of a simple long-drop latrine could radically reduce the amount of faecal matter that gets into the water supply. [“*Grimmer of hope Foundation*”]

**India:** In general the subcontinent of India has an inadequate and erratic water supply and lack sufficient toilet facilities. The situation is of particular concern for sanitation, since only one of three of the Indian population has any form of formal sanitation (including improved latrines).



Due to the non availability of toilets in rural area, defecation takes place throughout the countryside and in some urban built up areas. This presents a major health risk throughout this densely populated country.

**Guyana:** Poor service delivery and accessibility are the major obstacles hampering the sanitation service whilst the water is of poor quality and low levels. According to the 2002 census, only 5% of the population had access to a toilet linked to a sewer; 36% had access to a toilet linked to a septic tank or cesspit; 56% had access to a pit latrine; and 2% had no access to any sanitation facilities.

**France:** While most of the French population is served by sewers, there are still about 12 million people served by on-site sanitation systems such as septic tanks.

## **7. FACTORS INFLUENCING TECHNOLOGY CHOICE**

In the past the Civil Engineer was responsible for the design, supervision and also the principle role player in selecting the different technology for sanitation facilities. However, the end user (householder, clinic patient) and financier(Government) has now been very influential on deciding the choice of appropriate type of technology for the varied situation.

The following factors are addressed in the construction of rural sanitation for the Umkhanyakude District Municipality. [District Municipality Sanitation Programme December 2003: “*Clinic Sanitation Project Implementation Plan : KN-Revised District Municipality: (DC 27)*”]

### **7.1 Affordability**

Without a doubt, the key factor for the selection of sanitation technology is affordability to the end user and the organization including local and national government.

Before any sanitation technology can be chosen, the organization budget and the level of service or quality of the product must be established so that the various grants or subsidies from government can be incorporated to reduce the construction cost. Intrinsically linked to estimate construction cost is the value and tariffs of the operation and maintenance of the sanitation.

### **7.2 Institutional needs**

More jobs are created during the construction, operational and maintenance phases, involving local based suppliers and local labour force when demands of improved sanitation facilities are increased. The sanitation improvements projects will require localized capacity to continue and manage existing programme and the future operational requirements.

To speed up service delivery programme, especially in the rural area, the engagement of the private sector (suppliers and contractors) to fulfil certain functions in-conjunction with government or municipality.

### **7.3 Environmental impact**

All sanitation systems are designed to reduce the environmental impact of human waste disposal. The general procedure of rural clinic sanitation is that all toilet pits should be fully lined in form of brickwall construction for the pit. The construction detail of the pit is to be based on recommendation of hydro-geologist, and environmental sensitive area should not contaminate the water source. The long term risk of contamination must be correctly managed by monitoring the water quality from different local sources.

In area of environmental problems the probability of failure must be considered as part of the technology choice.

### **7.4 Social issues**

Due to the different and varied background of people in the field of culture, education and social development, there will be a considerable variation on the range of opinions acceptable to users of the sanitation technology. This social background must be catered for, so that appropriate facilities are used effectively and health benefits are gained by all users and the whole community.

### **7.5 Water supply service levels**

Clean drinking water is a scarce commodity and an expensive necessity in most parts of South Africa especially in Kwazulu-Natal. The increase usage of drinking and domestic water will require the sanitation system to take care of waste water. This implies that the provision of some form of soak away or even a piped sewer system for the disposal of waste water will be necessary. On the other hand, in areas of inadequate or unreliable water supplies, water-dependent sanitation systems may be out of the question and should be discouraged.

As the cost for the supply of water increases, it has become less and less economic to treat, pump and store large quantities of water only to flush down the toilet. In future the Government will need to encourage the development and widespread use of water-saving toilets.

## **7.6 Reliability**

It is critical that those Municipalities and households in poor rural areas with restricted budget are provided and aware with reliable and appropriate sanitation technology. In certain situation of new and innovative sanitation system designs, the technology must be thoroughly tested against established performance and evaluated in terms of cost projections and operational requirements.

There should be an independently objective institution(s) that will be able to carry out the test and evaluation on behalf of the Government.

## **7.7 Site-specific issues**

Before general on-site sanitation systems are selected for any sanitation development, a Geo-hydrological Engineer may be appointed to test the geology, soil percolation rate and the topography of the area.

The recommendation of the Geo-hydrological Engineer will ensure that site conditions that may make site technology problematic and cost of installing water borne systems unreasonable are considered at the early stage of the development .

## **7.8 Use of local resources**

The cost of creating employment for the local workforce is related to many aspects, e. g. The skills available in the local area, training and mentorship cost.

The construction of VIP toilet for clinic sanitation project is very conducive to labour based construction techniques. There is a need to ensure that all sanitation construction is labour-based and maximum use is made of local builders, plasterers and labour. The programme of monitoring the hire, train and utilize local artisans and labour is key to the factors that influence technological choice.

The employment of labour for sanitation project will in principle target individuals living in or adjacent to areas where work is being carried out. Women will be given equal opportunities as men and all workers.

Skilled artisans, including builders, block layers; carpenters, etc. will be sourced from the community and will only be brought into the area if these artisans are not available or not competitively priced.

## **8. ENVIRONMENT IMPACT**

Sanitation systems, which engage the treatment and disposal of human wastes, make a critical impact on the surrounding environment. Inadequate sanitation, or incorrectly constructed or ineffectually maintained toilets are some of the factors that contribute to the contaminate surface and ground water.

### **8.1 The environmental impacts of poor sanitation**

The ground water system is capable to endure limited amount of pollution. There is an acceptable boundary to the contamination that can assimilate, beyond which the water quality deteriorates to such a point that the water is not suitable for drinking or domestic use.

The major aspects which play a significant role in the effect of sanitation systems on water quality include:

- water resource sensitivity to contamination;
- ability of the local authority to operate it;
- soil type as well as the ground water depth;
- selected sanitation system.

Pollution due to inadequate and failed sanitation systems are attributed to:

- Sanitation related diseases such as diarrhoeas, cholera, typhoid, shigella, dysentery, gastroenteritis, hepatitis, and various worm infections,
- growth of algae along with certain aquatic plants,
- loss of bio-diversity resulting from the removal of oxygen in water

Extensive work has been done in the Umkhanyakude region with regards to Ground Water Assessments. However, as the number of toilets constructed is large, the engineer's judgement is best suited in the case. The main requirement is that the Department of Water Affairs and Forestry new Groundwater Protection Protocol (DWAF 2000) is followed and implemented when necessary. If there is a potential problem, steps are taken to prevent further environmental problems.

Wherever potential problems are identified, a sustainable and practical system for measuring

the level of pollution (usually nitrates and bacteriological indicators) in the boreholes is carried out by the sanitation engineer.

## **8.2 The Groundwater Protocol**

The negative impact on the environment of groundwater pollution problems associated with on-site sanitation systems is of great concern DWAF.

The following are extracts from DWAF “*A Protocol to Manage the Potential of Groundwater Contamination from On-Site Sanitation*”

### Part 1 INTRODUCTION

*The important role that groundwater influence in the health of local people cannot be overstated.*

*The Groundwater Protocol aims to provide simple tools for groundwater and sanitation planners and practitioners to ensure that the development programmes for communities continue to place a high value on the groundwater resources, and hence protect them from contamination from sanitation practices and other potential contaminants.*

*The guiding principle include*

- *The GW Protocol is intended to permit assessments of environmental impact of sanitation systems to be carried out using the lowest skills levels feasible.*

### Part 2 THE GROUNDWATER CYCLE AND CONTAMINATION PROCESS

*Groundwater constitutes a major proportion of all the freshwater that is available for human use.*

*Sources of contamination*

*In considering the potential for contamination of the groundwater by a proposed sanitation project or technology, it is essential that the contamination risk from all sources be considered.*

*These could include the following:*

- *Existing toilets, including unimproved pit latrines, all types of improved on-site latrines, and any off-site sanitation systems including waterborne sanitation.*
- *Solid waste dumpsites, including household waste pits.*
- *Grey water disposal practices (often disposed of in the garden or in a pit in the yard).*

*The type and level of potential contamination from these sources is dependent on numerous factors of size and age of the resource, the level of use, and the precautions taken to prevent contamination.*

#### *Contaminants associated with on-site sanitation*

*Of the broad list of possible sources of contamination may be divided into two groups:*

*(a) microbiological contaminants, typically viruses and bacteria, but also including larger organisms like protozoa and helminths (worms), and*

*(b) chemical contaminants, consisting of both organic (e.g. human wastes) and inorganic (e.g. salts) components.*

#### *Rates of contamination from sanitation systems*

*The aim of any sanitation practice is to ensure that contaminants do not come into contact with humans or animals either directly or through contact with the water or soil. Contaminants from humans and animals that are disposed of on or in the ground may be transported away from where they are disposed of usually are carried by water. The water that comes into contact with the contaminants may take one of three possible routes:*

- overland to rivers, dams and lakes;*
- into the ground to the groundwater table*
- into the ground and then seeping back out onto the surface*

*Fortunately many of the contaminants do not flow far with the water. Microbiological contaminants are quickly filtered out as the water flows through the soil, and many chemical contaminants are absorbed onto the soil particles.*

### **Part 3 TECHNICAL CONSIDERATIONS**

#### *Special adaptations of sanitation systems to reduce contamination*

*Where socio-economic or geographic conditions result in the choice of a sanitation system that could cause significant contamination of the groundwater, other options will need to be considered to reduce or prevent the contamination of the groundwater.*

*3.1.1 Pit toilets: Pit latrines may be adapted in three main ways. These are:*

- .. increasing the depth of the unsaturated zone by reducing the depth of the pit (The depth of the pit may be reduced by either building a part of the pit above ground);*
- .. sealing the pit but with a water close to the surface;*
- .. converting the sanitation system so that the pit only contains dry solids*

*3.1.2 Septic tank systems and aquaprivies*

*Septic tank and digester type systems are potentially the greatest threat of on-site sanitation*

*system to maintaining a good quality of groundwater. This is because they dispose of a lot more water than other systems into the ground, which acts as a carrier of the contaminants to the groundwater.*

### *3.1.3 Waterborne sanitation systems and conservancy tanks*

*Although waterborne systems are usually considered the most environmentally safe sanitation systems, there are many cases where waterborne systems have had a major impact on both the groundwater and the surface watercourses due to broken pipes and overflowing manholes and conservancy tanks.*

### *3.2 Aquifer vulnerability along with any probability of negative impacts on the groundwater supplies.*

*The vulnerability assessment is based on the estimated travel time for water to move from the ground surface to the water table.*

### *3.4 Geological conditions*

*The geological conditions will have a significant impact on groundwater flow and the amount of water that can be abstracted from a borehole or well. The geology also governs the change in water quality as the water moves through the unsaturated and saturated zones. Coarse-grained rocks and soils tend to have higher permeability and porosity, which in turn allows for easy and rapid flow of water.*

*The rock types and the thickness of the geological layers will determine the rate and the amount of reduction of contaminants that can take place, and the level of impact that surface drainage will have on the underlying aquifers.*

### *3.5 Hydrogeological conditions*

*The vulnerability of groundwater to pollution is largely reliant upon the character of the subsurface in addition to the water table depth.*

*With regard to conservancy tanks, the installation of proper overflow drainage, and piping this drainage to a safe disposal site will reduce problems arising from inadequate maintenance.*

### *3.6 Surface water conditions*

*Surface water systems have a significant impact on groundwater systems, and in many situations vice versa. Surface water infiltrates to the groundwater, and in many cases groundwater provides the water to springs and the base-flow to streams and rivers. As already stated for groundwater, it is equally important to protect surface waters from being*



*contaminated from sanitation systems and other contamination sources.*

#### *Part 4 APPROACH TO ASSESSMENT OF CONTAMINATION RISK*

##### *General approach*

*Two options are proposed for the assessment of the risk of contamination of the groundwater resources as a result of sanitation improvement programmes. The first option involves a two-stage approach and is recommended and the requirements for a single stage assessment are described in the second option.*

*These two options relate to the level of involvement of different role players in undertaking the assessment.*

*Two stage assessment – area based hydrogeological assessment followed by project based sanitary surveillance. This stage involves an area-based hydrogeological assessment, carried out preferably by a hydrogeologist. The size of the area can vary from a sub-catchment with 2 to 3 communities to a local municipality or whole district. The investigation would comprise an assessment of the geological formations, the major and minor groundwater aquifers, water bearing faults and fractures, and the major surface water resources.*

*Single stage assessment at project level - Where no area-based assessment has been carried out, a more detailed project level assessment will need to be carried out. This will include a higher level of hydrogeological investigation than for the stage 2 (community based) assessment of the two stage assessment. This assessment should still include participation by the community in carrying out many of the tasks that are required for the assessment.*

##### *Participation of communities in the assessments*

*The participation of communities in the assessment of the contamination risk is strongly encouraged.*

#### *Part 5 THE GUIDELINES*

*The assessment of the risk of contamination is based on the two risk levels described above, carried out within the institutional and regulatory framework of the region or province. A two-stage assessment process is recommended, although a single stage can be undertaken where constraints exist.*

*Stage 1 is the assessment of the vulnerability of the groundwater aquifers within a wider*

area.

*Stage 2 is a site specific assessment of the contamination sources and the use of the groundwater within a single community.*

#### **A. ASSESSMENT OF THE VULNERABILITY OF THE UNDERGROUND WATER RESOURCES**

*The vulnerability of the underground water source is related to the distance that the contaminant must flow to reach the water table, and the ease with which it can flow within soil as well as rock layers above the water table. An assessment of soil and rock types, and the distance to the water table may be obtained from an area hydrogeological report, from a site inspection.*

#### **B ASSESSMENT OF THE CONTAMINATION LOAD FROM THE PARTICULAR SANITATION SYSTEM AND OTHER SOURCES**

*The contamination load from a particular sanitation system is related to the design or type of sanitation system, usage of the system, as well as any ongoing maintenance. This must also be measured in the context of the total contamination load from all sources within the community.*

#### **C OVERALL RISK**

*The overall risk of contamination is based on both risk components. In estimating the overall risk, this should be determined firstly for the selected sanitation system, and then for each of the other significant sources that may be a threat.*

#### **D STRATEGIC CLASSIFICATION OF GROUNDWATER**

*Usages of the groundwater in addition to points of abstraction are the final components of the assessment.*

*Should the present and/or potential future strategic value of the groundwater imply that certain types of contamination are unlikely to be a problem, the sanitation system may be acceptable despite it posing a risk as assessed in components A and B above.*

*The strategic value of the groundwater is noted as a function of the aquifer's potential yield, the present or probable future use of the groundwater, and the existence of alternative water sources.*

*The overall aim of the groundwater protocol has been to maintain a simple procedure, but based on more understandable conceptual procedures so that local practitioners can address situations not clearly spelt out in the document.*

*However a non-geohydrologist should be able to use the outlined steps and tables to make a*

*reasonable assessment of the risk of and take appropriate decisions where the risk of contamination is unacceptable.*

### **8.3 Conditions at Umkhanyakude District Municipality**

The requirements of the ground water protocol for the clinic sanitation were followed. A preliminary ground water investigation undertaken by Umkhanyakude District Municipality (UDM) was completed and although there are no major aquifers in the area some risks were flagged. The principal conclusions of these investigations are:

- All toilet pits in the area should be fully lined.
- The two stage assessment was undertaken by UDM whereby the area was assessed by a hydrogeologist followed by the project based sanitary surveillance. The investigation involved the assessment of the geological formations, the major and minor groundwater aquifers, water bearing faults and fractures, and the major surface water resources. This was in minimum requirements of the ground water protocol.
- Part of the requirement was that the sample of open pits should be inspected and the final detailing of the pits based on the recommendations from these inspections by the hydrogeologist, however the most practical approach was to inspect the actual open pits rather than digging test pits. The principal cost is the lining of the pit and any additional work required will have a small impact on the budget and can be adequately estimated.
- The longer-term risk of contamination was managed by on the going monitoring of water quality from the different local sources at the new constructed toilet sites, A monitoring programme was implemented so that data collections starts before the current expansion in sanitation provision can have an impact.

There are sensitive areas where pit latrines may result in the contamination of water sources. Considering all the factors, providing VIP toilets remains the most feasible and viable way of improving sanitation especially when the pits are lined. Badly planned sanitation services can have negative impact on the environment such as overflowing of pits and contamination of groundwater.

### **8.4 The environmental impacts**

The geotechnical report of the UDM areas for the clinic sanitation shows that the quality of the founding material in the area varies greatly and therefore sampling and classification

during the tender and construction stages was required. It was observed that in the case where it was necessary for rock excavation, for the VIP toilets pit, there was a cost saving in comparison to the cost to construct and operate a water borne sewer system.

The proper operation and maintenance of sanitation systems is critical to protect the environment.

There are sensitive areas where the conventional pit latrines may result in the contamination of water sources. Thus considering the environmental impact to the surrounding soil, providing VIP toilets remains the most feasible and viable way of improving sanitation. The longer-term risk of contamination must be managed and will require on going monitoring of water quality so that data collection commences soon after the construction is completed.

## **8.5 Environmental education**

Education is referred to the way in which people learn skills and gain knowledge and understanding of the world. The Department of Education is committed to educate and disseminate information to rural communities to be involved in examining and monitoring the quality of their water resource so that ground pollution awareness is everyone's contribution to an ongoing crisis. The awareness of the people can improve the early detection of environmental problems.

## **8.6 Community involvement and Socio Economics Issues**

The following are socio economic issues that affect communities during the construction and maintenance phase of the project.

- **Gender Issues**

The transfer of skills, training and education of women in the construction of sanitation facilities is recommended as there is a realisation that skilled women are an asset to the community whereas skilled men tend to leave the area with their skills and leave the women behind to attend to the households.

- **Labour-Based Construction**

The Government labour policy ensures that all sanitation construction programme is labour-based and maximum use is made of local builders, plasterers and labour.

The construction of VIP toilets for clinic sanitation projects is very conducive to labour based construction techniques. At Umkhanyakude District Municipality, a Construction Manager was employed by to hire, train and utilise local artisans and labour. The Construction Manager ensured that materials, transport etc are available, preferably locally that quality control and programme time frames are met. Local people will carry out all other activities.

All contract documentation and specifications will clearly indicate the requirement that maximum use be made of local labourers, builders and entrepreneurs from within the area where construction activities are being carried out.

- **Employment Policy**

The employment policies will in principle target the neediest individuals within the community.

Employment will be targeted at individuals living in or adjacent to areas where work is being carried out. Women will be given equal opportunities as men.

## **9. TECHNICAL CONSIDERATION – UMKHANYAKUDE DISTRICT MUNICIPALITY**

### **9.1 Technical considerations**

The current situation at most clinics is that toilets are adequately provided when there is water for their operation.

### **9.2 The need for VIP toilets**

The situation that needs to be addressed is providing adequate toilets for visitors, and toilets that can be temporarily used by staff and patients during interruptions in the water supply.

The technology offered must therefore be a dry sanitation process and providing VIP toilets is recommended. Where necessary the pit is appropriately lined and detailed to reduce the risk of contamination of the groundwater.

Composting toilets have been considered unsuitable for this application at this point in time. The findings of the situation analysis are that the existing outside visitors' toilets are not being used effectively or being cared for, as indicated by their lack of cleanliness and the large amounts of domestic rubbish in the pits. In this type of use environment, it is considered that composting toilets will not function effectively.

Although a VIP technology is being offered, the toilets should in all other respects offer the same level of service and convenience as water borne toilets. The toilets are located where they are accessible and convenient.

Separate female and male toilets are to be provided. More women and children attend the clinics than men and the Department of Health has requested the provision of more cubicles for women than men. At least two cubicles are provided for women for every one cubicle provided for men. Where the existing inside flush cubicles is not suitable, one cubicle is provided with grab rails for use by disabled persons.

Adequate toilets for visitors and toilets that can be temporarily used by staff and patients during interruptions in the water supply must also be provided. The technology offered must therefore be a dry sanitation process and providing VIP toilets is recommended. The design requires that the pit will be appropriately lined and detailed to reduce the risk of contamination of the groundwater.

The project requires a relatively small value of work to be completed at a large number of sites distributed over the whole municipal area. Supervising work requires regular site visits and in these circumstances requires a substantial amount of travelling time. It is therefore not viable to use built in situ structures and the use of commercially available pre-fabricated concrete cubicles is not recommended. Screen walls and some paving are provided around the units to create a sense that the toilets are an integral part of the clinics facilities.

### **9.3 Hand washing facilities**

Improved hand washing facilities are also to be provided. Because of the unreliable water supply, a hand washing facility is provided separately, located between the toilets and the clinic building. It is specifically not enclosed so that it is easier to monitor, and wastage of water can be reduced. In addition to having taps connected to the internal plumbing system, there is a shelf for setting up a temporary bucket and tap system that can be used when the water supply is interrupted.

The upgrading of pit toilets includes the upgrading of pedestals and vent pipes and general maintenance and painting of cubicles.

### **9.4 Upgrading of existing facilities**

Existing toilets that do not comply with the minimum requirements of a VIP are a possible health hazard. These toilets will either be upgraded to meet the minimum requirements or be demolished. Existing pit toilets with either full pits or derelict superstructures are a similar hazard and will be demolished and the pits filled in and sealed.

## 9.5 Minimum requirements of Ventilated Improved Pit (VIP) latrine

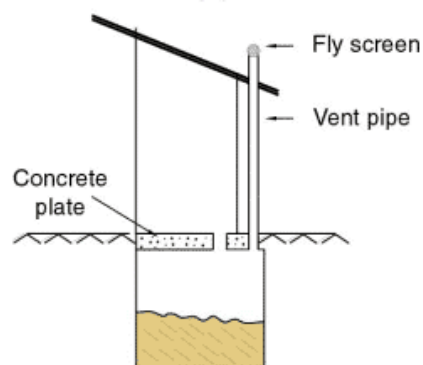
This is similar to the conventional pit latrine, but the top structure and the ground slab is recessed from the pit wall allowing for the vertical vent pipe to be positioned adjacent to the latrine on the top slab.

The opening in the squat hole allows air to flow into the pit structure and up through the ventilation pipe thereby extracting all foul odours. The VIP latrines design allows for the flies and insects attention and focus to be towards the light that is found at the extreme top of the 100mm diameter instead of the toilet pan region.

The excreta from the pan are dropped inside where the decomposable substances decay in the pit under anaerobic conditions. Gases (methane and carbon dioxide) from the decaying excreta exit via the vent.

Although a VIP technology is being offered, the toilets should in all other respects offer the same level of service and convenience as water borne toilets. The toilets should be located where they are accessible and convenient.

[UNEP. United Nations Environment Programme, Document ID289, [www.unep.org](http://www.unep.org)  
ILO, 1996. “New Framework Agreement for Labour Intensive Construction on Civil Engineering Industry.” International Labour Organization.]



**Figure 5: Ventilated Pit Latrine**



## **10. ALTERNATIVE TYPES OF VIP AND USE OF DIFFERENT BUILDING METHODS AND MATERIAL FOR THE CONSTRUCTION OF VIP TOILETS**

The construction material used for erection of toilets for the rural clinics in Umkhanykude District Municipality was mainly in the form of bricks and mortar as part of the substructure and superstructure. This was due to the stringent building specification set down by the local Department of Health for construction of toilets in the region.

In KZN rural areas, communities are committed to transformation of their society by the use local labour resource and sourcing building material from suppliers located within close proximity to the construction site of the sanitation facilities.

Annexure 26 shows the various building material used for toilet construction which includes the mud and timber type construction, blockwork and the kit type Archloo construction option.

### **A. SUBSTRUCTURE AND SUPERSTRUCTURE USING BRICK AND MORTAR CONSTRUCTION**

#### **10.1 Cleaning of the site and topsoil stripping**

After setting out and marking the positioning the proposed toilets in accordance dimensions on the architectural drawing the work commences. The site is to be cleared and kept clean during construction period. The preparatory work such as site clearance, the removal of all vegetation, topsoil, unsuitable ground material, rubbles and existing fences commences. The level of the surface bed is gauged using a dumpy level.

#### **10.2 Trench Excavation**

The contractor may use whatever plant he considers appropriate to construct the work to the required specification. In certain circumstances, restrictions are placed on the type of compaction equipment which can be used.

Trench excavation is undertaken in narrow trenching conditions with vertical sides(deeper than 1.5m) necessitating the use of shoring. To ensure site safety and stability trenches deeper than 3m has to be designed by an appointed Engineer.

Excavation for the trenches shall be carried down to such depth as necessary to obtain firm foundation. The depth and founding condition of the pit excavation is to be approved by a building inspector from the Department of Health together with the Engineer at the obligatory foundation assessment stage. Various checks are established, including the

inspection of dimensions of the excavations, and the levels of these excavations are also scrutinized. The appropriate dimension of the substructure pit is 6.882m x 2.525m x 2,000m.

As all the clinics were within a fenced boundary there was no need for the appointment of a land surveyor who will ensure that the new ablution facilities was set out correctly with boundaries and statutory building lines.

### **10.3 Construction of sub structure (i.e. the pit)**

After trench excavation the foundation of the pit is poured using 20MPa concrete. Brickwork is laid to underside of pit surface bed floor. This floor is necessary for cases where the latrines are fully lined.

Pit surface bed: The overall dimension of sub structure of the pit for the brick five seater toilet is 6285 x 2525 mm. The pit is approximately 2000 mm below the natural ground level. The 150 mm surface bed floor with welded reinforced Ref 245 BRC mesh is cast on well compacted existing soil to 96% MOD AASHTO. Concrete grade of 25 Mpa. .

A damp-proof course (DPC) is supplied for the brick wall's width on the surface bed slab beneath the brick wall.

Utilisation of brickwork 230 mm wide for the construction of the substructure is employed Brick force placed in every second course. Mortar joints not exceed 10 mm thickness and composed of 4 part of volume of sand and 1 part volume cement. The mortar mix shall be mixed dry ensuring uniform colour and evenly texture. The height of the 230 mm brickwork wall above the concrete pit slab to the height is 2000 mm. The internal brickwork of the pit was plastered providing a 230 x 240 mm opening between the three chambers.

The internal dimension of the pit is 2085 mm x 5842 x 2000 mm deep thus having a lined pit capacity of 24.36m<sup>3</sup>.

### **10.4 Concrete strip foundation for top structure**

The foundation of the toilet top structure is set out by the bricklayer and the trench excavated according to the Engineers drawing.

The typical size of the strip footing is 600x230mm for external wall and 400x230mm for non-load bearing walls (usually internal). The concrete for the foundation is poured with 20 Mpa concrete. The foundation is cast on natural ground. The brickwork is laid to the underside of the top structure surface bed.

Refer to Annexure 14 for the photograph of strip footing.

## **10.5 Backfilling of top structure to floor level**

The brickwork for the substructure walls to underside slab level of the topstructure is completed. The sub structure brickwork and the top structure brickwork is almost finished to the same level i.e. at least one brick course below the final top structure floor level. Backfill material is placed in the trench upto the underside of slab level of the top structure.

The backfill material is to be filled in layers of 150mm, spayed with water and compacted with using a hand compactor.

## **10.6 Floor slabs**

The concrete floor slab to be at least 100 mm thick using 25 Mpa concrete with BRC mesh Ref 193 placed at the centre of the slab. All exposed floor surface to be neatly finished using a steel trowel with 25 mm concrete screed.

The floor should be constructed of a durable slip resistance material such as a grano screed with suitable chip base, which can easily be cleaned. The fall on the floor should be limited to 1:75 and should drain from one or more even falls without channels.

Rear Precast slab: The precast panels are to be firmly positioned on 10 mm mortar bed at the rear of the structure. The three toilet cells to have 600 mm access manholes complete with precast manhole cover and 110 mm diameter hole for vent pipe.

## **10.7 Walls**

On completion of the floor slabs, the walls of the toilet must be bricked up to roof height. The door and windows are installed with lintol placed above all openings. Brick force is placed in every second course. Mortar joints between bricks should not exceed 10 mm thickness and composed of 4 part of volume of sand and 1 part volume cement

The internal and external walls of the top structure are bricked simultaneously. All external and internal cubicles above ground level are to be plastered and painted. Newly plastered surface shall be allowed to dry sufficiently prior to the application of plaster primer. Apply one coat of universal undercoat and two coats of white oil based paint shall be applied.

## **10.8 The roof**

After the construction of all external and internal walls of the top structure the pitched roof trusses are erected using 0.5 mm thick IBR galvanized roof sheeting with translucent sheeting or similar. The sheeting is nailed to 50x75 mm SA pine purlin tied fixed to the

150x50 mm pine beam. The beams are tied down on wall with 38x1.5 mm thick hoop iron ties. Exposed purlins are to be painted with creosote. The pitch of roof sheeting varies from 6° to 10°.

## **10.9 Finishes**

The internal and external finishes of the top structure commences after the erection of the roof with the tiling. The finishes include tiling for wall and floor, installation of wooden frame, door, handles and locks, glazing of window panes, hanging of ceilings, plastering and The plumber will install the Atlas VP 200(or similar) pedestal with seat and lid. The disable toilet includes disable pan, grabrail, wash-hand basin. (Refer to Annexure 23 – Photo of finish disable toilet on page 118).

The 110mm black vent pipe with fly screen on top, grouted into cover slab and held in position by two clamps. The vent pipe must be designed so that it can induce sufficient air flow through the toilet to leave the superstructure odour free.

A vent pipe covered by a fly screen, combined with a relatively dark interior to the superstructure, will eliminate faecal odours in the superstructure; prevent most flies from entering the pit and thus reduce the amount of fly breeding in the pit and prevent flies which have managed to breed in the pit from escaping.

## **10.10 VIP for special needs users including Disabled People**

### **10.10.1 VIP for special needs users including Disabled people**

With the introduction of inclusive education in SA , the special needs of disabled students and teachers, are considered when providing any configuration of toilets. These toilet facilities have very specific sizes, fittings and configurations which have been tested to meet the broadest range of special needs. While at best they are a compromise, it is essential that these facilities are constructed and fitted in- strict accordance with the technical requirements noted in the Appendix A20,A21 and A22.

### **10.10.2 Access to Rural toilets for disabled people**

The toilet facilities for disabled people must be located near the main circulation ways to facilitate easy access. The topography on which the clinic or school is built will determine how far away they can be located, as access is very gradient specific. The toilets should be accessed by a hardened pathway at least in wide. The gradient along the pathway should not exceed 1:12, with the exception of short sections less than 2 m long which may have a gradient of 1:10. Ideally the pathway should be covered where possible. All transitions at

doorways should not have a threshold exceeding 15mm in height.

### **10.10.3 Design Details**

There are no special requirements for the substructure and the superstructure can be constructed in the standard manner provided that in case of block work construction cavities in the blocks are filled wherever grab bars and other fittings are to be secured. Timber structures should be provided with substructure (reinforcing panels) to carry these fittings. The secure fixing of these fittings is essential for the safety of the user. The minimum cubicle size is 1600 mm x 1800 mm with an outward opening door located in one of the 1800 mm walls.

### **10.10.4 Floor**

The floor should be constructed of a durable slip resistant material such as a grano screed with suitable stone chip base, which can easily be cleaned. The fall on the floor should be limited to 1:75 and should drain from one or more even falls without channels.

### **10.10.5 Walls**

Depending on the construction of the top/superstructure, the walls should provide a surface adjacent to the grab bars which should be smooth with an acrylic paint (or better) finish. As noted above the walls should be capable of supporting the grab bars which carry the full weight of the disabled person. The grab rails should be constructed of 50mm diameter stainless steel tubing in accordance with Annexure A20. These should be fixed to the wall with masonry anchors or bolted in the case of timber construction. The cranked grab bar should be located adjacent to the pedestal WC, while the straight bar should be located across the rear wall behind the pedestal WC as set out in Annexure A20 and A21. The heights and configuration are critical and should be strictly adhered to.

### **10.10.6 Doors**

The door should open outwards as it is necessary to utilize the minimum cubicle size. Inward opening doors may only be used in cubicles which are at least 30% larger and then the configuration requires careful design. The clear opening of the toilet doorway is normally 760mm. This is normally provided by a 969mm door frame with a 44mm thick door for disable door. The door should be fitted with an internal grab handle as indicated on Annexure A20 and A21 as well as standard lever type handles and locks.

All door handles should be fitted to permit knock down opening to allow disabled users with limited hand function to open the latch or Jock. There should also be a slotted emergency opening mechanism which is accessible from the outside face of the door. This door furniture is essential to ensure independent use by the disabled person and ensure that

the user is able to operate the door with limited grasp function. A stainless steel sheet metal kick plate 300mm high should be fitted to both sides of the door if possible. This will protect the door from damage generated by the footrests of the wheelchairs.

#### **10.10.7 WC Pedestal**

The WC should be of a pedestal type which is located specifically in the location indicated on Annexure A20. The height of the seat should be 500mm above the finished floor level. The WC pedestal should be robust in design. If the WC is fitted with a separate seat, the seat should be constructed of solid hardwood or high density composite wood, fitted of corrosion resistant metal fittings and fixings. The WC pedestal and the seat should be securely fixed to the floor slab with masonry anchors. It is essential that this is not compromised in any way as it will generate accidents which may have serious consequences. The pedestal and seat should have a smooth durable finish to facilitate cleaning.

#### **10.10.8 Hand washing**

Where ever possible hand wash facilities should be provided within the cubicle. While this is not provided in the standard VIP, it is almost essential for a broad range of disabled persons to have direct access to a hand wash facility when seated on the water closet. A small wash basin is provided located as indicated on Annexure A20 and A21. As the amount of water for hand washing has to be conserved a low level tank should be provided to gravity feed a lever arm basin tap. The waste water from the basin should be diverted into a soak pit or (where the soil permeability permits) into the toilet pits.

#### **10.10.9 General**

The configuration of fittings and the dimensions indicated in Annexure A20 and A21 are critical and should be adhered to in all respects. The relative position of fittings within the minimum size constraints just permits the disabled user to enter, close the door and transfer onto the pedestal. The critical interrelationship of elements has been designed to take into account a broad range of special needs. In this respect certain compromises have been adopted and only specialists in the field of universal design are capable of generating variations which may be functional for all user groups. It is strongly recommended that wherever possible these approved standard layouts and configurations should be utilized as indicated in Annexure A20 and A21.

#### **10.10.10 Procurement of fitting for disable toilets**

The special grab bars can be custom manufactured by any suitable engineering works, however it should be noted that they are stock items from the larger plumbing suppliers. The ironmongery and other plumbing fittings are standard stock items and can be procured

from most building suppliers.

## **B ALTERNATIVE CONSTRUCTION TYPES OF VIP**

### **10.11 THE AMALOOLOO KIT FORM TOILET STRUCTURE**

The Amalooloo toilet structure is available in kit form and is assembled by non-skilled persons from local communities with minimal training. The system positively supports local community involvement and provides employment.

The two main components of the system are: Super structure (above ground level) and pit structure (below ground level).

#### **10.11.1 Amalooloo super structure: (refer to annexure 27)**

The VIP super structure consists of: precast concrete floor panel (1 off); Side panel (4 off); Back panel (2 off); Roof panel (1off) and Door (1 off ). The side panel has ventilation holes with galvanized brackets to secure the vent pipe. The galvanized self closing swivel door has aluminium handles and bolts.

The pedestal with seat and lid is positioned above the hole of the concrete floor slab panel. There is a 4m long urine diversion pipe that leads to a soakway.

The VIP super structure can be upgraded from VIP to Waterborne system without structural changes.

#### **10.11.2 Manufacturing specifications:**

All panels are manufactured with high strength concrete (40 Mpa 28 day cube test). Panels are reinforced with 4 mm deformed wire and Oxyfluorinated polypropylene fibres. The reinforcing was designed to provide sufficient strength during handling and all possible serviceable stresses, as well as load or impact loads. For coastal regions or areas where a high corrosion factor exists, the fibre content is increased and reinforced steel is galvanized to provide more resistance against corrosion. The minimum concrete cover is 13mm to any corrosive material. The concrete however, is of high quality with added protection.

All panels are provided with non-corrosive materials for fixing such as stainless steel, galvanized, brass and PVC.

#### **10.11.3 Handling:**

All panels can easily be handled by hand and no mechanical equipment is required for erection. Two persons can comfortably handle the side panels and 4 people can place the base and roof panels. (maximum handling expectancy -30kg per person). This is a pre-cast concrete product which has to be handled with care especially during off- loading and on-site handling. The complete structure can be dismantled and re-erected elsewhere by unskilled labour.

Re-location of top structure: The top structure can easily be disassembled and re-assembled onto a new pit without having to replace any of the elements.

#### **10.11.4 General:**

The manufacturers confirm that the structure is robust and able to withstand wind forces of 120 km per hour; Be able to withstand the vertical movement of heaving sub-soils without cracking; Has low maintenance costs; Require no water or electricity to assemble; Easy to assemble on site; Easy to assemble in confined spaces. (Between existing structures in difficult topographical areas); Minimum tool requirements for assembly i.e. screwdriver; spirit level; hand gloves for safety.

#### **10.11.5 Open base lined pit structure (see annexure 28):**

The rectangular precast concrete pit is approximately 1970 mm x 920mm x 950mm. This component consists of: Bottom precast concrete base elements (2 off); Top base slab (2 off); Side panel (4off); End panel (2off) and Back cover slab (1 off). The pit is designed to suit all types of soil conditions and Geotechnical scenarios. Emptying of the pit is done through the back cover slab as and when required by simply removing the cover slab.

The soilcrete backfill provides the necessary structural strength in combination with the panels to avoid collapse of the side panels in the worst case scenario where the ground water table is at ground level. The friction between the side panels and soilcrete also provides resistance against buoyancy where ground water table levels are problematic.

The present cost of the superstructure is R 1970.00, pedestal, pan and basin cost R1250.00 and the precast pit including concrete base slab is R580.00.

Manufacturers of AMALOOLOO VIP Toilet System have completed numerous structural and loading tests during the design and construction stages and have the relevant certification.

#### **10.12 ARCHLOO (refer to Annexure 29)**

The construction of the Archloo type of toilet is used in the cholera affected areas.

The basis timber main frame form is cut from a shutter board, or could be manufactured from appropriately sized planks. A single form section is cut using planks size of 150x35mm (or similar size) and a hand saw or jig saw to give the rounded shape. Using this as a template for the remaining sections can be cut to suite. The arch upright form frames are supported by four chocked planks as cross members. Hessian is then draped (stapled between the forms) and then plastered in layers. Once these layers have set, the thin shell should be self supporting. The catenary's shape of the arches makes this possible without the need for reinforcing. The forms can then be removed.



The pedestal and vent can then be manufactured in the same way. A typical pit is circular with a diameter of 1.4m. The catenary cover can be made in one section, or 3 sections. It can be made in situ or precast. The Archloo toilet can be built for a cost of +-R600.00 per unit.

#### **10.13 PET (Primary Effective Toilets)**

The Pet system was initially implemented at children crèches ten years ago. Due to various reasons, the manufacturing of the top structures of toilets out of corrugated iron was banned on all government funded projects, resulting in the building of permanent structures over the pit. This resulted in one of the big problems of VIPs, namely the operation aspect. Either the top structure must be demolished when the pit is full, or the pit has to be emptied.

In order to overcome the problem with regards to the top structure of toilet, a recycled plastic structure was developed. The recycled plastic is manufactured in 16mm thick sections and the structure can be assembled on the site. (Refer to annexure 30). The PET toilet requires a small concrete footing of approximately 1100mm x1100mm that can be easily manufactured on site. The possibility exists that the top structure can be assembled so that when the pit is full, the top structure can be turned 180 degree and another pit dug using the same slab. The only cost to change the toilet around will be the time cost to dig another pit by the user. The price to build a PET type toilet is competitive and compares well with the standard VIP.

The PET toilets have been installed in the vicinity of Qunu Clinic in 2002. The PET toilet is being used by approximately 200 congregants at the Mpheni Church in Mpheni.

[Gavin Pryce Lewis – Sustainable Rural sanitation]

## **11. THE VARIOUS COSTS OF SANITATION SERVICES**

### **11.1. Cost associated with water supply and sanitation**

The numerous cost components for the construction of a sanitation system are as follows:

- The capital cost relates to the initial building cost set aside for the construct the sanitation system that includes the cost of the property, property transfer fees, building plan and approval, and the main component i.e. the cost to erect the building.
- Recurrent cost relates to the operational and maintenance cost after the construction of the building.
- Replacement cost are the funds that is required to repair and replace pipes, pits and tanks after the end of the life cycle.

### **11.2 Cost comparison for the construction of 5 seater toilet in rural and urban**

As part of the Governments objective to ensure that there are functional basic sanitation facilities at all community clinic facilities within the Umkhanyakude District municipality, Contractors were invited to tender for the Construction of 5 seater VIP Toilets at Clinics in the Municipality.

The project required the preparation of contact documents, bill of quantities, drawings, specification and soil report for the construction of 5 seater VIP toilets at 20 sites within the Municipality. The adjudication of the tender and the appointment of Contactor were in accordance to the Municipality procurement policy.

The construction work included establishment on site, site clearance, excavation for foundation for the sub and super structure, construction of the lined pit, preparation of surface bed slab and suspended slab, brickwork of sub and superstructure, plastering, painting, installation of doors, windows, ablution fittings for normal and disable toilets units, roofing and landscaping.

Table 5 refers to the construction cost of a five seater toilet at Umkhanyakude District Municipality dated on 30 June 2005 in accordance to the Department of Health brickwork (common bricks and plaster) specifications and drawings. The toilet under consideration and constructed in the rural area was located at Gwalieni some 60km from the town Mkuze. Refer to Annexure 25 for locality plan of the region.

Cost analysis was carried out for a similar five seater urban toilet that was constructed in Pietermaritzburg.

Table 5 depicts the cost comparison for the construction of 5 seater toilet in the rural and urban surrounding.

**Table 5: Cost comparison for the construction of 5 seater toilet in rural and urban area**

BILL NO	DESCRIPTION	RURAL COST	URBAN COST
1	PRELIMINARIES	3 000.00	2 100.00
2	EARTHWORKS	3 276.00	2 500.00
3	CONCRETE, FORMWORK AND REINFORCEMENT	5 220.00	4 830.00
4	MASONRY(SUB AND TOP STRUCTURE)	11 200.00	7 200.00
5	WATERPROOFING	1 430.00	1 200.00
6	ROOF COVERING etc	4 660.00	3 980.00
7	CARPENTRY AND JOINERY	4 870.00	4 100.00
8	METAL WORK	3 551.00	2 980.00
9	PLASTERING	5 290.00	3 120.00
10	PLUMBING	9 050.00	8 110.00
11	PAINTWORK	3 100.00	2 900.00
12	GLAZING & TILING	2 050.00	1 800.00
	<b>TOTAL FOR 5 SEATER VIP TOILETS</b>	<b>56 697.00</b>	<b>44 820.00</b>
	<b>TOTAL FOR 1 SEATER VIP TOILET (Disable toilet included)</b>	<b>R 11 339.40</b>	<b>R8 964.00</b>

\*The cost excludes 12% professional fees for the design and 14% VAT \* Brickwork construction

[District Municipality Sanitation Programme: *“Construction of VIP toilets at clinic in Umkhanyakude District Municipality – March 2004 Contract No KT 386Volume 1*]

In our case study the construction cost of the toilet construction in rural and urban varied mainly due to the following:

- In the urban clinic toilet construction the availability of full water reticulation system required the omission of the lined pit as the sewer from the toilets are directly connected into the outfall system which in turn connected to the local sewer treatment plant. This omission of the pit lining has a saving is approximately R11 877.00 or 21% of the total cost of the construction of rural 5 seater VIP toilet. However the operational and maintenance cost of the urban option increase due to the requirement of bulk treatment plant.
- The urban construction was as follows: clear site, excavate trench(600x250mm), casting of foundation, brick to surface bed level, cast surface bed slab, brick work of the top structure, installation of window and door frames, roof construction and installation of drainage and sanitary ware.
- The rural clinic toilet requires the addition construction of the lined pit approximately 2.0m deep x 2.08m wider resulting in the increased cost of approximately 21%.
- The other marginal cost variation of the two schemes was due mainly to the increased transport cost of the delivery of building material to rural site. The labour cost for the two

schemes were similar because of the standardized payment for the local labourers as requested by the Department of Labour. The labourers were paid approximately R45.00/day.

- The cost of the creation of employment on sanitation projects is governed by a number of factors for example the existing skills available in the community; the cost of training; the cost of mentorship; time losses due to a longer start-up phase; the size of the sanitation project; the choice of sanitation technology. There were adequate available skilled artisans in the urban whereas in the rural area there was a severe shortage of skilled personnel.
- The stringent building specification of brickwork as opposed to blockwork has contributed to the higher construction cost of VIP toilet. The brickwork specification is the minimum accepted standard requested by the Department of Health. The DOH will maintain the toilets after construction.
- The above price includes the construction of disable toilet as part of basic sanitation.

The cost structure for the construction of the Amalooloo System is approximately R6500.00 per toilet.(Refer to Chapter 10). This is R2460.00 cheaper than cost of an urban toilet and R4839.00 cheaper than the rural construction toilet of a similar toilet. The stringent building and lined pit specifications used for the construction of rural sanitation has contributed to the cost variation between the two alternative construction of system.

### **11.3 The operation and Maintenance Cost.**

The ongoing operational and maintenance of the sanitation programme may also be considered as a vehicle for the creation of employment opportunities. However this is closely linked to the type of technology employed and the level of tariff collection possible from the community supplied with the service or subsidies available to the municipality.

For the on-site sanitation schemes many of the operational and maintenance task are the responsibility of the householder and hence do not lend themselves to using small community contractors. Householders are required to make their own arrangement for the pit emptying within 2 to 5 years.

For off-site sanitation schemes it is necessary to ensure continuous maintenance of the off-site component of the scheme and hence there is a potential for the creation of local jobs. The off-site system whereby the waste is gathered from toilets and transferred at a sewerage treatment plant is an ongoing process which has cost implication. The operational and maintenance task of the VIP toilets, aqua-privy, UDS toilets and poured flush toilets systems

may be done by the home owner or the small contractor which provides job opportunity to local people.

In terms of health and safety the VIP toilets compares very favourably with waterborne systems, but in terms of user comfort it is not very competitive. Financial restrictions and the availability of water are the main reasons why VIP is the best alternative especially for rural clinic sanitation.

## **12. LOCAL/COMMUNITY PARTICIPATION FOR CONSTRUCTION OF RURAL TOILETS**

The involvement of the local community participation is an ongoing process during which individuals, groups and organisations have the opportunity to participate and assist with the process for the completion of the project. The aims of community participation are towards improving project efficiency and effectiveness, empowerment and building beneficiary capacity.

Community participation starts soon after project conceptual stage, and should help to mould the concept and continue to be involved in all decision through the project process. Community participation should be broad in that it should involve all those people, group and organisations that have an interest in the development project.

The clinic sanitation programme is a multi sectoral issue and the major role players, the Department's of Health and Education has been involved to support the strengthening of clinic facilities and the promotion of health and hygiene. The involvement of other department, such as Department of Works that assists with the arrangement for the maintenance of all facilities and ensure that records are updated.

In accordance to Economic Development (ED) and Employment Creation for Umkhanyakude District Municipality, both material and labour for the construction of clinic sanitation have been sought from within the Local Municipality with skill enhancement through local/community participation. The community has been empowered through a community based approach to construction management.

As the Umkhanyakude District Municipality has implemented this project, the councillors, as representatives of the wards where the clinics are situated, provide the first level of local participation.

The next level of participation is the employment of local building contractors through the appropriate municipal procurement procedures, affirmable business practices, women equity, etc.

## 12.1 Labour-Based Construction

The labour intensive works is not a means of creating short term employment and infrastructure, but also as a means of promoting longer term and more sustainable development based on the increased use of local people. The major objectives for labour based construction projects include:

- Create immediate employment and income for the poor
- Create the basic of long term employment for the poor, especially in rural areas, by transfer of skills through training, by providing jobs in the maintenance and operation of the newly built infrastructure;
- Produce a general shift within the construction sector in favour of using more labour-intensive and less equipment- intensive methods so as to enhance poverty alleviation
- Promote the involvement of local communities and other groups in the planning, construction and subsequent maintenance and operation of infrastructure
- Increase the sustainability of infrastructure project through optimum use of local resources
- Imparting skills to government personnel through training

The construction of VIP toilets for clinic sanitation projects is very conducive to labour intensive construction techniques. A construction manager/contractor has been employed by Umkhanyakude District Municipality to hire, train and utilise local artisans and labour. The construction manager ensures that materials, transport etc are available, preferably locally, and ensures quality control and programme time frames are met. Local people carry out all other activities.

In many of the labour based construction there will initially have an increased management requirement, higher initial cost associated with setting up small entrepreneurs, additional training and the provision of mentorship services. To this end sanitation projects will include a specific budget item reflecting the additional costs that are planned for. It can be noted that cost saving are expected on larger sanitation projects due to the availability of semi-skilled builders and material suppliers.

The Extended Public Works Programme is currently targeting the unemployed people who do not have skills to be able to create their own employment. This is resulting in a need to reach many of these people who reside in impoverished communities, particularly those settlements remote from other economic activities. Thus the delivery of sanitation becomes the one of the key instruments of government for addressing job creation in a sustainable way.

## **12.2 Involvement of Previously Disadvantaged Individuals (PDI)**

In terms of the Umkhanyakude District Municipality requirements, preference has been given to suppliers and construction managers who are local and PDI's/PDC's.

Bricklayers, plasterers, hardware stores/suppliers, block yards, etc, from within the project area that are PDI/PDC have been utilised on this project, wherever possible. This is on condition that products and workmanship are competitively priced and meet quality requirements.

## **12.3 Employment Policy**

The employment policies in principle target the neediest individuals in the local householders including youth (male and female) women, unemployed and those single headed households. The opportunity to participate in this programme is readily given to the disable individuals on an equal basis.

Employment is targeted at individuals living in or adjacent to areas where work is being carried out. Women are given equal opportunities as men, and all workers are recommended by the Sanitation Project Steering Committee (SPSC). SPSC members are not allowed to contract their services to the project, as this is a conflict of interests.

Skilled artisans, including builders, block layers, carpenters, etc, are sourced from the community and only brought into the area if these artisans are not available or not competitively priced.



The SPSC formed a labour sub-committee which is responsible for identifying and recommending suitable candidates for employment as labourers, builders, etc. The labour sub-committee ensures that the employment policy is adhered to each time employment opportunities arise. The sub-committee also assists in dispute resolution and payment of labourers and builders.

It is estimated that approximately 100 local community jobs have been created during construction. This includes builders for block work, plasterers for lining, labour for movement of materials from store yards to individual households, quality assessors and transporters. In addition, jobs have been created in the Umkhanyakude Region for slab manufacturers, and welders and painters required for toilet manufacture.

#### **12.4 Wages and Labor Standards**

Wages are generally the minimum wages for KwaZulu-Natal Province or for the area where work is being carried out, as specified by the Department of Labour. The norm for the area is R70.00 per labourer per daily task and work is normally carried out on a task basis. This has been agreed with the SPSC and labour force prior to commencement of work.

### **13. IMPACT ON LOCAL PEOPLE AND COMMUNITY FEEDBACK AFTER THE CONSTRUCTION OF CLINIC SANITATION**

Feedback reports from the clinics after the construction of the sanitation VIP toilets at clinics indicate that:

- Implementation of the Clinic Sanitation Project Implementation Plan provides support to disadvantaged rural communities ensuring that the rural clinic is provided with the basic sanitation of Ventilated Improved Pit (VIP) or alternatives based on local infrastructure requirements and where possible higher level of service such as water borne sewerage.
- Initially the newly constructed disabled toilets were not being utilized, but after a few weeks' local patients at the clinic started using these toilet facilities because of the accessibility and availability. The disabled toilets have been a success in areas where they have been constructed and basic sanitation facilities are being provided.
- The clinics are concerned that they would like to have a regular water supply to keep up the health requirements.
- They are happy that sanitation facilities are improving, that maintenance is not being neglected whilst awareness, training and education of the rural community is ongoing.
- Improved health and safety of all who visit or stay over in the clinic by providing appropriate basic levels of sanitation and water service.

The criteria is to provide sustainable sanitation for rural clinics in an area where contractors have to travel long distances, sometimes in excess of 220 km to the nearest town for hardware supplies from the nearest store, have been met. The communities are pleased that they can see conditions are improving, particularly with the provision of disabled toilets. Although they are happy with the VIP toilets which can operate under dry conditions, regular water supply to the clinics will be useful and of great assistance so services can be provided for the really poor.

The Ventilated Improved Pit toilet has proven to be a convenient, hygienic and environmental acceptable sanitation system.

## **14. EDUCATION**

One of the important goals of any sanitation projects is the health improvement to rural communities after the toilets have been built. The peoples' health improvement requires behavioral change which may not be achieved with a health education talk by an expert. There is a need to encourage the behavioral change by sustained monitoring and promotion within each community. The Department of Health can employ a community health worker to provide sustained and effective health and hygiene education on sanitation and to educate people on a wide variety of health issues.

### **14.1 Education- Community involvement**

The health education for sanitation commences with the provision of a handwashing facility inside or outside the toilet where hands can be washed under running water with soap. In many areas where people live there is water available, not necessary for the waterborne systems, but sufficient to wash hand after the use of the toilet. This principle of washing hand reduces contamination and sanitation related diseases like diarrhea and cholera.

The issuing of pamphlets and visual educational material of the health and hygiene procedure can be easily pinned or placed inside the toilet for easy reference and ongoing education.

The special requirements of small children especially in early childhood development centres (such as crèches) should not be ignored with regards to the design and construction of toilets. There should be child-friendly toilet facilities with inputs from children.

To inculcate improved hygiene habits amongst school children, the provision of VIP toilets in rural area will become a strong element of primary health care programmes.

### **14.2 The Department of Health:**

The Department of Health plays a crucial role in identifying and prioritising the clinics for this Sanitation Programme and also plays a pivotal role in assisting with spreading of the health and hygiene messages at their mobile and fixed clinics in the area and through their Community Health Workers.

The Department of Health assists by providing training materials, monitoring the well-being (medically) and hygiene awareness programmes, monitoring the communities health, facilitating and attending community awareness workshops and educating the community on water, sanitation, health and hygiene. Extensive liaison has been undertaken with all the clinics, crèches and schools.

## **15. CONCLUSION AND RECOMMENDATIONS**

Health improvement is one of the important goals of all sanitation improvement projects. However improved health education will not be achieved by simply supplying toilets. Improved health requires behavior change, which also cannot be achieved with a single health education talk given by an outside expert. Behavior change requires sustained monitoring and promotion within the community. This is the key function of the community health workers employed on sanitation projects and the need of the sustainability of the community health worker's with regards to their position and employment within the community linked together to the activities of the Department of Health.

One of the key components of sanitation project where jobs can be created is the construction of toilet superstructure. A range of superstructures are currently being used in South Africa, not all of which promotes sustainable employment. When selecting the type of superstructure, planners and designers should consider the long term employment implication of the particular technology. For example the Archloo, while being a cheaper form of structure, is not a common form of construction that can be adapted to other building projects, nor does it promotes the establishment of small enterprises like block and brick manufacturers. The use of the different cost effective technologies and sustainable job creation should be captured and shared broadly with all role players. Various implementation models of rural sanitation are being applied in different provinces, and the lessons from these could be useful to municipalities that have not yet actively engaged their sanitation delivery challenges.

Although significant employment can be provided on the rural sanitation projects, the people employed should preferably be equipped to get further employment following the end of the rural sanitation project. Their training and skills should as far as possible equip them to be able to make further initiatives on their own as entrepreneurs or independent contractors. The promotion and building sanitation facilities should include a component of their training plan in entrepreneurship and running of small business, as well as provide accreditation opportunities for all trainees such that they will be able to use their credits or learnership on the qualification building programmes should they so choose.

The local and district municipalities can adopt in their planning and implementation procedures such that employment creation is a key component of sanitation development

without significant cost implication. The development of jobs in the manufacture, supply and delivery of materials using the local suppliers is the one of the ways to generate new opportunity for sustainable employment opportunities on sanitation project.

The local authority is responsible of the ongoing maintenance programme. The various basic sanitation types of toilet system including VIP and septic tanks must be inspected yearly by the local authority. The septic tank should be checked to ensure timely desludging and the drainage field/evapotranspiration area for efficiency. Regular groundwater quality monitoring should be done at those localities where there is a possibility of the toilet systems could contaminate an aquifer, especially if it serves a water supply. Stormwater systems should be periodically sampled in those areas that experience seasonally high water tables/perched water tables. Monitoring, especially in rural areas, should be mandatory wherever septic tank/conservancy tank effluent is disposed of at a communal site, irrespective of the technique employed.

Small and large businesses are required to join in partnership with the municipality for manufacturing and installing sanitation system, as the Government is not able to address the growing sanitation backlog.

## **16. FUTURE SCOPE FOR RESEARCH:**

Sanitation is an extremely complex issue. It is an issue that impacts on the daily lives of every human being, especially in many of the developing countries where the level of service is either poor or nonexistent.

The provision for cost-effective sanitation facilities for people with different needs and different background will allow designers to provide different types of technological choices for the solution of our sanitation requirements. A particular product may be right for a certain section of the market, but not for all consumers and conditions. In-depth research and innovative designs are still needed with regards to safety, comfort, ventilation, user preferences and education for proper use of the system.

Sanitation programmes in rural area are a challenge to all role players and with limited budgets, the adoption of re-use and recycling of human excreta on the long-term basis should be considered as solution of our growing sanitation needs. The use in some societies to recycle human excreta as fertilizer, as has been done for centuries in various parts of the world can be considered.



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**Annexure**  
**A11-A30**

