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Report on work in progress

Project: Developing and testing low cost sanitation solutions for Namibia's informal settlements

Funded by:
Namibian Chamber of Environment
Global Environment Facility – Small Grants Programme

Reporting period: 1 May to 31 October 2018

Submitted by: Development Workshop Namibia

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1 Introduction

This is a report on work in progress of the project 'Developing and testing low cost sanitation solutions for Namibia's informal settlements'. The project has initiated on 1 May 2018 and will terminate on 30 April 2019. The report covers the first 6 months of the project, from 1 May to 31 October 2018.

To date, the project has received support from two institutions that are providing funding for a total period of 12 months.

Namibian Chamber of Environment (NCE) (4 months: 1 May to 31 August 2018)

- Grant of N$ 80.000, plus:
- One intern for literature research and GIS mapping (75%)
- Two interns for GIS mapping (25% each)

GEF Small Grants Programme (8 months: 1 September to 30 April)

- Grant of USD 50,000[1]

The main objective of the report is to show project progress, especially in regards to the first set of project activities that were related to assessing sanitation solutions in Namibia and internationally. The report paves the way for the second phase of the project, with a focus on developing, constructing and modelling appropriate low cost sanitation systems for urban low income residential areas.

[1] While the GEF/SGP project component officially started on 1 September, funding has only been received on 26 October. During that period, DWN has pre-funded personnel time, but no other expenses.

2 Research objectives and activities implemented

Project objectives

<u>The primary objective of this project is</u> “to improve urban environmental conditions by introducing effective sanitation solutions in Namibia’s informal settlements and newly developed low income housing neighbourhoods.

<u>The specific objectives are:</u>
1. To significantly improve the environmental conditions for informal settlement residents;
2. For that purpose, to identify, test and promote financially sustainable low cost urban sanitation solutions that can be implemented at large scale.

An additional objective of the project is to identify and test different sanitation systems that can be integrated into the DWN/NCE programme for the provision of low cost urban land for housing. Ideally, these sanitation systems can be integrated on a full (or at least part) cost recovery basis.

In order to achieve those objectives, the project is implementing six different sets of activities:

Activity *Month*	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr
1 Field research in informal settlements in seven sample towns in Namibia;												
2 Revision of international literature and experience on low cost sanitation solutions;												
3 Identification of best practice sanitation solutions for Namibia;												
4 Further development, construction and testing of best practice sanitation solutions;												
5 Modelling of tested best practice sanitation solutions												
6 Stakeholder meetings for presentation of results and most efficient sanitation models.												

This reporting period of the first 6 months (1 May to 31 October) therefore covers the first three sets of activities:

1. <u>Assessment of existing sanitation solutions in a sample of informal settlements</u>
   Assessment of low cost sanitation solutions in informal settlement in seven different towns in Namibia, providing the project with a representative overview of sanitation solutions tested and/or in use in different regions across Namibia.

2. Assessment of regional and international best practice approaches to low cost sanitation
   Assessment of low cost sanitation experiences elsewhere in the region and internationally, including Latin America and Asia.

3. Identification of best practice sanitation solutions for Namibia
   Based on the analysis of Namibian practice and regional & international experience, identification of those approaches that either have worked well or have the potential to work well in the context of Namibia.

Research activities implemented

Following main activities have been implemented in the course of the reporting period:

- Broad literature assessment of Namibian experience on low cost sanitation;
- Household survey in Windhoek's informal settlements (for questionnaire, see Attachement 2)
- Field visits and assessments in Otjiwarongo, Okahao and Oshakati;
- Stakeholder interviews (for list of interviews, see Attachement 1);
- Visit to Habitat research centre in Windhoek;
- Topic specific literature assessments (i.e. sanitation policy in Namibia; functioning of Oxidation ponds);
- Broad literature assessment of international experience;
- Preliminary analysis of information and writing of draft report on work in progress.

Given budget constraints during the reporting period, the project could not implement field research in all seven towns as planned in the proposal. The assessment will therefore continue over the coming months as the project develops. All interns have received tailored supervision and extensive on the job training during the period of the project.[2]

[2] This included regular revision of the students' outputs, facilitating of feedback sessions and discussions with all team members, plus several on the job training sessions for specific aspects of the project, including: project management, use of Microsoft excel, use of GPS and data download to computer, use of ArcGIS and other GIS mapping software, work ethics, development of a questionnaire, development of an excel database and statistical analysis in an excel database.

3 Assessment of appropriate low cost sanitation systems

3.1 Assessing sanitation systems

3.1.1 Sanitation units, contextual variables and scale

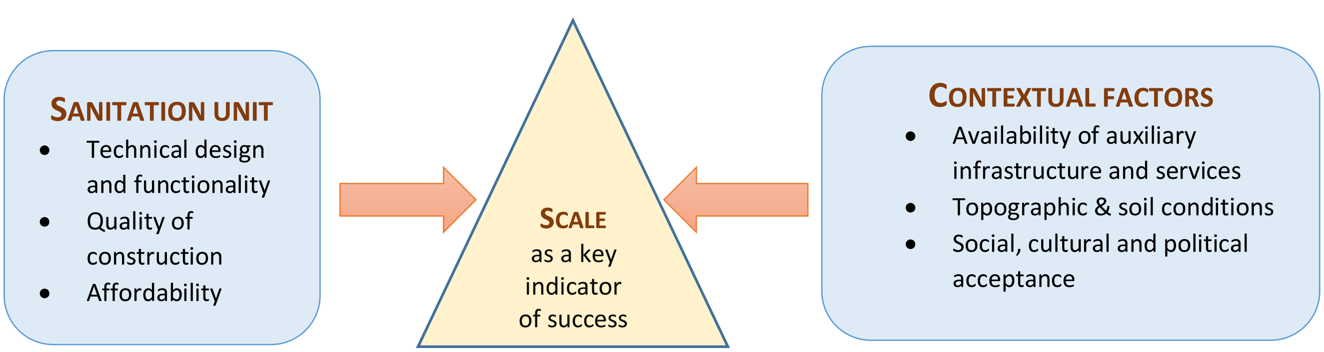
Sanitation units
Sanitation units are at the core of a sanitation system. A series of models exist and are further discussed in the context of this report. Typical sanitation units for example are communal flush toilets, dry toilet systems, or different pit latrine models.

The most important variables for good sanitary units are:
1. Technical design and functionality
2. Quality of construction
3. Affordability

Contextual factors
While the functionality and quality of the sanitation unit is fundamental for the well-functioning of the system, contextual factors are of equal importance, as for example:

1. Availability of auxiliary infrastructure and services that allow the sanitation unit to function
   - *For example the reliable provision of water without which a flush toilet system cannot work*
2. Topographic and soil conditions that condition the construction of the systems and risk of environmental pollution
   - *For example when rocky surfaces make excavation for pits or conservancy tanks difficult and expensive*
3. Social, cultural and political values and behavior that condition the implementation of specific sanitation systems
   - *For example the refusal to allow the construction of dry toilet systems by some local authorities*

Measuring success
Good sanitation systems gain value the more people they reach. The scale of a sanitation programme therefore is a key indicator to measure success of a programme.



3.1.2 Categories of sanitation systems

Sanitation systems can be grouped into three broad categories. The models of sanitation systems within those categories can vary considerably, depending on the specifications of the different system components.

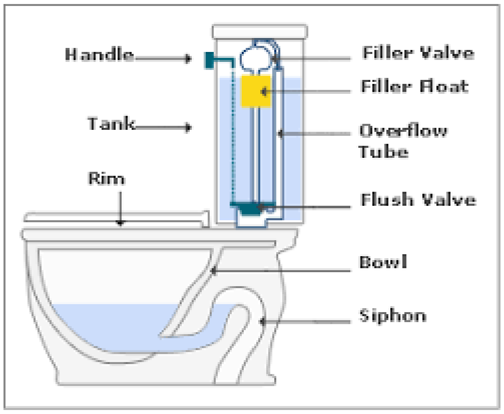
Category	Model variations
1. Water born sewage (Flush toilets / pour flush toilets)	▪ Private or communal flush toilets ▪ Linked to sewerage reticulation system, conservancy tank or septic tank ▪ With private water connection (flush toilet) or communal water connection and/or grey water use (pour flush) ▪ Waste treatment in oxidation ponds or other waste water treatment facilities
2. Pit latrine systems	▪ Simple pit latrines ▪ Ventilated Improved Pit (VIP) latrines ▪ Double vault pit latrines (with two pits) ▪ Dry or wet pit latrines ▪ Pour flush pit latrines
3. Urine Diversion Dry Toilet (UDDT) systems	▪ UDDT toilet bowls (e.g. Otji Toilet) or squatting pans ▪ UDDT through evaporation (e.g. Enviroloo) ▪ Double vaults or bucket based

The following chapters will look in more detail at toilet systems of these different categories, using Namibian and international experience.

3.2 Water born sewage

3.2.1 Private flush toilets

Private flush toilets have a water connection and a water seal in the siphon that keeps the odor from escaping trough the bowl. Pour flush toilets work by the same principle, but there is no water connection nor tank. Instead, the user pours water from a bucket, with the water collected from an outside source such as a communal water tap. Grey water, such as used water from bathing or the kitchen can also be used.



Main components of a flush toilet system


Pour flush toilet with seepage pit in Havana informal settlement, Namibia

Most often, flush toilets are connected to a sewage reticulation system. In the absence of such, a flush toilet can also be connected to a conservancy or septic tank (see chapter xx). Flush toilets can considerably increase the use of water in a households, as each flush of the toilet uses between 6-12 litres, depending on the toilet model. The availability of sufficient water therefore is fundamental, as well as the affordability of water. The use of grey water however can minimize the amounts and costs of water used for pour flush systems.

In informal settlements, pour flush toilets sometimes are connected to simple pits where liquids seep away through the soil. In these cases, the water seal makes such pour flush toilets more comfortable as no odour comes from the pit. However, through the constant seepage of waste water into the soils, there is a higher risk of soil and ground water pollution than with pit latrines for example.[3]

Costs estimates[4]

Item	N$	Observations
Toilet system (tank, bowl, flush mechanism)	1,500	
Sewer connection	15,000 - 20,000	
Septic tank locally built		

[3] As discussed in chapter 3.3, such systems are sometimes also called 'pour flush pit latrine'.
[4] The cost estimates in this and the following chapters are not yet complete, as much of the information will be collected in the course of the construction of demonstration systems. Nevertheless, this report leaves the space for the relevant numbers that will be inserted as the information becomes available.

Septic tank (plastic, 1000 liters) [5]	6,000	
Conservancy tank locally built (xxx litres)		
Conservancy tank (plastic)	6,000	
Pit with brick walls, using 20cm hollow blocks		
Water usage 1500 liters/month (50l/day)[6]		

3.2.2 Communal flush, communal pour flush and ablution blocks

In order to lower costs, flush toilets can be designed to be used by more than one family. Such communal flush toilets have similar technical features like household level flush toilets:

- The flush toilet mechanism is the same;
- They can be connected to a water reticulation system, or used as pour flush systems;
- They are preferably connected to a sewer system, but can also work with conservancy or septic tanks;
- Water needs to be available and be paid for either by the user of the local authority. (The grey water option does not exist in communal systems).

The construction of communal flush toilets can be done in different ways as illustrated in the following images: for example as free standing toilet units, communal ablution blocks or containerized solutions.

Community flush toilets in informal settlements in Windhoek

Community ablution blocks, Durban, South Africa

[5] Prices provided by Calcamite Water and Sanitation Solutions (www.calcamitetanks.co.za)
The tanks are sold in South Africa (as per 24 October 2018):

- 1000 liter for up to 4 people: ZAR 4270
- 1500 liter for up to 6 people: ZAR 6096
- 2500 liter for up to 9 people: ZAR 7600

The prices do not include transport or import taxes. The tanks are designed as septic tanks, but can be converted into conservancy tanks by closing the outlet. See below in chapter 3.2.3 for a picture.

[6] http://www.windhoekcc.org.na/documents/51b_tariff_booklet_2017_2018.pdf / tariffs of other towns


Community toilet block structure (India)


Toilet cabins (India)


Pour flush system (India)

Maintenance

The main challenge of all communal toilet systems is maintenance. If they are not sufficiently clean, repairs not done and vandalism not controlled, they become unusable within a very short period of time.

Different approaches can be used: in examples in Durban (South Africa) and Mumbai (India), maintenance is done by a paid care taker. In the case of Durban, those units that initially did not have caretakers became mostly unusable due to a lack of hygiene, vandalism and general lack of maintenance.

In Windhoek, the lack of maintenance is the single biggest cause of the high percentage of vandalized and unusable communal toilets. While in some cases the users organize themselves to clean and maintain the toilets, in most cases maintenance is not sufficiently organized. One reason is that when the toilets are constructed by the CoW, there is no provision to prepare the users for maintenance tasks. There is no policy to do so, no standard approach, nor specific activity to facilitate the creation and train maintenance committees.

While a paid caretaker system can work well for bigger ablution facilities (as in the examples of Durban and Mumbai), such system may be more difficult to implement for small communal toilet systems as they are commonly implemented in Windhoek.

Cost estimates

Cost item	Cost estimate	Observations
City of Windhoek communal toilet block (two toilets)		
Sewer connection		
Water connection		
Durban container ablution block (serving 100-200 households)	EUR 7,200	Without sewer connection and site preparation
Mumbai communal toilet block	EUR 800-1000	Per toilet seat, with approx.. 50 users per seat

3.2.3 Conservancy tanks

A conservancy tank is an underground tank which stores sewage that consists of blackwater (toilet waste) and greywater (kitchen, shower, sink, and laundry waste) until the time of emptying. It must be watertight to prevent the leakage of foul water or the ingress of groundwater.

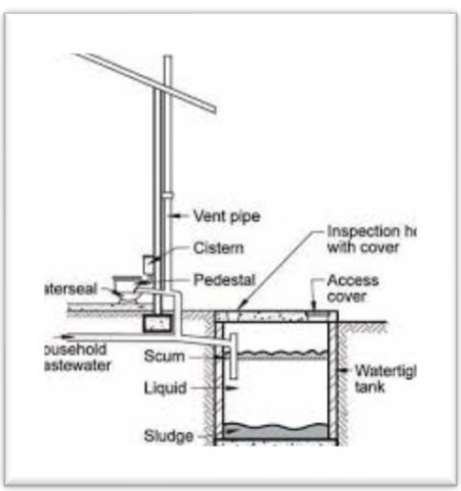
Modern conservancy tanks are commonly made from glass-reinforced plastics, polythene or steel.[7] In Namibia's informal and low income residential areas however, most conservancy tanks are made of bricks and concrete.

In Namibia, conservancy tanks have been used widely in the past (until an upgrade some 15 years ago, the whole town of Karibib for example used conservancy tanks) and are still used in many informal and low income residential areas. They provide a good solution in situations where there access to water, but no sewage reticulation system.

Conservancy tanks need to be emptied regularly, depending on the size of the tank and number of users. This service is provided by trucks with mounted tanks and pumps that suck the sludge from the conservancy tank onto the truck. The truck then disposes the sludge in the local oxidation pond or other waste water treatment site. The trucks are usually named 'Honey Suckers' and can be operated by the local authority or the private sector.

Conservancy tanks are usually used when households have domestic water connections. However, as discussed above, greywater can be used for flush systems linked to conservancy tanks, and in these cases access to communal water taps may be sufficient.

In hard surfaces such as rock, it can be difficult and costly to build conservancy tanks. Therefore, soil conditions are an important variable to be considered when deciding on the use of this sanitation component.



Conservancy tank design

Conservancy tank in Oshakati informal settlement, being emptied by a 'honey sucker'

[7] http://akvopedia.org/wiki/Conservancy_tank

Private sector ‘honey sucker’ in Oshakati

2500 liter plastic conservancy tank [8] (www.calcamitetanks.co.za)

Cost estimates

Cost item	Cost estimate	Observations
Local artisan built conservancy tank (xxxx liters)		
Construction company built conservancy tank (3000 liters)	N$ 13,500	
Construction company built conservancy tank (10,000 liters)	N$ 35,000	
Imported plastic conservancy tanks:		
1000 liter for up to 4 people	ZAR 4,270	Not including transport and import duties
1500 liter for up to 6 people	ZAR 6,096	
2500 liter for up to 9 people	ZAR 7,600	
3000 liter for up to 12 people	ZAR 9,030	
4500 liter for up to 15 people	ZAR 11,120	
5400 liter for up to 25 people	ZAR 19,390	

3.2.4 Septic tanks

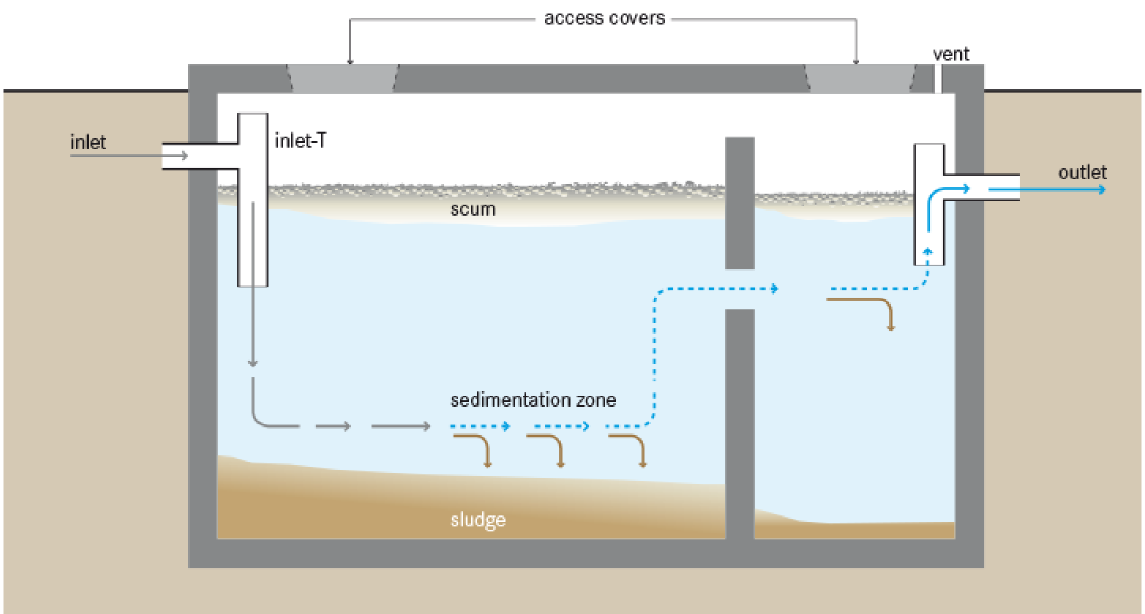
A septic tank is an underground chamber made of concrete, fiberglass or plastic, through which domestic wastewater flows for basic treatment. Settling and anaerobic processes reduce solids and organics, providing some treatment to the wastewater. Therefore, septic tank systems are a type of simple onsite sewage facility and can be used in areas that are not connected to a sewage system. The term ‘septic’ refers to the anaerobic environment that develops in the tank which decomposes or mineralizes the waste discharged into the tank.

Groundwater pollution may occur and can be a problem. However, ground water pollution risks are lower as compared to pits, as the water is minimally treated, and the water outlet is close to the surface, giving more space between the effluent and the ground water than is the case with a 2 meter deep pit for example.

All wastewater of a household can flow to a septic tank. As the minimally treated liquids exit the tank, it fills up only slowly with solids. These however also need removal, but at much lesser

[8] www.calcamitetanks.co.za

intervals than conservancy tanks (for example every 5 or 10 years). Modern plastic septic tanks may look exactly like conservancy tanks but do have an internal division and outlet.
In Namibia, conservancy tanks are often called 'septic' tanks. This however is a misnomer, as the function of septic tank is very different from those of conservancy tanks. Septic tanks are rarely used in informal settlements or formal low income residential areas. One reason may be the price, another one the lack of knowledge of local artisans of how to build them. Also, Namibian regulation stipulates that a permit must be obtained for the construction and installation of a septic tank.[9]



Schematic of a septic tank (https://en.wikipedia.org/wiki/Septic_tank)

3.2.5 Sewerage reticulation systems

Reticulated sewerage is a system of pipes, manholes (and often pumps) with connections to properties in a certain area, through which waste water is disposed from the individual properties to a central treatment facility.

Compared to water reticulation systems, sewerage reticulation systems are more complex and expensive, mainly due to following reasons:

- Sewage pipes need to be bigger than water pipes, due to the solids and general thicker constitution of waste water compared to clean water;
- Sewage systems need manholes on regular intervals for maintenance and control purposes;

[9] To be further investigated.

- The use of gravity to guarantee flow is more challenging than with water systems (that for example use water towers). Pump stations are often needed, at considerable costs.

Cost estimates

Cost item	Cost estimate (N$)	Observations
Sewerage reticulation connection to dense layout with 300m2 plots	N$15,000 – N$21,000	Not including sewer main to water treatment facility
Sewerage reticulation connection to less dense layout with 300m2 plots	Up to N$ 40,000	
Pump station	Approx. N$ 1 million	

3.2.6 Oxidation ponds

Oxidation ponds are large, shallow ponds designed to treat various wastewaters naturally through the interaction of sunlight, bacteria, and algae. They are designed to reduce organic content and remove pathogens from wastewater. They are man-made depressions confined by earthen structures. Wastewater enters on one side of the pond and exits on the other side, after spending several days in the pond, during which treatment processes take place. There are often several ponds with different functions to reduce organic content and remove pathogens. In most ponds both bacteria and algae are needed in order to maximize the decomposition of organic matter and the removal of other pollutants. [10]


Oxidation pond in Otjiwarongo: this is a rather large pond, due to the size of the town.

Oxidation ponds are especially well suited for warm climates, because the intensity of sunlight and temperature that are needed for the treatment process. They cost less to build than other treatment facilities and can be considered as one of the cheapest wastewater treatments options in terms of maintenance.

However, Oxidation ponds do require relatively large areas, they emit odours that may be incommoding to close-by residential areas, and there is a risk of ground water contamination or overflow, especially when the pond is operating above its rated capacity.

[10] https://en.wikipedia.org/wiki/Waste_stabilization_pond

Therefore, while reticulated sewerage systems have no negative environmental impact on the household level (opposed to the risk of ground water pollution of pit latrines for example), there are, as the following example shows, environmental risks associated to the functioning and maintenance of the oxidation pond.

Example Ongwediva - Sewage Dams get full

The Ongwediva town council built an overflow canal from one of the sewage dams to allow the sewage to flow into the Elyambala pan (oshana), because all the 20 oxidation dams of the council are full to capacity and cannot keep up with the town's fast-growing population. However, after the good rains in the area, the Elyambala pan was filled with rain water which was being contaminated by sewage water from the oxidation dams. This toxic mixture has been flowing into the nearby villages of Elyambala and Otshinyadhila. The contaminated pans have fish which villagers catch for own consumption and for sale to other people. This poses a serious health hazard to the villagers and people who consume the fish. In addition, cattle, goats, sheep and donkeys also drink the contaminated water while cattle herders always wade through the water when tending the animals. People in the area including school children are forced to walk through the water risking contracting some diseases. The town council has decided to construct additional sewage dams to deal with the problem […].

"Elyambala Village under Sewage Water" The Namibian, 1 April 2015

3.3 Pit latrines

3.3.1 Design and concept

A pit latrine or pit toilet is a type of toilet that collects human feces in a hole in the ground (pit) which is usually covered with a concrete slab containing a drop hole. There are many varieties of pit latrines, according to the choice of:

1. Toilet seat connected to the drop hole
2. Ventilation systems to minimize smell
3. Construction of the pit
4. Type of superstructure on top of the hole

Properly built and maintained, pit latrines can decrease the spread of disease by reducing the amount of human feces in the environment from open defecation. It decreases the transfer of pathogens between feces and food by flies for example, which is a major cause for infectious diarrhea and intestinal worm infections. In short, pit latrines are a low cost method of separating feces from people. By 2013, pit latrines are used by an estimated 1.77 billion people world wide. [11]

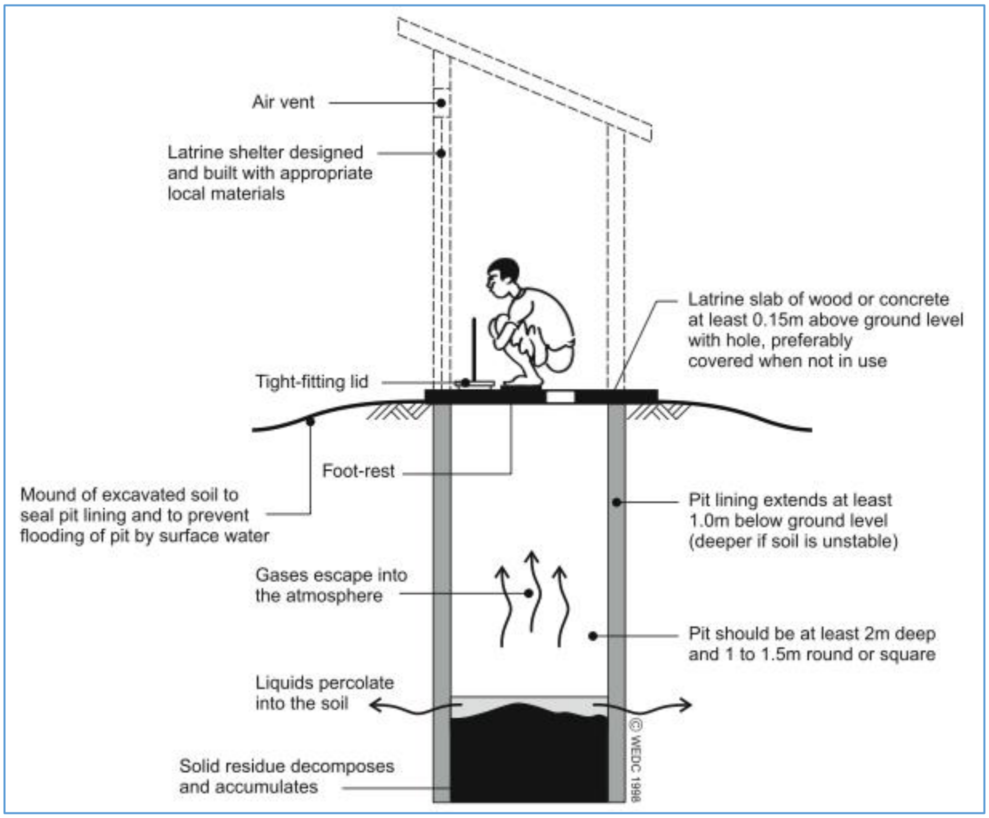
The Indian government for example has been running a campaign called 'Clean India Mission' since 2014 in order to eliminate open defecation by convincing people in rural areas to purchase, construct and use toilets, mainly pit latrines. It is estimated that 85 million pit latrines

[11] https://en.wikipedia.org/wiki/Pit_latrine

have been built due to that campaign as of 2018.[12] In South Africa, in the informal settlements of Durban, there are also an estimated 45,000 improved pit latrines contributing to improved sanitation where water born sewage is not reaching (Roma et al. 2011). Pit latrines are internationally accredited: a simple pit latrine with a slab for example counts as improved sanitation, as measured by the Sustainable Development Goals.[13]

The pits of pit latrines are seepage pits and not sealed, as in the case of conservancy tanks. There is therefore a risk of ground water contamination, especially in following cases:

- Where the ground water table is very close to the bottom of the pit;
- Where the ground water table occasionally rises above the bottom of the pit and the pit gets flooded;
- Where the pit gets flooded from surface water, causing contaminated run off water and increased levels of seepage;
- Where the pit is built in rock and fissures allow contaminated liquids to reach the ground water.



Design of a simple pit latrine (http://civilengineersforum.com)

[12] https://en.wikipedia.org/wiki/Pit_latrine
[13] Goal 6: Clean water and sanitation

Therefore, if local hydrogeological and soils conditions are ignored, pit latrines can cause significant public health risks via contaminated groundwater, especially if that water is used for human consumption. In addition to the issue of pathogens, there is also the issue of nitrate pollution in groundwater from pit latrines.

It has been found that the linear travel of pollution is governed primarily by the groundwater flow velocity and the viability of the organisms (Lewis et al. 1980). A useful and widely accepted guideline based on this research is that the maximum distance fecal pathogens will move through unfissured soil (including sand) is as far as the groundwater moves in ten days. In low-lying flat areas, with a high groundwater table, the groundwater flow is almost certain to be less than one metre/day, so a distance of 10 metres from latrine to source is adequate.[14]

As discussed below, there are pit latrine models that can be used under difficult soil and hydrological conditions, such as elevated pit latrines or latrines with shallow pits.

In general, pit latrines should be considered a viable alternative to open defecation. Under almost any circumstances, any kind of pit latrine is an improvement if compared to the negative consequences of open defecation. Second, more than any other sanitation system, pit latrines are often owner built and therefore truly affordable for the poor. Also, well built pit latrines can last for decades, as the example of Oshakati shows below.

Pit latrine designs

There is a wide variety of pit latrine designs, depending how the different components of the latrine are designed and built. The main components of a latrine are:

1. Toilet seat
2. Pit
3. Ventilation
4. Super structure

[14] http://www.lboro.ac.uk/orgs/well/resources/fact-sheets/fact-sheets-htm/lcsahgt.htm

3.3.2 Toilet seat

The drop hole can be connected to a toilet seat or squatting pan for user comfort. Pit latrines usually designed as dry toilets without water for flushing. However, a normal toilet seat or squatting pan with water seal can be used, and water poured after each use. In this case, the latrine becomes a 'pour flush pit latrine'.

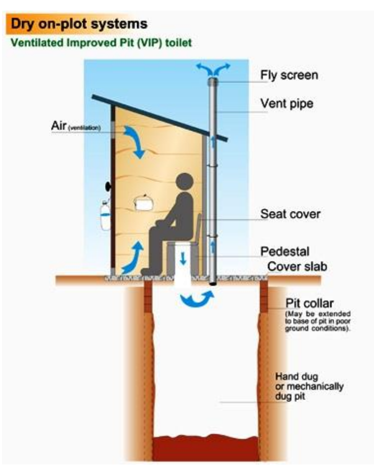
Improvised toilet seat in a pit latrine (Havana informal settlement, Windhoek)

Design of squatting pan with water seal, pour flush system. (https://en.wikipedia.org/wiki/Pit_latrine)

'Normal' toilet seat on pit latrine, floor with tiles, and used in combination with pour flush system (Havana, Windhoek)

3.3.3 Ventilation

Ventilation systems can be used to minimize the smell in pit latrines. Such pit latrines are then often called 'VIP latrines', standing for 'Ventilated Improved Pit latrines'.



Design of VIP Latrine (http://civilengineersforum.com)

Very basic owner built VIP latrine (Havana, Windhoek)

Professionally built VIP latrine, with extra big black ventilation pipe and urine diversion (Otjiwarongo; Ecosolutions, http://www.otjitoilet.org)

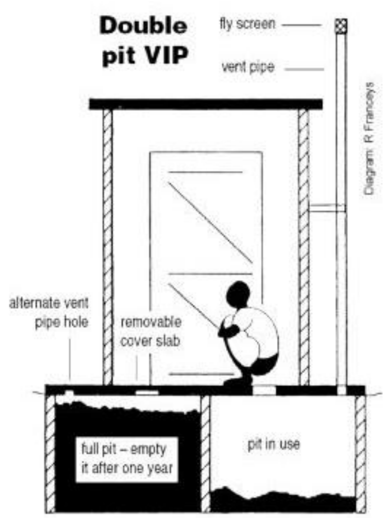
The ventilation works better with a big black pipe as on the picture above to the right. The black colour increases heating by the sun and the larger pipe allows larger volumes of air to be heated and to circulate. As the air in the pipe is heated, it rises and sucks more cold air through the toilet seat. This way, the smell inside the toilet structure is reduced even more.

3.3.4 Pit

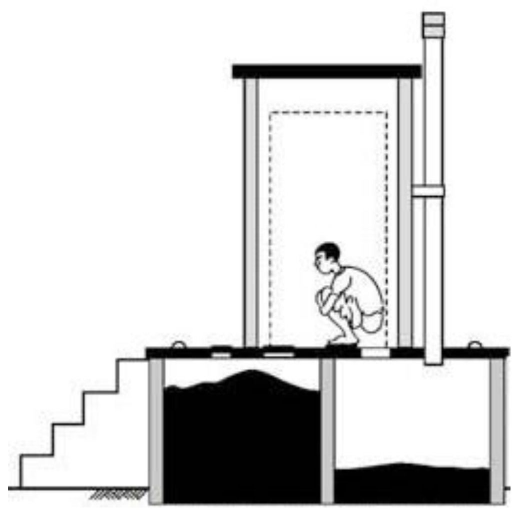
The pit has to be reinforced, except under conditions of reasonably hard soils where a slab on top may be sufficient. The most common pit reinforcement is construction with bricks. The VIP latrine from Ecosolutions for example uses some 530 bricks (type: 'super bricks'). Other options for reinforcements are concrete rings, or, for more improvised and smaller owner built latrines, 200 liter oil drums for example.

The space of the pit influences the time it takes to be filled. The VIP latrine from Ecosolution for example is designed for a 1.9m deep pit that needs 10 years to be filled with a maximum of 5 users. Filling of the hole is slowed by the fact that part of the solid matter degenerates naturally. After 10 years, the existing hole can either be cleaned or a new whole be built, and the top structure and toilet seat moved.

To avoid the cleaning of the pit and moving of top structure, some pit latrines are built with two chambers ('double vault' pit latrine). Once the first one fills up, the drop whole is sealed, and a second drop hole (in the same superstructure) used to start filling up the second one. As the second one fills, the solid matter in the first one degenerates further.



Double vault pit latrine design (http://www.washplus.org)



Elevated double vault pit latrine. This model can be used in flood prone areas or where groundwater is close to the surface. (http://helid.digicollection.org/en/d/Js2669e/7.6.6.html) Elevated pits can be higher in diameter to compensate for reduced depth (Brandberg 1985).

Examples of home built pit latrine and pour flush toilet systems

Wet and dry pits

Wet pits are those pits where urine goes in the same pit together with feces. Dry pits are those where urine is diverted into a sperate (small) seepage pit (just like in UDDT systems as discussed in the next chapter). Research suggests that feces degeneration processes in wet pits are more sufficient (Mara & Sinnatamby 1986).

3.3.5 The Okakedi VIP pit latrine (Oshakati)

During the 1990s, the Oshakati Human Settlements Improvement Programme (OHSIP) had a significant impact on the development of the four main informal settlements in that town, Oneshila, Evululuko, Uupindi, and Oshoopala. The four settlements were upgr aded during that project with the aim to improve the livelihoods of its residents. For example, Uupindi became semi-formalised after plots, house numbers, roads and open spaces had been provided. Infrastructure such as street lights was funded by the Danish Council, while other services were supplied by the Town Council.

For the provision of improved sanitation, the project introduced dry toilet systems. Different designs of waterless toilets were obtained and demonstration models constructed at community centres. After residents weighed pros, cons and costs of each design, a preferred model was selected. The selected model convinced by being odourless, and from this derives its acronym 'okakedi' toilet, standing for okanjuwo kakena edimba ('non smelling toilet').

	
Hollow cement brick	'Super brick'

Special brick making projects were initiated in parallel to provide the bricks (hollow core blocks) of the toilets. At the height of production, 100 people were involved in brick making at four community centres, producing more than 70,000 bricks every month (equivalent of 240,000 standard sized 'super bricks')[15]. Toilets were built on every plot where the owner requested one and had paid a small registration fee. Local contractors were doing the work but were required to hire at least 50% of their work force from the informal settlements. In the course of the project, 1300 okakedi toilets were built in the four informal settlements (Fuller 1996).

The okakedi toilet is VIP toilet design with shallow but horizontally extended pit. Many of the toilets constructed in the 1990s are still in use and are testimony of an exceptionally well designed VIP toilets system design and solid construction quality. The exact design of the toilet is not known, but a replica will be constructed in the course of this project.[16]

3.3.6 Maintenance Free Eco Toilet

The maintenance free Eco-Toilet is in fact a comfortable ventilated Urine Diverting Dry Toilet (UDDT) where the solid remains in the chamber undertaking a composting and degrading process. The liquid is drained apart via our UDS-Bowl. The ventilation is driven from a big 2,4m high steel pipe with a diameter of 280mm.

The big size of the sun heated ventilation pipe ensures that enough air is really properly moving and no smell will bother the user. As an extra benefit this Self-builder-Set includes a second floor slaps (outside under the ventilation pipe) which can be removed once the pit is full. That way the composted solid can be removed instead of investing in the construction of a new pit latrine.[17]

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[15] The so called 'super bricks' are small bricks that are used in most of Namibia for the construction of houses. All bank financed housing is required to use those bricks. However, due to its small size and lack of hollow space, the cement and sand content is considerable, as well as the effort when produced and laid. In much of northern Namibia, bigger hollow bricks are used. These bricks have better insulation characteristics, making houses cooler in summer and warmer in winter.

[16] Despite extensive research through the Danish Consulate, IBIS and former staff of the OSHIP programme, no plans nor personnel with technical knowledge on the toilets could be identified. In Oshakati itself, the knowledge of how to build these toilets is not present any more in the town council, but the project will try to identify local builders who were involved in constructing the toilets in the 1990s in order to rebuilt this very successful design.

[17] http://www.otjitoilet.org/Pit-Latrines/

Costs estimates

System	*N$*	
OSHIP pit latrine model		
Maintenance Free Eco Toilet (VIP latrine self-build-kit) from Eco solutions in Otjiwarongo	N$ 5,000	Not including sand, bricks, cement, labour
Basic owner built VIP pit latrine	N$ 1000-5,000	

3.4 Urine Diverting Dry Toilets (UDDT systems)

3.4.1 Alternative to pit latrines and flush toilets

UDDT stands for 'Urine Diverting Dry Toilet'. The most important design elements of the UDDT are:

1. Separation of urine and feces (either at the source or in the vault)
2. Waterless operation
3. Ventilated vault or removable containers for feces storage and treatment[18]

A UDDT is actually very similar to a 'dry' pit latrine where urine also is diverted at the source. The main difference is that a UDDT has a sealed pit (or vault) and no seepage takes place. UDDT's often require the regular removal of dried feces, which is not necessary in the case of pit latrines.

There are several types of UDDTs: the single vault type which has only one feces vault; the double vault type which has two feces vaults that are used alternately; and the mobile or portable UDDTs which are a variation of the single vault type and are commercially manufactured or homemade from simple materials. A UDDT can be configured as a sitting toilet or as a squatting toilet (with a urine diversion squatting pan).

During normal use, a UDDT is just as hygienic and safe to use as any other type of toilet. <u>However, the main challenge of UDDTs is related to the removal of dried feces:</u> health aspects need to be considered carefully, and social and political acceptance of removing and transporting dried feces can be an issue.

While the liquid sludge of conservancy tanks allows the use of honey sucker trucks, there are no similar mechanized ways to remove dried feces. As a result, it is done manually. In general, UDDTs are also slightly more expensive than pit latrines.

There are examples of large scale UDDT sanitation programs: In Durban (South Africa) for example, the local authorities built some 90,000 double vault UDDT toilets for households in informal settlement and rural areas around the city. These UDDT toilets were built from 2003 to 2010 and cost EUR 830/unit. The toilets were fully subsidized, but the owners were responsible for vault clearing every 6-12 months (Roma et al. 2011).

[18] https://en.wikipedia.org/wiki/Urine-diverting_dry_toilet

3.4.2 *Otji toilet*

The Otji toilet is a UDDT. It has been developed and is produced by Eco Solutions CC, a company based in Otjiwarongo.[19] Urine is diverted into a seepage pit, while solid matter is collected in a 90 liter plastic container that is perforated to facilitate air circulation and drying of the feces. The drying process is based on ventilation and dehydration, driven by the sun. Therefore, the "back" of the toilet is always oriented north (in southern hemisphere). Air then circulates through the toilet into the drying area and out through the ventilation pipe, making the toilet odourless. The collection container is situated under the toilet bowl and moved to the adjacent drying area when full. The container with the dried feces is later emptied, with contents discarded at a dump site by the local oxidation pond. The empty container is moved back beneath the toilet bowl. It is estimated that four people can use one container for about four to six months before it has to be emptied.

The Otjitoilet (front view)

Back view of the Otjitoilet, with ventilation pipe and open chamber where the peforated containers are positioned.

Perforated 90 litre container

[19] http://www.otjitoilet.org

Urine diversion bowl designed and produced by Ecosolutions in Otjiwarongo.

Some 400 Otjitoilets are still operational in Otjiwarongo, providing improved sanitation to a large part of the town's informal settlements. Some Otjitoilets are used in Windhoek and some in Omaruru.

A fundamental key component of the Otjitoilet is the removal of feces. If that service is not functioning, the system breaks down. In Otjiwarongo for example, the municipality charges a small percentage on water usage to cross-subsidize a private company (Ecosolutions) to regularly empty all Otjitoilets in the town. This system works very well, and the Otjitoilet is accepted as a viable sanitation solutions.

In Windhoek however, the removal of feces never seems to have worked well. As a result, toilets either became unfunctional, or users had to empty the containers themselves. It is for this reason that Otji toilets have a bad reputation in these areas.

Sometimes, the use of a plastic container also leads to associations with the discredited 'bucket' system, although this system is very different from a UDDT. The bucket system accumulates fecal sludge in liquid form that is dangerous to handle, from a health point of view. The dried feces of the Otjitoilet on the other hand are largely free of pathogens after many months of drying.

3.4.3 Enviro loo

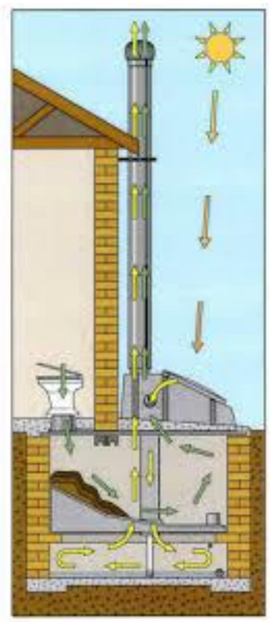
Enviro Loo is a South African Product and commercially distributed in Namibia by Omuramba Impact Investing CC.[20] Similar to the Otji toilet, it is a UDDT. However, while the Otjitoilet diverts urine from feces through the bowl, the Enviro Loo makes the separation in the vault. Liquid and solid waste is separated as they enter the container, with liquid waste draining to the bottom of the container (from where it then evaporates) and solid waste remaining on the perforated drying plate.

[20] http://www.omuramba-impact.com/about.html

Similar to the Otji toilet, the waste is exposed to continuous airflow that is driven through the unit by the ventilation system, generated by the air that is warmed in the large black ventilation pipe at the back of the toilet.

In Namibia the Enviro Loo is in use in high density areas in Windhoek and Eenhana, at the Langer Heinrich uranium mine, at the Twyfelfontein World Heritage Site and Bloedkopje tourism site, and at schools in North-Central Namibia.[21]

Eviroloo in the Havana informal settlement in Windhoek



https://www.omuramba-impact.com/

Maintenance assistance in three month periods by either in-house consultants or trained personnel is recommended.[22] It is a very versatile system and can be adapted to most conditions. As the units don't go deep, it is also quite suitable for hard soil surfaces.

In Namibia, Enviro Loos are commercialized at approximately N$ 20,000. It may therefore not be a viable solution for widespread use in informal settlements and newly developed low income residential areas.

3.4.4 Ecosan toilet

Eco Sanitation Limited, based in South Africa, produces and distributes the EcoSan waterless toilet, a sanitation system that converts human waste into dehydrated, compostable material.

The human excrement falls down a vertical chute (see number 2, in the image below to the right) and into one end of a specially designed helical screw conveyor (3). Every time the toilet lid (1) is lifted, a mechanism rotates the conveyor. With each rotation the human excrement

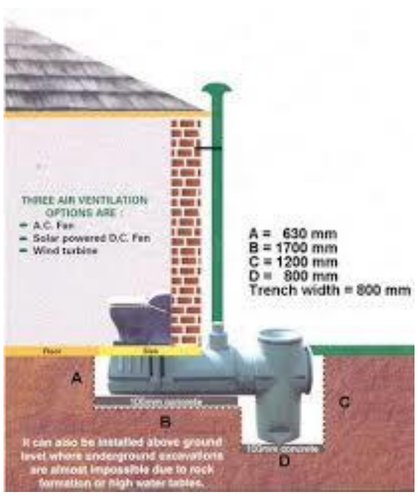
[21] https://www.omuramba-impact.com/water-friendly-sanitation.html
[22] http://www.enviro-loo

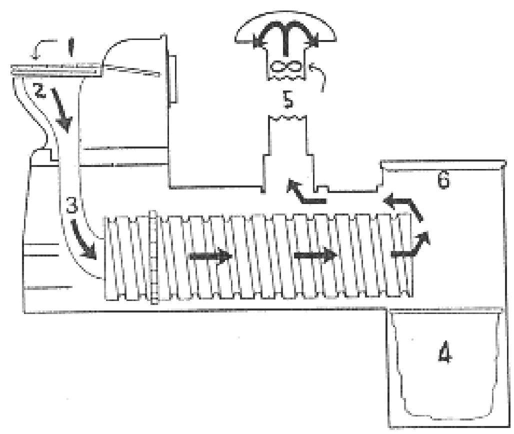
slowly moves along, taking approximately twenty five days before falling into a reusable collection bag (4). It takes six months for the bag to fill with dry and odorless waste.[23]

The dry waste is manageable and can be processed in the following ways.

- Use it in the making of compost
- Dispose of it by using municipal waste services
- Use it as a source of fuel

Large objects like beverage cans, disposable nappies or other objects accidentally dropped down the chute will not block the system.





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The Ecosan toilet has been widely used for rural sanitation programmes in northern Namibia, specifically Ohangwena, Oshana, Oshikoto, Kavango and Zambezi Regions. More than 10,000 units were ordered from South Africa and installed in rural areas from 2011 to 2013, before being replaced by another toilet system. Overall, the Ecosan Toilets were a failure in the rural programme due to many reasons.[24]

Costs estimates

System	Cost	Observations
Otji Toilet Self-build-kit	N$ 7596.35	Excluding cement, bricks, sand, builder
Otji Toilet built by Eco solutions	N$ 12,000-15,000	
Enviroloo by Impact Investment CC	N$ 20,000	
Ecosan toilet system		

[23] http://www.ecosan.co.za/product_info.html
[24] http://www.informante.web.na/millions-down-pit-latrines.17148

4 Conclusions

4.1 Key issues

This assessment clearly shows that there is no single 'best practice' solution that can be applied in different contexts. Rather, a diverse range of sanitation systems and subcomponents of successful approaches exist. These must be eclectically under different circumstance and in different contexts. The creation of a complete inventory of the most successful systems and sub components will be one of the main outcomes of this project.

The assessment also made a preliminary analysis of the conditions that must exist for different systems to work. These are:

Water born sewage
Water born sewage with a reticulation system and conservancy/septic tanks need water and waste water treatment capacity for the system to work. If considering water born sewage, a project must therefore assess following:

1. Availability of bulk water
   - *Is there sufficient water to service the additional households?*
2. Cost of water if it is available
   - *What are monthly average costs for the end user and can she/he afford it?*
3. Availability of water treatment capacity
   - *Is there sufficient capacity at the oxidation pond or other treatment facility?*
4. In the case of conservancy/septic tanks: can sludge removal service be provided by local authority or private sector?
5. In case of communal flush toilets: can a reasonable consensus be achieved from the population in terms of use and maintenance?
6. Can the capital costs for the sewage reticulation system be financed within the context of this project?

Considering pit latrine systems
If a project is considering the installation of pit latrines, following key issues must be assessed

1. Are pit latrines supported by the local authority?
2. Are pit latrines socially accepted?
3. Are pit latrines already in use in the specific location? If yes, what models are use?
4. Are the soils & water tables favourable to the construction of deep pits? If not, can elevated pits be considered?
5. Are the soils & water tables favourable to prevent ground water pollution? Can a monitoring system be set up?
6. Can the capital costs for pit latrines be financed within the context of this project?

Considering UDDT systems

If a project is considering the installation of UDDT systems, following key issues must be assessed:

1. Are UDDT systems supported by the local authority?
2. Are UDDT systems socially accepted?
3. Are UDDT systems already in use in the specific location? If yes, what models are use?
4. Are the soils & water tables favourable to the construction of deep pits? If not, can elevated UDDT systems be considered?
5. Is there a reliable service for dried feces removal?
6. Can the capital costs for UDDT systems be financed within the context of this project?

Summary of conditioning factors for different sanitation systems:

Sanitary unit	***Key conditions***
1. Individual sewer connections	▪ Water available and affordable ▪ Sufficient waste water treatment capacity
2. Communal flush toilets or ablution blocks	▪ Water available and cross subsidized ▪ Effective maintenance ▪ Sufficient waste water treatment capacity
3. Conservancy tanks	▪ Reliable sludge removal (private sector)
4. Septic tanks	▪ Approved by local authority
5. Different pit latrine systems	▪ No risk of ground water contamination ▪ Enabling soil/ground water conditions or possibility of elevated pit designs
6. UDDT systems	▪ Socially and politically acceptable dry feces removal process

Examining the costs

The option(s) or options that may be considered suitable must then be examined by the consulting engineer, and a preliminary cost estimate provided. This cost estimate must be discussed with the local authority and project beneficiaries in order to decide on the final solution.

Main challenge: Even low cost sanitation solutions are mostly not affordable for the urban poor

One of the single biggest challenges to provide low cost sanitation on a large scale is the fact that even the most low cost solutions are hardly affordable for the urban poor. International and Namibian experiences are showing this clearly. Efforts must therefore be undertaking to access complementary grant funding so support the provision of sanitation solutions for the lowest income segments of the project beneficiaries.

In the absence of complementary funding, there are different options that require innovative thinking on a case by case basis, such as for example:

- Owner built pit latrines: Where possible, cheap owner built pit latrine systems can be adopted, providing a solution that is most likely affordable to the poor;
- Cross subsidies: if a project has mixed levels of service provision and plot prices, a certain percentage on the pricier plots can be added in order to subsidize the sanitation solutions systems for the poorest in the same project area;
- Communal flush toilets: where sewer lines are built in a mixed income area and can be financed through the more expensively serviced erven, communal toilets can be erected at specific locations to serve the lower income residents. The only cost for those residents would then be the construction of the toilet superstructure, as the reticulation system is paid for by the other users.

The scaling up of a sanitation programme is likely to have more success when integrated into a broader development programme

International experience shows that the provision of sanitation systems on a large scale is easier if the sanitation component is part of a wider programme. International experience further shows that it is nearly impossible for stand alone sanitation projects to work on a cost recovery basis.

The integration of the sanitary component into the DWN/NCE programme for the provision of low cost land for housing therefore provides a unique opportunity to provide sanitation to a certain segment of low income residents on a full or partial cost recovery basis, through the sale of minimally serviced erven. In this case, the end user does not specifically pay up front for a stand alone sanitation solutions, but provides scheduled payments for a bigger product, a minimally serviced plot with title.

The importance of social sensitization and mobilization

There is a general bias in favour of water born sewage and against dry toilet systems (pit latrines & UDDT). However, where water is not available or not affordable to the target population, efforts must be undertaken for the population to accept and support dry toilet systems. Much can be done to promote such sanitation solutions with the local population through appropriate means of social sensitization and mobilization campaigns.

4.2 Next steps: Construction of demonstration sanitation systems

Based on these conclusions, this project will construct different demonstration sanitation systems in order to:

- Assess the exact construction costs and reduce those costs where possible
- Improve functionality where possible
- Explore the possibilities of home owner self build approaches

The main outcome of the construction of these demonstration systems is the development of a catalogue of tested low cost sanitary options that includes building designs & instructions, schedules of quantity and costs.

The demonstration systems will be built in pilot project areas of the DWN/NCE land programme, these currently being Oshakati, Okahao and Karibib. The designs built in each area will be those most likely to be integrated into the land programme in that specific town.

Following systems are planned so far:

Oshakati	1. Okakedi VIP pit latrine
	2. VIP latrine from Ecosolutions
Okahao	3. Conservancy tank (local construction)
	4. Septic tank (local construction)
	5. Pit latrine (model to be decided)
Karibib	6. Communal flush toilet
	7. Elevated pit latrine

5 Attachments

5.1 Attachment 1: People and institutions consulted for the sanitation assessment

Name	Position	Organisation	Location	Date
Nangolo Ashipala	Section Engineer: Water and Waste Water Department of Infrastructure Water Technical Services	City of Windhoek	Windhoek	8 May 2018
Zelda Scheepers	Section Engineer: Water and Waste Water, Department of Infrastructure Water Technical Services	City of Windhoek	Windhoek	28 June 2018
Maria Amunyela	Technician	Habitat R&D Centre	Windhoek	7 June 2018
Annemarieke Mooijman	UNICEF consultant for Sanitation	Consultant	Windhoek	15 August 2018
Jean Kaseya	Chief, Child Survival & Development	UNICEF	Windhoek	19 June 2018
Matthew Shuuya	Water and Sanitation Specialist	UNICEF	Windhoek	19 June 2018
Frikkie Holtzhausen	Managing Director	Lithon Project Consultants	Windhoek	Several meetings
Gert Maritz	Director, Civil & Transport	Lithon Project Consultants	Windhoek	Several meetings
Cilliers Mostert	Director	Knight Piésold Consulting	Windhoek	Several meetings
Peter Arndt	Manager and Founder	Eco Solution CC	Otjiowarongo	31 May 2018
Mr. Andreas	Technical Officer, Water and Sanitation Services	Oshakati Town Council	Oshakati	15 June 2018
Simon Shinguto	Manager Technical Services & Infrastructure	Okahao Town Council	Okahao	15 June 2018
Lesley Goreseb	CEO Karibib Town Council	Karibib Town Council	Karibib	16 August 2018

5.2 Attachment 2: Household survey questionnaire

WATER AND SANITATION SYSTEMS IN WINDHOEK INFORMAL SETTLEMENTS

Name of interviewer: Questionnaire number:

Date: Name of Area:

Section A: General Information *(indicate whom you interviewed!)*

Position	Gender	Age	Occupation

SECTION B: WATER SERVICES

1. **What type of water supply does the household use?**	
Communal water tap – prepaid meter	
House connected with piped water – prepaid	
House connected with piped water – private meter	
Shared private tap with private meter between household	
Communal water tap – no meter	
Rainwater collection	
Other (specify)	

2. Do you treat your water in any way to make it safe to drink?

Yes	No

If yes. What do you treat your water with?

………

3. If you use communal water tap – meter: *How far is the communal water tap?*

………

4. Type of access do you use?

Your own access card	
Your own access card	
The card of a neighbour without payment	

5. What are your perceptions on the quality of water from the source selected at **(1)**?

………

SECTION C: SANITATION

1. **What type of toilet facility does your household use?**	
Flush/pour flush	
Septic tank	
Ventilated improved pit latrine (VIP)	
Pit latrine	
Otji Toilet	

Enviro loo	
Bucket	
Bush or field	
Other please specify	

2. Do you own a private toilet?

Yes	No

b) The toilet type? How much did you spend?

……

c) Do you want an individual toilet? Which type? How much are you willing to pay?

……

d) Who built the toilet? When?

……

e) What type of structure is used to build the toilet?

……

f) How many people use the toilet?

……

g) Does the toilet still work?

……

h) What challenges do you experience?

……I

f it's a dry sanitation system: How often does it get emptied? Who emptied it? Where does the solid waste get dropped?

……

Communal Toilets

a. What type? Who built the toilet? When?

……

b. Do you pay for the toilet? If so, how much?

Yes	No

………

b. What type of structure is used to build the toilet?

……

c. How many households use the toilets?

……

d. Who cleans the toilets?

……

e. What problems experienced with a communal toilet?

……

f. If the toilet is broken who do you report to, how long does it take to be repaired?

……

g. What are you suggesting in terms of the management of the toilet?

……

What do you think about Dry Toilet System?

……

What do you think is the suitable sanitation solution in the informal settlements?

……

5.3 Attachment 3: International case studies

5.3.1 Case study 1: Communal ablution blocks in Durban, South Africa

Type of sanitation system: Communal ablution blocks
Project title: Community ablution blocks with sewers or infiltration
Location: Durban, South Africa
Duration: 2004-2010 (case study period)
Budget: EUR 31 million / N$ 466 million
Beneficiaries: > 600,000 informal settlement residents

In Durban, an initiative was started to provide communal water and sanitation facilities to informal settlements in the urban and peri-urban areas of Durban that don't have access to water and sanitation facilities, located within the sanitation waterborne edge. The purpose is to provide each household with access to basic services, while awaiting formalization. The installation of Community Ablution Blocks (CABs) is part of a programme which aims to eliminate informal settlements. The CAB's are a temporary solution to sanitation issues for informal settlements which not be upgraded in 5-15 years. It is was started by eThekwini Health, Architecture and Housing Departments in 2004 and at the end of 2008 it was taken over by eThekwini Water and Sanitation. Until 2011, 600 000 inhabitants were impacted by the project and 108 brick blocks were built by the eThekwini Health, Architecture and Housing Department and 240 container blocks were built by the eThekwini Water and Sanitation Department.

The cost of prefabricated containers was 65,000 ZAR (7,200 EUR) without counting the storage tank. The total costs for a pair of CABs, including transport, site preparation, O&M, hardware and software is approximately of 200,000 ZAR (22,100 EUR)

- The toilet block is connected to a storage tank or to VIP pits if there is no sewer connection.
- To reduce the cost of transporting the effluent, an effluent minimization strategy (diversion of grey and urinal effluent, low flush) is used.
- The effluent is reticulated into a storage tank (or individual pits) and emptied at regular intervals by the municipality.
- One block serves 100-200 informal households made up of 4 people per household on average. The structure has a section for males and females but does not have showers. The pit is only for urine and feces.

Maintenance is the key issue. Following adjustments proved important:

- Local caretakers are appointed and paid a regular salary by eThekwini municipality.
- Toilet paper and washing material are provided by the Municipality and freely distributed by caretaker.
- The provision of lights and fences, as well as constant presence of a caretaker provides a safer environment.
- Materials have been replaced by plastic pipes and taps.

5.3.2 Case study 2: Dry sanitation systems in Burkina Faso

Type of sanitation system: UDDT double vault system
Project title: Urban urine diversion dehydration toilets and reuse
Location: Ouagadougou, Burkina Faso
Duration: 2007 - 2009
Budget: EUR 1.5 million
Beneficiaries: > ??

In 2005, the German Technical Cooperation (GTZ), the West African Centre for Low Cost Water Supply and Sanitation (CREPA), and the National Office for Water Supply and Sanitation (ONEA) developed a project proposal for a 3-year project entitled "Ecological sanitation in peripheral neighbourhoods of Ouagadougou.

In the first year, there was an intensive dialogue period with various stakeholders from municipal authorities, households and the local private sector, in order to assess needs and establish the framework within which the system was developed. The baseline study as well as a strategic ecosan plan including technical, logistical and organisational proposals were made and validated with the various stakeholders, before any work began to put the system in place. Masons were trained to build three different urine diversion dehydration toilet (UDDT) types. Gardeners and farmers were consulted and trained on the application of treated urine on their crops in the beginning of the project. When the project started to be operational, the use of treated feces got in vogue among farmers since they thought it would be easier to use and apply it compared to urine. Households were consulted on their preferences, and community-based organisations were supported in setting up collection and transport businesses (associations).

Once the first of two vaults of the UDDT is full, it should be closed for a while (approximately 6-12 months), while the second vault is used. The feces in the first vault remain in the vault for at least six months for sanitisation by drying/storage. The vaults are then emptied by the collection service workers and brought to an eco-station for a further drying/storage period of two months and for final packaging. Double vault UDDTs were designed for households with 6 to 7 members and the storage time for the feces is about 6 to 8 months. However, two vaults of this size can normally cater even up to 15 persons. Construction cost are equivalent to N$ 4,324, of which 61% subsidized by project and 39% paid by end user.

All UDDTs were built entirely above ground to facilitate the air circulation in the vaults/buckets, thus accelerating the drying process. The toilet buildings have a small staircase (2 to 3 steps).

At the household level, operation and maintenance include keeping the toilets clean, covering the feces after defecation with ash, and monitoring the urine and feces levels in the collection jerrycans and vaults.

5.3.3 *Case study 3: Flush and pour toilets in Kenya*

Type of sanitation system: Individual flush and pour flush toilets
Project title: Up-scaling Basic Sanitation for the Urban Poor
Location: Kenya
Duration: 2011-2018
Budget: EUR 18.4 million (9.2 million GIZ, 9.2 million Bill & Melinda Gates Foundation)
Beneficiaries: > 400,000 informal settlement residents

UBSUP is a country-wide up-scaling programme aimed at providing access to basic household sanitation across all Kenyan urban low-income areas. The main objective of the programme is to improve access to basic household sanitation in low income urban areas of Kenya, create demand for on-site sanitation (household toilets), cover the entire sanitation service chain from toilet to treatment, provide sustainable sanitation to 400,000 people by end of 2018 and create business opportunities in terms of toilet construction, fecal sludge collection, transport, and treatment services.

UBSUP is a demand driven programme. The WSP promotes and implements the project in the urban low-income areas through innovative social marketing techniques (door-to-door, community gatherings, road shows, etc.) aimed at increasing the demand for improved on-site household sanitation. Households are encouraged to build toilets with a permanent superstructure (concrete or masonry walls) and which comply to building standards.

Once the construction of the toilet is complete, the water utility inspects the toilet. Upon approval of the structure, the household receives a post-construction incentive funded by UBSUP -$200 for a new toilet or $150 for a rehabilitated toilet. This- corresponds approximately to half of the construction costs.

Emptying and transport services for the sludge (from septic tanks) are either provided by private vacuum tankers. Emptying and transport of the dry sludge (from UDDTs) is offered by a group of entrepreneur equipped with a customized motorised tricycle (tuk-tuk) - the so-called Sanigo (provided by UBSUP). This group of manual emptiers referred to as Sanitation Team, are trained and supervised by the water utility. After collection of the dehydrated sludge from the vault of the UDDT they process it to produce compost.

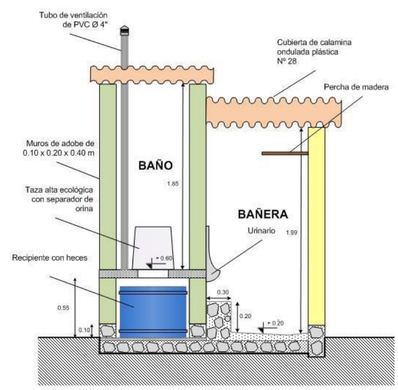
A range of technology options is needed to cater for different socio-cultural and economic contexts in different area of implementation. Alternatives to UDDTs must be provided to the residents of areas where this technology is culturally not accepted. The same way, an alternative technology must be offered to the DTF where the terrain does not permit operation without pumping. Finally, reuse options only be considered when socially accepted and economically relevant.

Developing sustainable demand for sanitation services takes time. At the beginning of the programme, demand for sanitation was not evident. After vigorous marketing and the first positive results visible, demand picked-up dramatically. This suggests that the provision of affordable technologies and sanitation incentives is effective in triggering demand for improved household sanitation amongst poor households.

There is a willingness to pay for sanitation services. Contrary to the common belief that the poor are not willing to pay for sanitation services, UBSUP has shown that, with enforcement of the Public Health Act by the Public Health department and appropriate sanitation options and systems in place, residents of urban low income areas are willing to pay for quality services.

5.3.4 Case study 4: Dry sanitation in Bolivia

Type of sanitation system: UDDT, showers, hand washing basins, on-site grey water treatment
Project title: Large-scale ecological sanitation in peri-urban area
Location: El Alto, Bolivia
Duration: 2008-2012
Budget: EUR 1.33 million
Beneficiaries: > 897 households



CORTE A – A´

The general objective is to improve the health and living conditions of the families settled in peri-urban areas of El Alto city by providing ecological toilets that are sustainable and also enhance agricultural productivity. Water conservation is promoted by the project.

A UDD toilet with container, treatment of grey water at the household level, and communal management of the urine and feces. Toilets are located close to the houses, and access is through built-in steps within the toilet unit, supported with internal walls facilitating the use for people with mobility limitations. Previously, the shower consisted of a room with a tank to store water if there was no water connection. Recently, the shower is connected to the water supply system. The hand-washing basin is located outside of the toilet unit and can be used for laundry as well. Previously, grey water from the shower and hand-washing basin were treated in situ with a grease trap and infiltration trenches. Recently, the grey water is used for small gardens at households.

Average costs per unit are EUR 713, of which EUR 556 are subsidies and the remaining 22% labour and in kind contributions from households.

Some conclusions coming from this project are:

- Households located in the more populated areas have shown more acceptance and demand for the sanitary unit.
- The sustainability of the project is highly related to the contributions in the initial investment to construct the sanitary unit made by each household. The higher the contribution, the likelier the household is to keep using and maintaining the UDDT.
- There is a need to define criteria and agreements to frame the participation of the households in the project and thus reduce the occurrence of situations that lead to the abandonment of the UDDT. In the case of El Alto, ownership of the house with permanent residence has been identified as a fundamental criterion for the participation of a household.

5.3.5 Case study 5: Community toilet blocks in India

Type of sanitation system: Communal flush and pour toilets
Project title: Mumbai Municipality Slum Sanitation Program
Location: Mumbai, India
Duration: Phase I: 1997-2003 / Phase II: 2003-2012
Budget: EUR 21.5 million (phase I)
Beneficiaries: > 250,000

The objective of the Slum Sanitation Program (SSP) is to improve the inadequate sanitary conditions within Mumbai's slum areas through the provision of community toilet blocks. 328 toilet blocks were constructed with 5 100 toilet seats during phase 1 to serve 250 000 people. An additional 35,000 toilet seats have been planned for phase II. The capital cost per toilet seat is 800 to 1000 Euros.

The toilet blocks:

- have an average of 10 to 20 toilet seats
- have a usage norm of 50 users per seat
- are designed for 30 years lifespan
- have a caretaker's room which can be used for community activities (Computer or English lessons, library)

Pour-flush toilets
Most of the toilets are located in community toilet blocks with two-floor reinforced cement concrete (RCC) frame structures. They are pour-flush toilets that require half a bucket of water for flushing. They have waste disposal to septic tanks and aqua privies (preferred connection to sewer-lines if possible). They have an overhead water tank and have 24 hours water and electricity. The toilets are designed for a 30 years lifespan. The advantage is that the water seal of flush toilets effectively prevents odours. The system however requires a constant source of water, plus access to a sewer line or a regularly emptied conservancy tank.

Community participation:

- The participatory approach of the SSP to integrate slum dwellers in planning, designing, constructing as well as in operation and maintenance of the toilet block, was a pre-condition by the World Bank. The World Bank's assumption was that NGOs and CBOs which are strongly involved in the program are accountable, non-corrupt and pro-people.
- The World Bank´s project design aimed at creating incentives for private contractors, NGOs and CBOs to work in a joint-venture to provide community toilet blocks within the slum areas. The toilet construction should take place within a flexible framework with NGO-led partnership with construction contractors and contractor-led partnership with NGOs. The private contractors were asked to construct the toilet blocks in close collaboration with NGOs which act as mediators between the slum dwellers and the contractors. It is therefore assumed that NGOs represent the concerns of the slum dwellers. The partnership of NGOs with private contractors should guarantee that slum dwellers needs' are properly integrated in planning, design, and construction of the toilet block. This new institutional approach aimed at combining the software skills of NGOs (interacting with slum dwellers) with the hardware.

In terms of lessons learned, following key issues stand out:

- The implementation of the SSP has demonstrated the following achievements:
- significant improvements in quality, maintenance and cleanliness of the community toilets compared to the past toilets provided by the MCGM
- successful impact of a participatory, demand-driven approach where community members are willing to pay membership fees and O&M costs
- community toilets can bring people together facilitating various community activities and can strengthen the relationship between slum dwellers, NGOs, politicians and municipal officers
- successful partnership between NGOs, contractors and CBOs working jointly together to provide community toilet blocks within a flexible institutional framework

The implementation of the SSP has identified the following challenges:

- the majority of the toilet blocks have no connection to sewer-lines due to the amount of time and costs this would require
- almost 30% of the new toilet blocks have no water connection mostly due to the high costs involved
- implementation of "one-size-fits-all" approach regarding the applied technologies (two-floor community toilets with septic tanks) despite

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