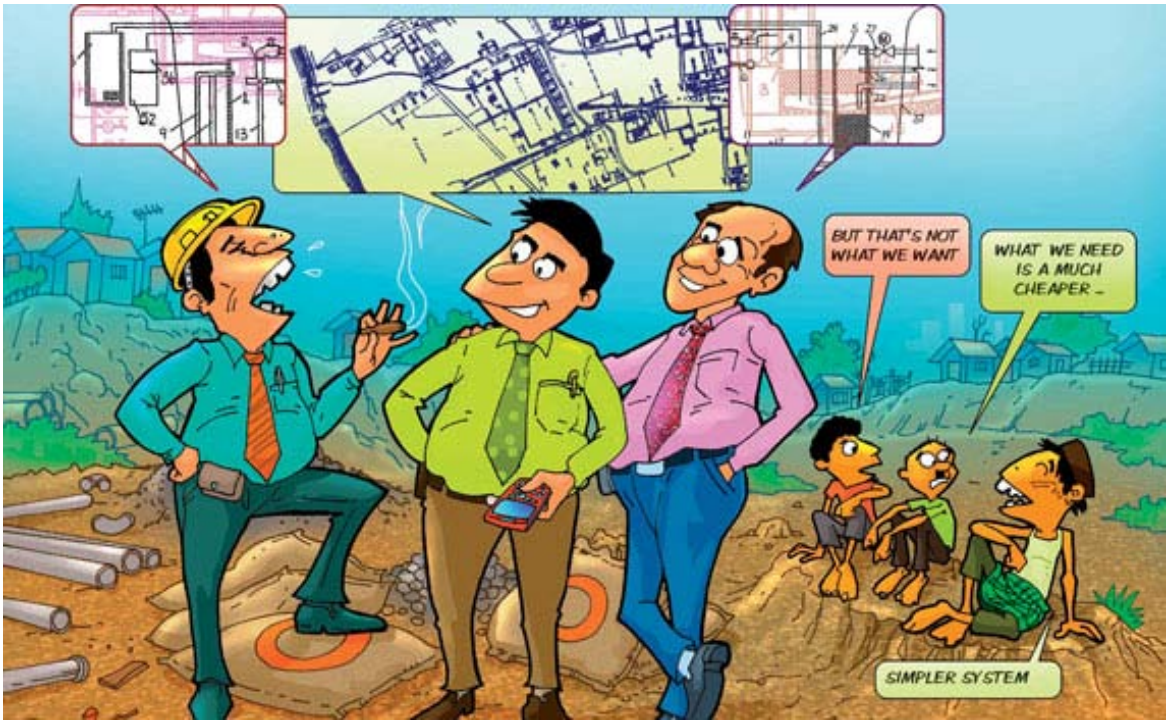
Water Services Trust Fund

Public Sanitation

Public Sanitation Design Guideline



Cartoon from WSP Water and Sanitation Program Calendar 2009

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1 DEFINITION OF "A WELL DESIGNED TOILET"

Architecture and sociology agree that spatial impact influences society which is determined by the interaction of customs, values and norms and its architectural form of expression. To fully understand this impact might be difficult or even impossible. But to understand that it exists gives the opportunity to use design to change behaviour.

Anyone, who has even been in an overcrowded or uncomfortable public toilet, will value a good toilet design. Public toilets are places where one is obliged to ease oneself in unfamiliar surroundings among the strangers of the same sex. Therefore, the fundamental principles of design of toilets include psychological studies and not just physical clearances and space requirement.

The usual demands placed on a high traffic and heavily used facility requires extra thoughts for each process. A well-designed public toilet has to be:

a) clean and dry

b) well ventilated

c) safe and user-friendly

d) vandalism proof

e) easy to maintain

f) and needs to have a carefully planned layout

Toilets located in either public or in high-density residential settings need to be inclusive and safe environments. They need to be facilities that people feel confident to use, are easy to maintain, and are resource efficient. To achieve this, toilets need to be well located, well designed and effectively managed.

There is a close relationship between design and management. Design choices should be made that allow for easy cleaning and management, resistance to vandalism, low maintenance requirements, and user convenience.

Design and material choices need to ensure that the life expectancy of the structure can be realised. Besides, toilets should be designed and constructed in accordance with environmentally sustainable, equity (access and usability) and efficiency (cost over time) principles.

Guidelines

This document has been designed to guide the design of further public toilet facilities, and – if possible – the refurbishing process of existing public toilets.

The main strategies behind the design of public toilet facilities are:

- Review of existing public toilets in terms of usage levels, facilities, fittings, accessibility, user convenience and acceptance, signage, water and energy requirements, safety, vandalism levels, and determination whether any public toilet should be removed, refurbished, or replaced.
- Analysis of demand for improved public sanitation facilities in public places and residential areas without sufficient provision of toilet facilities to determine where a public sanitation facility is required.
- Consideration of holding an architecture competition to develop an innovative public toilet design within these guidelines.
- Determination of the feasibility of water and energy saving devices and develop a prioritised installation program as required.

Toilet requirements

A public toilet should be provided where it is required and appropriately used. Public toilets can be expensive to provide and are resource intensive to clean and maintain. Toilets that are rarely used may be causing an unnecessary cost to upkeep, particularly those that are frequent recipients of vandalism. Due to the investment and maintenance and operating (water, energy, materials) costs involved, it is important to determine if a toilet block should be closed and demolished or be refurbished or replaced. It should be noted that some existing toilets may currently attract poor usage levels because of their condition, rather than their location.

So the question that needs to be answered first is: Is the toilet needed?

Consultation

It is recommended that key stakeholders are consulted to determine the requirements for toilet facilities and what issues should be considered when constructing or refurbishing them. The main stakeholders of a toilet facility are its users or its intended users. Before implementing a one-fits-all approach it is vital to talk to the people who want to use the facility and at the end to pay for this use. Besides, it might be important to talk to operators of existing public facilities to get an overview about the main problems they encounter when it comes to operation and customer contact and/or complaints.

2 SUSTAINABLE DESIGN PRINCIPLES

Public sanitation facilities should be built and managed in accordance with sustainable design principles. Sustainable designed sanitation facilities aim to lessen their impact on the environment through energy and resource efficiency. Besides, they will improve the sanitary conditions in low-income areas and the safe disposal of wastes.

Consideration must be given to the inclusion of the following objectives in the design stage:

- minimising of water and non-renewable resource consumption
- promoting health and hygiene
- reducing initial investment cost without spoiling functionality
- meeting the demand of intended users
- enhancing of durability of materials and equipment
- easy to extend, upgrade and replicate
- safe disposal of waste products with focus on possible reuse options
- reducing of environmental pollution
- providing options to reuse waste products
- meeting minimal space requirements

Adopting these principles often requires taking the following measures:

- demolish and rebuild only when it is not economical or practicable to reuse, adapt or extend an existing structure;
- make the most of the site, e.g. by studying its history and purpose, local micro-climates and the prevailing winds and weather patterns, solar orientation, and the form of surrounding buildings;
- design the building to minimise the cost of ownership and its impact on the environment over its life span by making it easily maintainable and by incorporating techniques and technologies for conserving energy and water and reducing emissions to land, water and air;
- wherever feasible, use the construction techniques which are indigenous to the area, learning from local traditions in materials and design;
- put the function of the building and the comfort of its users well before any statement it is intended to make about the owner or its designer. That is, make it secure, flexible and adaptable (to meet future requirements);
- build to the appropriate quality and to last. Longevity depends much on form, finishes and the method of assembly employed as on the material used.

- avoid using materials which cannot be reused or recycled, especially in structures which have a short life.

Understanding place

Sustainable design begins with an intimate understanding of place. If we are sensitive to the nuances of place, it helps determine design practices such as ensuring natural ventilation and using natural lightning.

Understanding environmental impact

Sustainable design attempts to have an understanding of the environmental impact of the design by evaluating the site, the embodied energy and toxicity of the materials, and the energy efficiency of design, materials and construction techniques. Negative environmental impact can be mitigated through use of sustainably harvested building materials and finishes, materials with low toxicity in manufacturing and installation, and recycling building materials.

Embracing co-creative design processes

It is important to listen to every voice. Collaboration with systems consultants, engineers and other experts happens early in the design process, instead of an afterthought. Besides, **listening to the voices of local communities is crucial**. The public toilet should be designed by an interdisciplinary (professional) team. The design evolving out of this should reflect the input of all stakeholders who are involved by engaging them in a series of feedback loops.

Understanding people

Sustainable design must take into consideration the wide range of cultures, religions and habits of the people who are going to be using and inhabiting the facility. This requires sensitivity and empathy on the needs of the people and the community.

Therefore, a sustainable design involves giving consideration to a variety of factors: aesthetic, environmental, biological (gender), ergonomic, social, cultural, political, and moral. It is about using one's imagination and technical knowledge to engage in a central aspect of the practice - designing and building in harmony with the local conditions as well as focussing on the improvement of the living conditions through sanitation provision. One needs to think rationally about a combination of issues including cost, sustainability, durability, appropriate materials, and sense of place. The challenge is finding the balance between the above-mentioned factors and economic constraints. However, consideration must be given to the needs of the communities and the ecosystem that supports them.

Islamic toilet etiquette

In areas with a high Muslim population Islamic toilette etiquette has to be taken into consideration. The Islamic faith has particular rules regarding personal hygiene when going to the toilet as well as requirements when it comes to toilet design. This code is known as *Qadaahul Haajah*. Main aspects include:

- Muslims are prohibited from facing or turning their backs on the Kiblah - the direction of prayer - when they use the toilet. This is important when designing the cubicles as well as siting the toilet seats / squatting pans.
- A person should be out of sight of people when going to the toilet.

- Toilet users should sit on the feet (e.g. squat) or do not sit more than needed respectively.
- After relieving oneself it is essential to perform *Istinjaa* (washing with water) of the anus and/or genitals with the left hand and water. At the beginning of *Istinjaa*, it is preferable to use toilet paper three times.

It is important to note that parts of the Islamic toilette etiquette may not be compulsory to all Muslims and fall into the category of the *Sunnah*. Therefore, it is important when designing the public toilet facility to conduct interviews and/or discussion with potential Islamic users on their needs.

Environmental factors and constraints

As for the architectural side, the building enclosure and layout should be designed so as to maximize the use of natural resources, i.e. natural ventilation, daylight, rainwater, etc.. At the same time the architect/designer should consider the necessity of incorporating artificial lighting and mechanical ventilation systems to ensure that the toilet would still function properly when there are shortfalls in the natural resources. Besides, the choice of proper building materials is essential. Malodour substances and/or bacteria could be trapped in building materials easily and start to grow. As time goes by, these smelly substances would become very difficult to get rid of. Therefore, building materials with smooth surfaces and minimum gaps should be used.

Energy

From energy conservation point of view, it is necessary to minimize the use of energy consuming equipment wherever possible. But however, this should not be at the expense of the proper functioning of the public toilet.

In general, the major electricity consuming installations in public toilets are ventilation and lighting systems. To reduce the energy consumption of the lighting system the designer has to make good use of available daylight. Whilst for ventilation system, maximizing natural ventilation can reduce the energy requirement for mechanical ventilation fans. However, minimizing the use of artificial lighting and mechanical ventilation must not desert the proper performance of the toilet. A careful balance should be made.

The basic principle to be employed is to utilize artificial lighting and mechanical ventilation systems only when they are absolutely necessary so as to minimize the use of energy.

Effective measures to reduce energy consumption are the use of skylights and other passive light design features, low energy fixtures, timers / sensors on lighting, the use of solar power (if possible), the use of natural ventilation, and the use of light coloured and reflective internal surfaces.

Water

Besides electrical energy, one other natural resource that needs preserving is water. To avoid unnecessary wastage of water, spring-loaded or time controlled taps could be used. This would avoid running water tap being left unattended due to absent-minded toilet users forgot to close or not closing the water taps properly. It might even be considered to use seized buckets for flushing the toilet, showering and hand washing.

Furthermore, rainwater collected from the roof of a toilet or the greywater produced (wastewater from hand washing and bathing without human faeces) could be stored up and used for flushing purpose.

The installation of flow regulators on taps is highly desirable. The average flow (if pressure within the system is ok) as set by the user is 12 l/min. A flow regulator is a simple device which reduces the flow of water from a tap or shower. This reduces the amount of water that is wasted. Installing a flow regulator in the shower head will decrease water flow from around 12 l/min litres per minute for a conventional shower head to 9 l/min. Installing a flow regulator in the hand wash basin outlets can decrease water flow from 15 to 20 l/min to around 6 l/min.

Besides, the use of dual-flushing or auto-flushing devices for water closets and urinals (if not designed waterless) are good means to deter the spread of malodour. Foul stuff generated by the users could be automatically flushed away as soon as the user leaves the urinal or WC. By doing this, it would minimize the retention time of the foul stuff inside the toilet and enhance the ventilation effectiveness. Dual-flushing devices reduce the water consumed for flushing because it allows for partial or full quantity of water to be discharged from the cistern into the associated toilet.

Alternative Design

Conventional design might not always provide the best solutions for different environments and framework conditions. Environments can limit the possibilities of implementing standard designs and/or technologies. Installing public sanitation facilities in unplanned urban areas may require the wastewater treatment on-site as there in most cases is neither a sewer network available nor is the site accessible for any emptying service. Besides, alternative designs can reduce the costs of public toilet facilities effectively.

Composting or waterless toilets can be used where the water supply is limited or not available at all.

Instead of connecting the toilet to a septic tank that requires periodic desludging, it can be connected to on-site anaerobic treatment and the produced biogas can be used as an additional benefit for heating water, cooking or lighting of the facility.

Rainwater harvesting can provide an additional source from which to meet the water needs of the toilet.

Utilising renewable energies through the use of the solar technology — photovoltaic panels – can provide reliable, cost-effective and ecologically sound lighting and warm water.

3 MAIN FEATURES

The most common public toilet design in Kenya is a building, with separate male and female cubicles and separated wash areas contained within one structure. Public toilets at markets and bus stations often contain also shower/bathing facilities for men and women.

Generally all public sanitation facilities should include:

- A clearly visible entrance point
- A waiting area with bench next to the entrance
- A notice board in the lobby / entrance area
- A lockable box for customer suggestions and/or complaints in the lobby / entrance area
- A notice board in the operators shop
- A lockable door to close the facility properly outside business hours
- Hand wash basins and shower facilities with cold water
- Push button (spring-loaded) or time controlled taps to avoid water wastage
- Flow regulators on all taps to avoid water wastage
- Sanitary disposal units in each female toilet cubicle
- A rubbish bin in the male and the female section as well as in the entrance area
- Use of natural light (or solar power)
- Low energy fixtures and timers / sensors on lighting (where required)
- Natural ventilation
- Common and robust fittings for ease of replacement
- Cubicle and shower doors lockable from the inside

Toilet configuration

All public toilets should include a minimum of 2 female, 1 male and 1 urinal toilet. Generally the requirement will be determined by the site and the frequency of usage.

The following guide to the number of toilets required should be regarded as a rule of thumb to calculate the minimum number of toilets required:

- All public toilet facilities should include a minimum of 2 female and 1 male toilet and at least 1000 mm of urinal trough (or at least one single urinal bowl).
- Public places: one toilet in each section per 100 users per day.
- Residential areas: one toilet in each section per 50 users per day.
- Urinals: 1000 mm of urinal trough per 100 users (1 man urinal), 1900 mm per 200 users (2 man urinal), 2850 mm per 300 users (3 man urinal), in the males section.

Additional cubicles may be required in locations where persistent queues of people waiting to use the facility are evident during peak periods.

Shower configuration

All public toilets should include a minimum of one shower facility for females and males each. If considered convenient and necessary space is available the number of showers may be increased.

Outside lighting

The provision of lighting after dark may attract undesirable activity. Generally, the majority of public sanitation facilities will not require lighting after dark except in specific sites where toilets will be used at night. In this case, it is important to provide lighting for the surrounding area of the facility and along the entrance and any direct access areas of the public sanitation facility

Where after dark use is permissible, it is preferred, that all lighting fixtures are solar powered (if possible), low energy, and incorporating timers or sensor control. Lighting fixtures must be mounted above pedestrian reach, and be resistant to insect infestation and vandalism. Lighting should be consistent and even enhance safety and comfort.

For security reasons toilets should provide a clear line of sight for casual surveillance around the sanitation facility.

Signage

Directional signage should provide users with clearly visible directions to indicate the location of the public sanitation facility. There should be sufficient signs leading to the facility. Further to this, signages used should be sufficient and prominently displayed in all main traffic passageways, so that the user does not need to ask for directions.

The toilet gender should be clearly identified by use of common symbols for male and female (and unisex for disabled).

Opening, closing and cleaning times should be provided along with the WSP's and operators contact number for reporting of any problems. Signs should be protected to damage and should enable easy cleaning.

Vegetation

Public toilets should not be located near thick vegetation that detracts from clear visibility of the toilets. Surrounding plants should not grow over 700 mm in height.

Low level, suitable, decorative vegetation are recommended as they add to aesthetics and deter vandalism. Plants with low maintenance, low water requirements and weather resistance should be selected. Local plants should be preferred.

Access

Public sanitation facilities should be clearly visible and easily accessible to all users.

Access to toilets should be easy also for disabled users. Steps and ramps should be avoided, instead it is recommended that the site around the toilets be flat or of a small grade. Paths should be provided up to the entrance of the toilets providing all users with a continuous path of travel.

If public toilets are supposed to be provided at public places like bus stations and markets, the location of toilets should not be too remote from the main traffic area to avoid long distance walking. It has to be easily accessible for those with urgency. For safety reasons public toilet facilities should be easily visible for users and passersby. By placing public toilets in

active areas, unsafe and unwanted activity is reduced. The facility should be visible from all or most directions.

Same applies for public sanitation facilities in residential areas. The distance between the houses of potential users and the toilet facility should not exceed 200 metres.

For safety reasons public toilets should be easily visible for users and passersby. By placing public toilets in active areas it will reduce unsafe and unwanted activity. It should be visible from all or most directions.

3.1 The Building

Building exterior

The building exterior should be well presented, clean, well managed, welcoming and should ensure that users feel safe and comfortable.

For security reasons the gates and doors should be able to be closed and locked where applicable. Facilities must provide a clear line of sight for casual surveillance around the sanitation facility. Where after dark use is not permissible lighting will not be required.

The entrance should be clearly visible, while providing easy access to all users and some feeling of privacy. Entrance doors may need a lock if the facility is not intended for use at night.

Single entrance/exit plans work satisfactorily provided the path of the users do not cross each other and the entrance is wide enough. Dispensing with the entrance door to the public toilet not only helps to improve the ventilation within the toilet but also minimizes hand contact for hygiene reasons. In many toilets, doors have been replaced by offset entrance maze which blocks the view yet allows easier, hands-free access.

Consideration should be given to the positioning of the mirrors and to gaps created by hinges. For example, the access entrance to the male section should not open directly to the urinal area. Entrances opening onto a wall surface with the mirror reflecting the urinals should be avoided.

Orientation

Public sanitation facilities should face public areas such as footpaths, roads, or places with high usage.

The operator's room

Public sanitation facilities are supposed to be operated by a contracted operator. He/she will be responsible to collect the user fees as well as to keep the toilet clean. The public sanitation facility should incorporate space for the operator to sit, to collect the money while at the same time being able to overlook the entrance to the female as well as the male section entrance. The operator's room could also provide additional space for the operator to establish a small shop, where he/she can sell consumable goods (e.g. newspapers, scratch cards, sanitary products).

Customer care

When entering the public toilet facility there has to be a provision of e.g. an inbuilt poster frame and/or a display board that can be used by the operator to place information. This mainly refers to the advertisement of business hours, tariffs, cleaning schedule and user education. Besides, there should

be a lockable box, where customers can place comments and/or complaints if desired.

Waiting area

If sufficient space is available, a protected waiting area with seats should be provided where mothers can leave their children while using the toilets or users can wait if all facilities are occupied.

Doors

Doors should be wide enough to enable easy access for all users. There should be no corners, and it should be light coloured, clearly visible and well lit.

It is not necessary for doors to fill the door frame. Opaque and semi-translucent materials can be used in sections of the door for ventilation and natural light. Doors should incorporate design features that allow for easy access if a person collapses behind the door, (for example outwards opening doors or inwards opening doors with hinges that allow the door to be lifted clear), whilst still remaining vandal resistant.

Roof

Installations of skylights that provide natural lighting are recommended. Gaps between the roof and wall can provide light and ventilation. The roof should also provide shelter.

Roof design should also be considered (e.g. northerly aspect, loading) to ensure that solar power can be utilised, either now or in the future. Roof design should also include opportunities for rainwater collection.

Wall continuity

The entrance walls should be built with a semi-translucent material such as metal meshing to increase visibility and natural light. It is recommended these walls have a continuous gap below the wall and roof for ventilation.

It is preferable that there is also a continuous gap in the brick work between walls and roof. This gap can be covered with a grill or batons (batons should not be able to be climbed) for ventilation and light.

Low level openings in the brick work will also increase ventilation. The walls must provide privacy inside cubicles. Outer wall placement and composition should ensure that a direct line of vision cannot view any areas that may be used as change facilities.

3.2 Toilet Interior

There are a number of different activity spaces within a public sanitation facility: space occupied by the appliances itself, additional space required by the user and further space for their own belongings or circulation within the facility. In many cases, these latter spaces may overlap on occasion. Common sense will dictate when this is appropriate and when it is not.

Placing the appliances in order of use simplifies the circulation and reduces the distance travelled by the user.

For hygienic reasons, public sanitation facilities should be designed to minimise hand contact as far as possible. Electronic products for toilets such as flush valves and faucets require minimum maintenance but offer

enhanced operations that promote sanitation and perceived cleanliness because of hands-free operation.

It is difficult and costly to insulate the toilets acoustically. This problem can be resolved by planning isolation as much as possible.

No unsupervised installation can prevent vandalism. Even with the most vandal resistant appliances, an unsupervised facility will eventually become sub-standard. The operator/attendant plays an important role, which will result in well-maintained toilets.

However, all designs should allow for individual items to be replaced. Pipe work, traps and electrical supplies should be concealed for aesthetic and hygiene reasons.

Public safety inside the public sanitation facility should be supported by limiting contact with other users, and by presenting a light, bright, well-ventilated environment.

Interior design

The interior design should maximise user visibility and minimise the opportunity for collision and conflict. No blind corners will leave open sightlines throughout the facility. The use of light colours is recommended for maximum visibility.

Urinals

The minimum requirement for the male section is either a single urinal or a urinal trough of min. 1,000 mm. Urinals are to be waterless or automated, and designed to prevent a build up of uric acid.

If not waterless urinals should be fitted with a flush valve and an automatic flushing device. The fixture should be concealed for easy maintenance and to deter vandalism.

Urinals can be designed as individual wall hung units, more than 300 mm wide, or as a trough properly graded towards the opposite wall. The length of the trough needs to be adapted to the requirements: 1,000 mm per 100 users per day (1 man urinal), 1900 mm per 200 users (2 man urinal), 2850 mm per 300 users (3 man urinal) should be considered. Standing in front of the urinal trough, it should be bordered by walls on the left and on the right side.

The lip of the collection area should project from the wall by at least 250 mm. Space around single urinal(s) should be 400 mm away from the site wall and 750 mm from the next urinal if more than one is provided. Standing in front of the urinal there should be at least 900 mm to the wall behind. A concrete step of 325 mm could be built in front of the urinal. Between the step and the wall behind should be at least 575 mm.

Water closets

All water closets (WCs) should preferably consist of squatting pans with P-trap fitted with a flush valve and an automatic flushing device with a manual bypass. However, also sitting pans or toilet benches can be considered. The fixture should be concealed for easy maintenance and to deter vandalism.

Toilet cubicles should be spacious, well lit, vandal resistant and easy to clean. WC cubicles should be 800 mm (min) x 1,750 mm (min).

Coat hooks should be affixed behind cubicle doors. A platform could be installed in the cubicles for putting personal items.

A floor trap should be provided if sitting pans or toilet benches will be used. The flooring of the WC cubicles should be properly graded towards the floor trap so as to keep the floor as dry as possible.

Showers

Where bathing facilities are required, at least one shower head and stall with cold running water for each sex shall be provided.

Shower cubicles should be spacious, well lit, vandal resistant and easy to clean. Shower cubicles should be 800 mm (min) x 1,750 mm (min).

The shower cubicles shall have waterproof floors and walls. Floors shall be adequately pitched to one or more floor drains properly connected to the wastewater disposal/treatment facility.

The fixtures should be concealed for easy maintenance and to deter vandalism.

Coat hooks should be affixed behind cubicle doors. A platform could be installed in the cubicles for putting personal items.

Disabled toilet

Toilets should be no less available for disabled people than for non-disabled people. Toilets for disabled people should be conveniently located, bearing in mind that some disabled people need to get to a WC quickly. Their position should, wherever possible, be adequate to ensure they are easily accessed.

Each public sanitation facility should have at least one designated unisex toilet for disabled people, not integrated with male and female toilets. A unisex toilet allows assistance by a companion of either sex, and it is less demanding of space than provision on an integral basis.

WC compartments should be designed to reflect ease of access and use. They should allow for wheelchair manoeuvre and have space for a helper. Doors should open outwards. Toilet doors should have a clear minimum opening width of 925 mm. The cubicle should be provided with hand washing and drying facilities.

Provision for parents

Toilets used by a high number of mothers / parents with small children should contain baby change and feeding facilities for hygiene purposes. This should take the form of a separate designated room. The specification will need to be sensitive to parent needs and be vandal resistant.

Walls

Light coloured tiled walls are easy to clean, reflect light and offer a sense of space. Walls must provide sufficient privacy as well as ventilation. They can also be used to maximise the use of light.

Floor

The use of non slip tiles or other floor coatings that are easy to clean and vandal resistant are recommended (not just concrete). Floors should slope slightly to an internal drain and / or floor trap to reduce water pooling.

Doors

Doors should not be floor to ceiling; they should provide an internal lock for privacy and denote usage. Doors should incorporate design features that allow for easy access if a person collapses behind the door (for example outwards opening doors or inwards opening doors with hinges that allow the door to be lifted clear), whilst still remaining vandal resistant. Doors should also provide hooks on the back, and be easy to clean.

Cistern enclosure and pan

The cistern and pipes should not be accessible to the public. They can be contained in a separate room or duct accessible to maintenance staff through an access panel. There can also a false wall be placed to separate the cistern from the public. If it is not possible to hide the cistern from the public a strong emphasis has to be given on the cistern quality to be strong and vandalism proof.

Fittings

Fittings should be common throughout public toilet facilities, to provide for easy replacement. Toilet roll holders (if considered) should be robust and secured well. Sanitary bins must be provided in each female cubicle. Air freshener units can also be considered. A mirror must be provided above the wash facilities. Mirrors should be flush with the wall surface.

Wash facilities

Wash basins with no visible piping are the preferable option. Taps must be metal and spring loaded or timed to regulate water usage. Flow regulators must be installed to conserve water. Taps must be easy to reach and to use for smaller or less able people. A soap dispenser should be provided. The dispenser will be concealed and will avoid wastage.

The provision of paper towels is preferred.

Wash basins should be substantial in size. Single basins should have a minimum size of 500 mm in length and 400 mm in width. One jointly used wash trough could be an alternative to individual basins.

All wash basins should be installed into washstands. The washstands should have backsplash and apron or rounded down edges.

As an effort to conserve water, electronically controlled taps can be considered. Sensor controlled taps with their precise flow settings and positive shutoff characteristics, offer effective means for providing adequate water flow when it is required. Further to this, it will minimize hand contact.

The water pressure and tap/wash basin position should not cause water to splash onto user's body during activation. Where there are 2 or more basins, one should be installed at child's height.

Liquid soap dispensers, paper towel dispenser or hand dryer and litter bins should be installed adjacent to the wash basins.

Servicing

A storage facility or room should be provided to cater for the storage of cleaning materials and other things such as toilet paper, towels and soap.

Lighting

It is preferred that natural or solar lighting is used as opposed to electrical lighting. The toilet design should incorporate the use of as much natural light as possible through skylights, translucent glass blocks and other passive design features. Where natural lighting does not provide sufficient light it is recommended that solar powered sensor lighting is used.

Artificial lights, where required, should be high mounted and vandal resistant.

Skylights and other sources of natural lighting are strongly recommended. Wide entrances, light coloured and reflective internal surfaces, gaps under doors and exterior walls, grills and batons below the roofline, will assist to maximise the use of natural light and minimise the requirement for artificial lighting during the day.

Timers or sensors on lights as well as low energy fixtures are required.

In terms of lighting design, long life and high efficacy lamp source should be used. The building enclosure should be designed for maximum utilization of natural daylight. With the aid of energy conservation devices such as photocell sensors and occupancy sensors, unnecessary artificial lightings could be switched off when situation permits.

A well-designed lighting system will save electrical energy and improve the appearance of the toilet. Poorly designed fixtures with discoloured diffusers go a long way to make a toilet dingy. Dark and shadowy, off-coloured lighting can create the impression that a toilet isn't clean.

Natural lighting can be used to help create a softer, friendlier environment. Harsh lighting can create a cold and unwelcoming air while being inappropriate for the tasks being performed. It can also highlight hard-to-clean areas. Thoughtful selection of fixtures and lamps coupled with careful placement is essential.

All public sanitation facilities should be provided with warm-colour lighting for general lighting as well as down lights above the wash basin/mirror.

Warm-colour lighting aids in creating a better ambience in the toilets, which in turn encourages more care and responsibility from the users.

Ventilation

Proper ventilation of a public toilet facility is one of the highest priorities. Ineffective ventilation can make a public toilet unbearable, even if it is well designed. Effective ventilation ensures that vitiated air is quickly extracted, and helps to avoid dampness and subsequent growth of mould on floors and walls.

Gaps and grills should provide natural air ventilation. All public sanitation facilities should be mechanically ventilated.

The toilet enclosure and layout should be designed to maximize its breathing ability.

The mechanical ventilation system should be so designed that malodour generated is removed at the source as quickly as possible and will not be diffused away. The mechanical ventilation system of exhaust fans and, where applicable, ventilation ducts and grilles should ensure that every part of the toilet is within 3 m of the fan inlet or an intake grille, measured horizontally. Preferably, intake grilles should also be provided at low levels near the WCs to enable foul-air to be extracted quickly before diffusing into other areas of the toilet.

Fire prevention

Non flammable material should be selected in the design of public sanitation facilities. Opportunities to start fires should be removed, and the opportunity for the flame to spread should be minimised.

Ceilings

Ceilings should be light coloured, vandal and fire resistant and provide natural light and ventilation. Ceilings may be required to support ventilations and lighting systems.

Public health

It is appropriate for public health information to be supplied. It may be appropriate to provide condom and sanitary dispensing machines, both will need to be encased in a vandal proof unit.

A regularly cleaned waste disposal bin must be put in place at a convenient distance from the toilet.

Provision of facilities

All public toilet facilities should be fitted with:

(a) Toilet paper.

(b) Paper towels.

(c) Soap for hand washing.

(d) Waste bins inside each male toilet cubicle, sanitary disposal bins in each female toilet cubicle and additional waste bins directly below or in close proximity to the washbasin in each section as well as in the toilet for disabled (if available) as well as in the lobby and outside the sanitation facility.

(e) Suitable air fresheners to promote a fragrant, pleasing environment.

(f) Sanitizers.

(g) Small buckets to carry water for anal cleansing.

If not provided directly to the customers, some of the items above can be provided by the operator, like the toilet paper, paper towels, paper towels with sanitizer or the small buckets.

Installation standards

All pipe works should be concealed, except for final connections to the fixtures. Surface mounting of cables should be avoided. They should be fully concealed. Corners and edges should be rounded. Access panels to pipe ducts should be located as far as possible in inconspicuous areas.

Further improvements

The ambience of public sanitation facilities can be enhanced further by:

(a) Introducing easy maintenance plants inside the toilets as well as surrounding the public toilets.

(b) Placing of wall pictures, e.g. on health education.

(c) Placing of ornaments or sculptures at the ‘dead’ corners of the toilets.

(d) Choosing different colour shades for walls, floors, doors.

3.3 Materials

Materials used should be durable and resistant to vandalism and neglect. Applied finishes such as paint should be avoided.

Examples of good materials:

(a) Floor: Non-slip ceramic tiles, natural stone, homogeneous tiles, terrazzo, terrafloor tiles.

(b) Wall: Ceramic tiles, natural stone, homogeneous tiles, glass blocks, aluminium panels, phenolic cladding.

(c) Doors: wood, steel

Carefully selected, durable materials minimise maintenance and prevent misuse. It is highly desirable that painted finishes are avoided, together with any materials, which are affected by moisture or corrosion.

Floor finishes are available in a wide variety of materials. When selecting a finish, it is important to note that the material supports the image being presented. The finishes must be sufficiently durable to withstand the anticipated traffic levels and the toilet-cleaning frequency should also be sufficient to keep the floor looking well maintained and clean.

Non-slip homogeneous tiles are often selected because they are durable and are relatively easy to clean. The walls should be tiled, allowing the cleaners to sponge down the walls and floors thoroughly with little difficulty. Another alternative is to use ceramic tiles or wall cladding.

Wall and floor tiles of large surface areas are encouraged for easy maintenance. The tile size should be at least 100 mm by 200 mm.

It is important to use colours to brighten the toilet, create interest, and produce a conducive environment. Colour, achieved with materials and lighting, is one of the vital ingredients in creating ambience. It can be part of the tile or stone finishes, or added to the applied finishes such as the enamelling on steel or aluminium. If paint is to be used, it should be restricted to areas that are out of reach, e.g. ceilings.

Generally preference should be given to materials that are recycled, recyclable and renewable. Local and/or locally produced materials shall be used to the greatest extend. Reuse of materials upon refurbishment or demolition of toilets should be considered. Durability of materials is important and directly translates into minimal additional resource use.

3.4 Equipment

Each toilet facility contains two types of equipment that is sanitation hardware such as toilet bowl, squatting pans, urinals and wash basins on one side and standard facility hardware such as electrical lighting appliances, mirrors, door handles and locks on the other. Both types are key-parts of a toilet facility and therefore need to be of high quality, durable and robust as well as preferably locally available. This is important for the longevity of the installed equipment and hence low cost of maintenance and high service quality.

Furthermore, a good technical status of equipment will always be of high value for the toilet customers who can rely on a high standard of sanitation services as compared to frequent break-down when using low-quality equipment.

The following list of criteria for a high quality level of equipment should be a guideline for procurement:

1. Durable: other than plastic, preferably strong metal and/or ceramic, especially the equipment exposed to direct human usage and reach like cisterns, flushing valve, dispensers, bins, taps etc..

2. Easy to clean.
3. Equipment like squatting pans and toilet bowls / pedestal should be of ceramic materials for easy cleaning and comply with high quality standards of brand name companies.
4. Equipment that can be integrated and concealed into walls, floors and ceilings or can be heavily bolted or otherwise securely attached to prevent damages, vandalism and theft.
5. Equipment with least possible amount of moveable parts.
6. Equipment is preferably operated manually than electrically.

4 TECHNOLOGY OF WASTE TREATMENT

Public sanitation facilities should be connected to a reticulated sewer if available. If it is not possible to connect to the sewer then consideration should be given to the use of secondary treatment plants which will treat the wastewater to a higher standard than a basic septic tank. Other systems that may also be considered are composting toilets. The type of system to be used will be determined / influenced by the site characteristics.

The following on-site and off-site wastewater disposal technologies are acceptable:

4.1 Connection to the sewer system.

Level:

Wet off-site system

Description:

Full-flush toilets connected to a sewer (pipe) network which drains to a wastewater treatment facility.

Principles of operation:

Waste from the toilets, and possibly greywater (e.g. from sinks and showers), is flushed using significant volumes of water into the sewer system for removal to a treatment facility. There are several types of such facilities treating effluent to high standards prior to discharge into the aquatic environment.

Operational and institutional requirements:

Requires a reliable and uninterrupted water connection. Specific design criteria must be applied throughout the sewerage network. Skilled, organised and effective operation and maintenance capability is required for sewers and the full functioning of wastewater treatment facilities.

Costs:

Capital: € 150 – 300 for a sewer connection. € 450 – 900 for a sewer connection plus secondary treatment. Operating: up to € 130 per year.

Experience and comment:

Widely used in Kenya. Appropriate anal cleansing material is required. The health consequences of failure are devastating in comparison to onsite, dry sanitation systems. Generally, the sewer systems incl. the respective treatment facilities are operated by the WSPs. Many sewer systems and corresponding treatment facilities in Kenya are in a poor state of repair mainly because of the lack of maintenance and reinvestment over the past years, therefore not keeping up with increasing wastewater flows due to growing urban areas. Due to their irregular, unplanned layout, many (former) informal settlements lack sewer systems as a proper design and construction has not been possible because of lack of public spaces (mainly roads) and lack of funds. Despite heavy public investment in sewerage systems in most primary and some secondary cities, only 10-15% of the urban population in Kenya benefits from access to the sewer network. Sewer systems cover only a small fraction of the urban area and even where available, the connection costs are

high. For those households within proximity of the sewerage network, the cost of a connection can be twice as much as a water connection. In addition, households must then consider the cost of in-house installations (e.g. connecting toilets and modifying plumbing). Once connected, households also incur a wastewater charge that may represent over 50% (sometimes as high as 90%) of the water bill. Because water is required for flushing the water price has to be taken into account.

Advantages:

+ Treatment efficiency 95 % BOD (biological oxygen demand) removed.
+ 90 % suspended solids (SS) removed.
+ Low land requirement for sewers.
+ High effluent quality.
+ Sufficient experience exists how to construct, operate and maintain the system.
+ Operation and maintenance is carried out by a professional body (WSP).
+ Generally operates with few service interruptions or emergencies.
+ Provides the greatest user convenience.
+ Permits discharge of large amounts of water.
+ Does not pose any risks to health when functioning properly.

Disadvantages:

- Implementation requires skilled labour and contractors.
- Operation and maintenance requires a professional body (WSP).
- In hot climates concrete and asbestos-cement pipes are subject to rapid deterioration from corrosion due to hydrogen sulphide formed in the sewer.
- Requires manufactured parts (water seals, toilet bowls).
- Only liquid waste accepted therefore must be connected to a flush toilet.
- Requires high volumes of water for transportation to treatment site.
- Not suitable where water supply scarce, limited or unreliable.
- Substantial amount of flushing water required, which also adds to the operating costs ☞ Prone to malfunction (blockage) where total water use is less than about 75 litres per capita per day.
- Requires high land space for off-site treatment plant.
- High operation and maintenance requirements.
- Requires expert staff for operation and maintenance.
- Treatment process needs constant monitoring and control.
- High construction costs.
- Import of selected construction materials may be required.

4.2 Connection to a conservancy tank.

Level:

Wet on-site system

Description:

A storage system, i.e. a sealed tank, where low-flow or full-flush toilet systems are used.

Principles of operation:

Waste is flushed into the tank where it is contained in isolation from the surrounding environment before removal by a tanker for treatment.

Operational and institutional requirements:

Tank sizing dependent on flush volumes, domestic wastewater levels and frequency of emptying. Access for mechanical emptying and the availability of treatment and disposal facilities has to be ensured.

Costs:

Initial cost: € 200 – 500 (including labour and materials). Actual costs will depend on the tank volume, whether materials are available locally and local prices. Operation and maintenance account for around 1 % of the investment costs per year plus the amount for emptying. Because water is required for flushing the price has to be taken into account.

Experience and comment:

Commonly used in Kenya. Recommendable in more sensitive soil and geo-hydrological environments.

Advantages:

+ Does not require electricity.
+ Both greywater and blackwater can be flushed through the system.
+ Means of sullage disposal.
+ Permanent structure.
+ Small land requirement.
+ Easily understood by the operator.
+ System is robust with little day-to-day attention.
+ High user acceptance and convenience.
+ Low initial costs, with system capacity closely matched to demand.
+ Employment generation through increased demand for emptying services.
+ Low health risks.

Disadvantages:

- Reliable and ample water supply from water connection required.
- Construction requires skilled labour.
- High degree of municipal involvement required to ensure equitable service and proper vehicle maintenance when it comes to the provision of emptying services.
- Not suitable where water supply is scarce or unreliable.
- To be a permanent solution periodic desludging is required.
- Physical access for emptying services is necessary.
- Sludge needs careful handling.
- Requires septic sludge transportation and safe disposal and/or treatment.
- High reliance on emptying services.

4.3 Connection to a septic tank.

Level:

Wet on-site system

Description:

An in-house full flush-toilet connected via pipe and plumbing fixtures to an underground watertight settling chamber (the 'digester') with a liquids outlet connected to a:

a) Subsoil drainage / soakaway system or
b) Small diameter sewer with liquid disposal to a central collection sump or existing sewer system.

Principles of operation:

Waste from the toilet, and greywater from sinks and showers is flushed into the settling chamber where it is retained for at least 24 hours to allow settlement and biological digestion. This reduces the sludge volume and provides preliminary treatment (about 35% BOD reduction and 65 % suspended solids (SS)).

Partially treated liquids then pass out of the tank into the subsoil drainage / soakaway system. Alternatively, liquid effluent is conveyed by a system of small-diameter pipes to a communal treatment point (which may be off-site treatment works reached either via existing sewerage or by tanker).

Digested sludge gradually builds up in the tank and requires removal by tanker.

Operational and institutional requirements:

The system requires a reliable water connection. Specific design criteria must be applied to the settlement tank and soakaway system. This option is applicable only in areas of low settlement density and where soils have a high ability to drain effluent away.

Although the water requirements of a septic tank connected to a small bore sewer system may be less than those of a septic tank and a soakaway, a reliable water connection is needed. Routine maintenance of pipe network is essential.

Access for emptying of septic tank, as well as availability of sludge treatment and disposal has to be ensured.

Costs:

Septic tanks connected to a soakaway cost € 700 - 1,200. Actual costs depend on the volume of the tank, whether materials are available locally and local prices. Furthermore it depends on the soakaway used. Drainage trenches are more expensive than simple soakaway pits. Costs for operation and maintenance account for approximately 1% of the investment costs per year plus the cost for emptying. Hiring a suction truck for desludging a septic tank costs between € 15 to € 60 (Price for one load between 6 to 10 m^3).

There is no information an actual prices for septic tanks connected to a small-bore sewer system, but capital cost are much higher.

Experience and comment:

Septic tanks connected to a soakaway are widely used by urban households in Kenya, in areas where reliable water supply is available but no sewer has been provided. The system provides a high level of service and user convenience. Failures appear due to insufficient water supply and because emptying is not carried out.

Septic tanks connected to small bore sewer systems are not common in Kenya. But existing septic tank and soakaway systems can be easily converted for convenience and/or environmental reasons. Failures are the same as for septic tanks above, and additionally due to lack of maintenance of the pipe network and off-site treatment plant.

Advantages:

+ Does not require electricity.
+ Reliable.
+ Several options for effluent collection.
+ Works well where the soil is permeable and not liable to flooding or water logging.
+ No separate sullage disposal required.
+ 25 – 50 % COD removal.
+ 40 % BOD reduction of raw sewage.
+ 65 % suspended solids reduction.
+ Construction material and construction skills locally available.
+ Easily understood by the operator.
+ System is robust with little day-to-day attention required.
+ Easy to maintain.
+ With a proper soak-away minimal risk to public health.
+ Users have convenience of conventional cistern flush toilet.

Disadvantages:

- Most expensive on-site sanitation technology.
- It only accepts liquid waste and therefore must be connected to a flush toilet.
- Reliable and ample water supply from water connection required.
- Not suitable where water supply scarce or unreliable.
- Requires manufactured parts (water seals, toilet bowls).
- Requires sufficient soil permeability 10^{-7} m/sec to dispose effluent.
- Nearby shallow wells cannot be used for drinking water supply.
- Availability fails due to clogging of the soil.
- Not suitable for flood prone areas.
- Low effluent quality; still contains pathogens, cysts and worm eggs.
- Construction requires skilled labour.
- Effluent may contaminate groundwater.
- Soak-away must be 15 – 30 m away from ground and surface water sources.
- Groundwater table must be about 1 m below soak-away.
- Requires construction control.
- Requires periodic desludging.
- Sludge needs careful handling.
- Requires septic sludge transportation and disposal.
- Requires access for emptying services.
- Large land requirement for effluent disposal unsuitable for high-density housing.

4.4 Connection to a Decentralized Treatment System (DTS).

Level:

Wet on-site system

Description:

A low-flush-toilet connected via pipe and plumbing fixtures to a system of anaerobic and/or aerobic treatment modules that allow on-site and decentralized off-site treatment of toilet and other domestic wastewater.

This system offers the option to reduce the pollution load to such a level that a connection to a sewerage network is not necessary and the effluent can be safely released into the environment and/or re-used for different purposes. Pathogens reduction is sufficient.

The anaerobic treatment produces methane/biogas as a beneficial by-product. Requirements for space and maintenance are different for each module and determine over their suitability for certain site-conditions either as a single module or as a combination of different modules.

All modules require a watertight structure as to protect the environment from pollution. The anaerobic modules further require an airtight construction in order to capture biogas. The following treatment modules are applicable in the following order with each module further improving the effluent quality:

(i.) Biogas settler (primary treatment) with gas capture connected to

(ii.) Anaerobic Baffle Reactor (ABF) with gas capture (secondary treatment)

(ii.) Or Anaerobic Up Flow Filter (AF) with optional gas capture (secondary treatment)

(iii.) Aerobic constructed wetlands or ponds (tertiary treatment)

with the following disposal options according to pollution load:

- ☞ after (i): Disposal into a sewerage system (small diameter or conventional) with terminal treatment system (central, semi-central, decentralized system) or to a central collection sump.
- ☞ after (ii): Disposal into a subsoil drainage / soakaway system.
- ☞ after (ii) and (iii): Disposal into the receiving water course or discharge into an irrigation system and other re-use schemes with lowest required pollution load according to NEMA and/or WHO guidelines.

Sludge coming out if the system needs to be treated and disposed of safely by either applying it to drying beds to harvest dried sludge, planted sludge beds to compost sludge, or by putting it into simple trenches for composting.

Principles of operation:

An anaerobic treatment system treats wastewater making maximum use of natural gifts like gravity, microbiological activity or temperature. This results in a system which can work without technical energy input and requires only minor maintenance. Wastewater is fully treated on-site and the liquid phase is discharged into the receiving water course. There is no electricity and operational attendance required to run the system.

Sludge is removed in an interval of once every one or two years after the storage capacity has been reached.

Wastewater from the toilet and other domestic and industrial sources is piped into the Biogas Settler (BS) with an airtight flat or doom shaped cover section to capture the emerging biogas. The waste is retained for ideally 24 to 48 hours to allow mechanical treatment with retaining contaminants by sedimentation/flotation as well as biological treatment, often called digestion.

The Anaerobic Baffle Reactor (ABR) consists of a series of chambers, in which the wastewater flows up stream. Activated sludge is located at the bottom of each chamber. The inflowing effluent is intensively mixed up with the sludge, wherein it is inoculated with bacterial mass which decomposes the contained pollutants.

The Anaerobic Up Flow Filter (AF), also known as fixed bed or fixed film reactor, has a similar flow pattern like the ABR. Some filter materials such as gravel, rocks or specially formed plastic pieces provide additional surface area for bacteria to settle on. Non settle-able and dissolved solids are treated by bringing them in close contact with a surplus of active bacterial mass fixed on filter material.

The Horizontal Gravel Filter (HGF), also known as constructed wetland, is made of reed planted filter bodies consisting of fine gravel. The filter is normally planted with helophytes like cattails, papyrus and reeds. The main removal mechanisms are biological conversion, physical filtration and chemical adsorption. Operation and maintenance of the system is simple (mainly garden work). The spatial requirements are compensated by integrating it with the landscapes.

Polishing ponds are shallow artificial lakes. The removal mechanisms are sedimentation of non-degraded and degraded suspended particles, and aerobic oxidation by intake of oxygen via water surface and photosynthesis of algae. The elimination of pathogens by exposure to UV ray represents the third treatment mechanism and often the most important one.

Digested sludge gradually builds up in the chambers and can remain for a period of 18 to 24 months. After that it requires removal by tanker or other means of pumping system.

Operational and institutional requirements:

The system requires a reliable water connection and should only be applied in areas where the connection to a functioning sewer system incl. suitable off-site treatment facility will not be economically feasible or possible in the short-term.

The system works only on gravity, hence requires no external energy input. Routine maintenance of the system includes regularly checks for eventual blockages which can be easily manually removed.

Access for sludge removal is recommended but can also be undertaken in areas with very limited access conditions since the liquidised sludge can be pumped with simple equipment and manually transported. The digested sludge has to be disposed into simple composting trenches that turn the sludge into a valuable organic fertilizer and soil conditioner.

Costs:

DTS application provides state of the art technology at affordable prices because material/inputs used for construction are locally available. Actual costs will depend on local prices.

Construction costs: The initial costs for the construction of a DTS are in general lower or comparable with conventional aerobic systems like Sequence Batch Reactors (SBR), since no mechanical or electrical items are required and the costs for collection and discharge of the wastewater (sewer pipes) are much lower. The costs per 10m³/day are between 2'000 to 4'000 Euro; including all costs for the construction.

Running Costs: Since a DTS requires no process energy and the maintenance of the systems is simple garden work for the wetland and desludging of the underground tanks (every second year), the running costs are much lower than for conventional systems (5 to 10% of a conventional systems), depending mainly on the costs for the desludging tanker (in the range of 40 to 60 Euro per 6m³ load).

Experience and comment:

Only limited experience with the system exists in Kenya. In recent years NGOs and

private organisations as well as international donors tried to implement the system in Kenya. Most of the systems implemented are fully functional and working to the desired treatment level. Besides, experience shows that the production of biogas in most cases does not allow for continuous use as an alternative energy source. However, it provides a high level of service and user convenience as the user does not experience any difference to a connection of a sewer network.

The system has proofed to be an effective, environmentally-friendly, low-cost and easy to manage treatment in many un-sewered areas in India and China. It provides a high level of service and user convenience.

Operational procedures and costs are limited only to sludge removal every one or two years and routine maintenance of pipe works (removal of blockages).

It is a flexible system in terms of adapting it to the complicated site conditions like limited space availability and treatment efficiency. It virtually requires no space, since it is an underground construction, the above space can be used as e.g. parking space, playground or simply covered with a plastic sheet and lawn on it.

Design and construction requires an experienced engineer to adjust the layout to the various site conditions to reach an optimum of treatment and reduce costs. Good workmanship and construction supervision is essential to reach envisaged treatment efficiency.

Advantages:

+ No connection to sewerage system required since full on-site treatment possible.
+ Resistant to organic and hydraulic shock load.
+ Greywater can be managed concurrently.
+ No electrical energy required.
+ Minimal space requirements – option of zero foot-print.
+ Can be built and repaired with locally available material.
+ Reliability, robustness and longevity.
+ Moderate capital costs, low operating and maintenance costs.
+ Easily understood by the operator with little day-to-day attention required.
+ Reuse of wastewater and its contents (water, nutrients and energy).
+ Environmentally-friendly due to high removal efficiencies in terms of organic content (up to 95% of BOD[1], COD[2]), TSS[3] and pathogens.
+ The produced methane (biogas) can get captured and used as a renewable energy source in direct application for cooking, heating, lighting or electricity production via a gas generator.

Disadvantages:

- Requires constant source of water
- Requires expert layout dimensioning and construction supervision.
- Construction requires skilled labour.
- Requires periodic desludging.
- Requires access of emptying services.
- Operators need training on how to operate the system.

[1] Biochemical Oxygen Demand or Biological Oxygen Demand (BOD) is a chemical procedure for determining how fast biological organisms use up oxygen in a body of water. It is used in water quality management and assessment, ecology and environmental science. BOD is not an accurate quantitative test, although it could be considered as an indication of the quality of a water source.

[2] COD (Chemical Oxygen Demand) is commonly used to indirectly measure the amount of organic compounds in water. Most applications of COD determine the amount of organic pollutants found in surface water (e.g. lakes and rivers), making COD a useful measure of water quality.

[3] TSS (Total suspended solids) is a water quality measurement

4.5 Composting Toilet / Urine Diversion Dehydration Toilet (UDDT).

Level:

Dry on-site system

Description:

A single top-structure over a sealed container, which could be one or two chambers side by side, with access for the removal of decomposed waste. Urine is diverted through the use of specially adapted pedestals or squatting pans so that urine is diverted from the faeces (Urine Diverting Dehydration Toilet (UDDT)). A vent pipe may be installed to encourage drying of the faeces.

Principles of operation:

Urine-diverting toilets use a special pedestal or squat plate in which the urine enters the front part and is thus separated from the faeces which fall directly downwards into a vault or container. Dry absorbent organic material, such as wood ash, straw or vegetable matter is added after every toilet use to reduce moisture and therewith deodorise faeces. This enhances the biological breakdown (composting). Dry faeces (reduced to 20% of the wet faeces) are easier to handle and transfer. The distinct advantage of this method is that the urine can be collected separately, making it available as a liquid fertiliser. The dry faeces may be used as a soil conditioner. The potential to serve as a fly breeding medium is reduced compared to the facilities where urine and faeces mix.

Operational and institutional requirements:

The system does not accept domestic wastewater. Ensure ease of access by caretaker/operator and promotion of manual 'turning' of compost and removal of composted/desiccated material. Suitable disposal site / area necessary.

Costs:

Urine diversion dehydration toilets cost between € 200 and € 350 per unit. Actual costs will depend on the number of units, volume of the reception chamber, materials used, finishing standards and the type of superstructure provided.

Experience and comment:

Urine diversion dehydration systems have not been widely used in Kenya, though a number of units have been installed in mostly rural areas. Experience from South Africa, Uganda, Burkina Faso and Botswana suggests that UDDTs are well accepted by communities especially. Compared to other on-site sanitation facilities costs are still high. Effort needs to be put into reducing investment cost.

Control of moisture content is vital for proper operation. Contents often become too wet, making the vault difficult and unhygienic to empty, as well as malodorous. User/operator educational requirements and continuous input are significant for proper operation to ensure a proper composting process.

Proprietary systems have been piloted in South Africa, generally with inconclusive results as to their likely success on a large scale and under varying conditions.

Control of moisture content is vital for proper operation. Contents often become too wet, making the vault difficult and unhygienic to empty, as well as malodorous. User/operator educational requirements and continuous input are significant for proper operation in terms of the composting process.

Advantages:

+ Does not require a constant source of water.
+ Suitable for all types of users (sitters, squatters, washers, wipers).
+ Applicable where rocky or groundwater conditions prohibit deep excavation, because entire structure is built above ground – there is thus no need for digging and lining.
+ Reuse of contents as fertilizer (urine) and soil conditioner (dried, composted faeces)
+ Protection of ground water resources and above ground water sources.
+ Easy removal of solids from the chambers as they are shallow.
+ Reduced odour and fly nuisance in latrine compared to 'ordinary' pit latrines.
+ Does not require water for use.
+ Does not require electricity.
+ Volume of the processing vault is fairly small, as it is emptied periodically.
+ Urine may also be led into a shallow soak pit adjacent to the toilet if not used as a fertilizer.
+ Pathogens from human faeces do not reach the water flow cycle.
+ Small land requirement on plot.
+ Composted humus can be safely handled.
+ Urine can be used as fertilizer.
+ O&M costs are negligible if the compost is used.

Disadvantages:

- Requires education and acceptance to be used correctly.
- Wood ash, soil, leaves etc. have to be added regularly.
- Prone to misuse if excessive amount of water enters chambers (e.g. anal cleansing).
- Cultural resistance against handling human waste may prevent the operator from emptying the vaults, but usually local labour can be hired to do the job which increases O&M costs.
- Relatively high initial construction costs as compared to pit latrines.
- Construction requires skilled labour.
- Separate sullage disposal facility required.
- Special care has to be given to making the vaults water resistant.
- Requires a specially designed seat-riser or squatting slab or pan that is functionally reliable and socially acceptable.
- User/Operator education on how to empty the chambers and on how to handle and use the urine and the compost for agricultural purposes is necessary.
- Should only be used where people are motivated to use human excreta as a fertilizer and soil conditioner.
- Requires manual removal and disposal of finished composting material after a period of time; therefore not suitable if the users are unwilling to handle composted humus.
- Unsuitable in high density areas where users are not motivated to produce good humus for agricultural use, or are unable to obtain complementary waste materials to regulate the moisture and carbon content (pH) of the vault contents.
- Requires great deal of user care and maintenance; therefore not suitable in areas where sufficient user care cannot be reasonably expected
- Need to keep the toilet lid closed when not in use.
- Wood ash, soil, leaves etc. have to be added regularly; therefore not

suitable if there is insufficient organic waste material available.

- Non-biodegradable materials, such as stones, glass, plastic, rags etc., should not be thrown into the toilet, as they reduce the effective volume of the vaults and hinder the composting process.
- Potential advantages of ecological sanitation can only be realized as long as the system functions properly.
- Users may not understand how to operate the system properly and leave the latrine contents too wet, which makes the vault malodorous and difficult to empty.
- Requires manual removal and disposal of finished composting material after a period of time; therefore not suitable if the users are unwilling to handle composted humus.
- Finished compost can still be contaminated with pathogens and should always be handled with care - proper management of the excreted faeces is crucial.
- Anal cleansing material should not be put into the vault.
- Excreta may be visible.
- Nuisance through cockroaches.
- Does not prevent mosquitoes from breeding in the pit.
- Extra cost of urine diverting pedestal or squatting plate, water tight vaults.
- Sanitizing and recycling human excreta is inevitably more complex than simply disposing of them as wastes.
- Users are too eager to use the latrine contents as a fertilizer and do not allow sufficient time for the compost to become pathogen-free.
- Not appropriate where water is used for anal cleansing (design has to be changed to allow cleansing water to be collected separately).
- Problems with acceptability.
- Continuing long-term and vigorous program of user education will normally be necessary to ensure that toilets are used correctly.
- If local authority or WSP collects the compost and transported it for use, operating costs could be significant.
- Conditional suitable if there is no local market for the humus produced.