Large-scale peri-urban and rural sanitation with UDDTs eThekwini Municipality (Durban) South Africa

Fig. 1: Project location

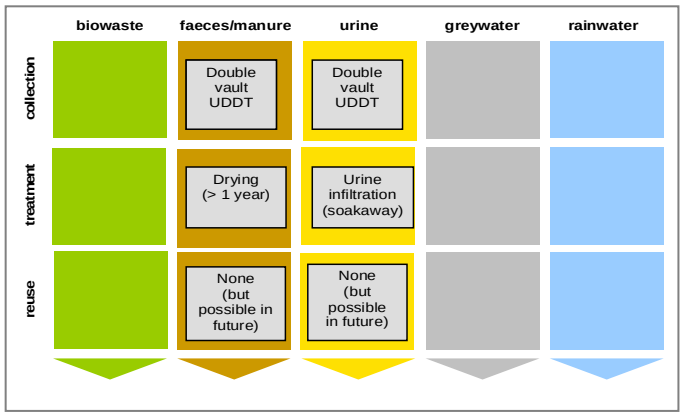

Fig. 2: Applied sanitation components (UDDT stands for urine diversion dehydration toilet).

1 General data

Type of project:

Large-scale Free Basic Water Supply and Sanitation (UDDT) provision to households in rural and peri-urban areas of eThekwini municipality

Project period:
Start of construction: 2003
End of construction: ongoing (but most UDDTs completed by end of 2010)
Start of operation: 2003
Project end: Ongoing

Project scale:
75,000 household UDDTs have been installed in 65 peri-urban and rural areas of eThekwini municipality, serving approximately 450,000 people in total (6 people per household).
Total approximate investment as of 2007: EUR 62,179,000 or ZAR 594,723,187 (equivalent to approx. EUR 833 per household for water and sanitation).

Address of project location:
eThekwini Municipality, Durban, South Africa

Planning institution:

eThekwini Water and Sanitation (EWS) Unit

Executing institution:
Construction Branch of EWS
Institutional and Social Development (ISD) consultants
Project Steering Committee (PSC)

Supporting agencies:
eThekwini municipality (funded through Municipal Infrastructure Grant)

2 Objective and motivation of the project

In December 2000 the eThekwini municipal boundary was expanded from 1,366 square kilometres (km^2) with a population of 2.5 million people to 2,297 km^2 with a population of 3.5 million people. The newly included areas were predominantly rural and had little or no sanitation and water infrastructure. The eThekwini municipality had been providing Ventilated Improved Pit (VIP) latrines and 200 litre water tanks to the rural areas that were included in the municipal boundaries prior to the expansion.

The newly included areas that had to be serviced by eThekwini municipality after the expansion resulted in a "backlog" for sanitation and water. The high cost of emptying VIPs and the inaccessibility of many rural settlements due to the topography led the eThekwini municipality to rethink the manner in which they would provide sanitation and water services to these areas.

Fig. 3: A household with a UDDT is visited by a local facilitator (source: EWS).

The development and implementation of urine diversion dehydration toilets (UDDTs) in eThekwini municipality began in 2002; this was regarded as the most cost effective technology to implement towards addressing the sanitation "backlog" in the rural and peri-urban areas. The prevention of further outbreaks of waterborne diseases among the population and the lowering of maintenance costs of the sanitation system for the municipality were the driving forces of the project. When the rural water and sanitation project

started, the municipality estimated a "backlog" of 175,000 households without adequate sanitation including 68,500 households even without access to safe water[1].

This rural water and sanitation project is unique in South Africa as it integrates the delivery of household water facilities (yard tanks) and appropriate sanitation services (UDDTs) as well as household hygiene education and operation and maintenance training as a single 'package'. The municipality delivered approximately 75,000[2] water and sanitation packages to un-served areas between 2003 and 2007. Based on an average household size of 6 people, this equates to 450,000 people served.

3 Location and conditions

In South Africa, the Department of Water Affairs and Forestry formulates the national policies and legislation governing the delivery of water and sanitation. The legislative pillars of the water and sanitation sector in the country are found in the National Constitution of the Republic of South Africa, the Water Supply and Sanitation Policy (DWAF, 1994), the Water Services Act of 1997 (RSA, 1997), and the White Paper on Basic Household Sanitation (DWAF, 2001).

In Durban, the eThekwini Water and Sanitation (EWS) unit is mandated with the implementation of policies under this legislative framework and is responsible for water and sanitation service delivery in the municipal area.

Fig. 4: The hilly terrain in eThekwini rural areas with no road access (source: Gounden, 2008).

eThekwini Municipality, the local authority of Durban, comprises an area of approximately 2,297 km^2, with a total population of 3,468,084 (South African Institute of Race Relations, 2009). eThekwini has a sub-tropical climate with temperatures ranging from 16°C to 25°C during winte r (June to August) and can reach 32°C with relatively high humidity during summer (December to February). The average yearly rainfall is quite high at 1020 mm.

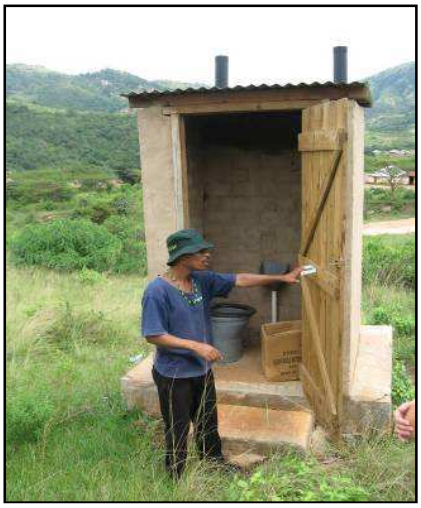

Fig. 5: Double vault UDDT in Maphephetheni in the eThekwini rural area (source: EWS).

Peri-urban and rural areas of eThekwini municipality are not served by waterborne sewer systems, due to problems of land ownership, sparse housing density, inaccessible terrain (hilly) and high capital and operating costs. Existing sanitation in the poorest part of Durban are Ventilated Improved Pit (VIP) latrines (approximately 45,000 are present in the municipality), and open defecation still occurs[3].

In these peri-urban and rural areas, the average household size is 6.5 people[4]. The vast majority of the population is of isiZulu ethnicity. Average employment levels are very low at 13% of the population living in the areas, whilst 12.5% is unemployed (hence searching for employment) and 27% is economically inactive (eThekwini Municipality Community profiles)[5].

The groundwater table varies as the terrain is very hilly. On the lower slopes many streams do emerge indicating a low groundwater table. Currently groundwater is not used for drinking water in the area as water is supplied through the bulk water supply system which is cheaper than drilling boreholes for groundwater.

In 2010, the under-five child mortality rate in South Africa was 57 children per 1000, and it has been slowly decreasing during the last twenty years[6].

[1] It is very difficult to estimate this backlog exactly: Another estimate by Teddy Gounden put the figures in 2002 at 140,193 households without access to sanitation including 55,432 households also without access to water supply.

[2] As of 31 March 2011 the official number of registered UDDTs remained at 75,000, and the total number built is not known for sure as not all UDDTs constructed have been captured on the GPS system, primarily due to changes in project management. This is currently being investigated. There may actually be as many as 90,000 UDDTs.

[3] VIPs were chosen for the infill areas of Umlazi and KwaMashu where people had settled on land which was deemed to be unsuitable (normally too steep) for normal housing.

[4] In informal settlements there are approx 5.5 people per dwelling. In rural areas there are 6 to 6.5 people per dwelling.

[5] The remaining portion of the population is either under the working age or over the working age, or have voluntarily decided to remain out of the labour market.

[6] The under-five mortality rate is the probability (expressed as a rate per 1,000 live births) of a child born in a specified year dying before reaching the age of five if subject to current age-specific mortality rates (http://www.childmortality.org and http://www.childinfo.org/).

4 Project history

A number of factors contributed to the eThekwini municipality reviewing its strategy to deliver water and sanitation to the peri-urban and rural areas within the municipal boundary. The over-arching contributing factor was the expansion of the eThekwini municipal boundary in December 2000. In addition the 45,000 VIPs needing emptying together with the large cholera outbreak in August 2000 in the province of KwaZulu-Natal within which eThekwini is located contributed to the decision to review the strategy. The UDDT program was initiated in 2002 as a cost effective and health-promoting solution to addressing the high maintenance costs associated with emptying the VIPs, the health consequences of poor sanitation on the population and the sanitation "backlog" situation.

The cholera outbreak which occurred in the province of KwaZulu-Natal in August 2000 had 113,966 registered cases by January 2002, and 259 deaths were recorded[7]. This incident and its consequences on the population's health brought the government's attention to addressing the water and sanitation backlog in South Africa as a matter of urgency, pushed the matter up the priority list of the government and gave the existing sanitation programme in eThekwini municipality a big boost.

The eThekwini Municipality decided to provide a packaged solution of both sanitation and water simultaneously. The basic sanitation and water package was to include a urine diversion dehydration toilet (UDDT) and a 200 litre yard water tank to all households outside of the reach of the waterborne sewage system. The project was driven by the need to introduce a sustainable (cost effective) approach to accelerate the delivery of water and sanitation services to the poor un-served areas of the eThekwini municipality.

A pilot project began in 2003 in the Mzinyathi area, a peri-urban area west of Durban central. During the pilot project various designs for sanitation were looked at and the final decision to adopt the UDDT system was taken. The pilot and other implementation areas were selected on the basis of technical feasibility, financial need and human resources available as well as a health related index. Areas with a high incidence of waterborne diseases and where open defecation was still an established sanitation practice were given priority.

The following protocols were applied:

Planning protocols:

- Prioritisation of project areas by the Health Department.
- Local stakeholders consultation (EWS, health department, councillors)
- Feasibility study by EWS: boundary definition
- Approval of Council, approval of budget
- Appointment of Institutional and Social Development (ISD), geotechnical and hydrological consultants to undertake surveys.

Implementation protocols:

- Resource allocation, programming, site establishment and start construction.
- Introduction of project and project team to community by trained ISD community facilitators.
- The rule governing the number of toilets built per household was that only households with more than 8 people could have *two* toilets[8].

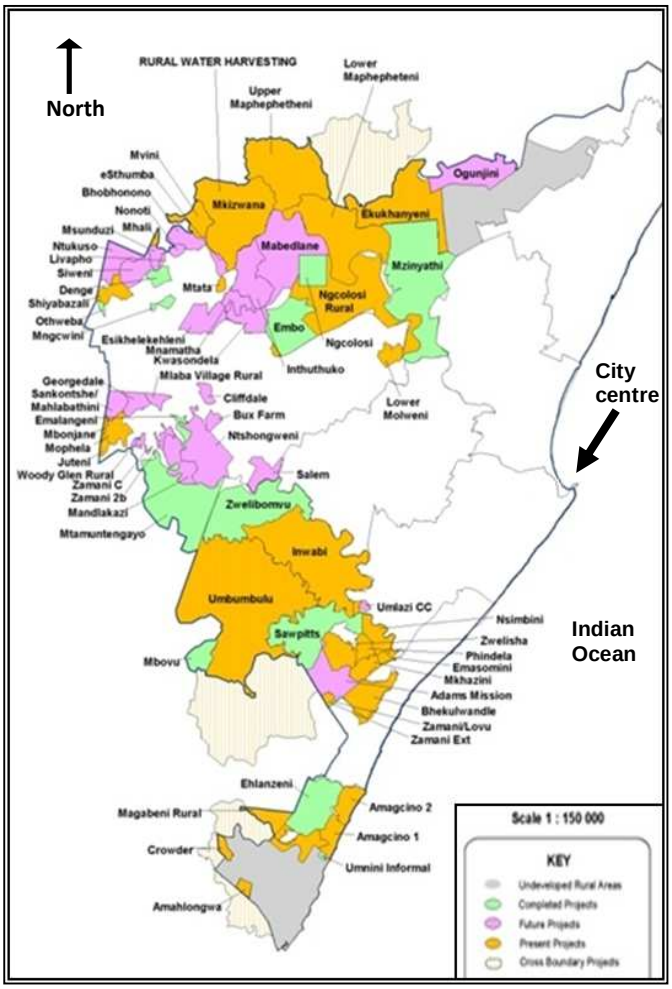

Fig. 6: Rural Water and sanitation project areas in eThekwini area (source: EWS, 2005). The municipality's coastline is 75 km in length, and the area is at its widest point 50 km wide. The colours on the map are: grey for undeveloped rural areas; pale green for completed projects; pink for future projects; yellow for current projects and white for cross boundary projects. (an updated map has been requested)

The construction began slowly as various technical components were trialled in 2003. Thereafter construction rose to 1,100 units per month (for 11 months of the year). As targets were met the rates declined again. By late 2005 the project had rolled out 13,000 water tanks and 35,000 UDDTs. The roll-out of water supply also saw 30 reservoirs and 1,500 km mains pipelines being laid. The lower adoption rate of the water tanks was attributed to the once off EUR 36 connection

[7] The fatality rate was less than 0.2% which compares well with the World Health Organisation's accepted norm of 1% during cholera outbreaks.

[8] Prior to having toilets, the isiZulu traditional custom was to have a designated area well away from the homesteads for defecation. Traditional customary rules state that the daughter in-law may not use the same defecation area as her in-laws. Hence in some cases building only one toilet per household still leaves the daughter in-law without access to a toilet.

fee for the water, which was not charged for UDDT implementation.

Currently, in 2011, there are 75,000 UDDTs verified. As the ongoing mapping of the UDDTs by the EWS with a GIS system takes place this number is expected to increase, possibly to 90,000. The project is now being reassessed and the implementation teams are doing follow-up visits and are also providing facilities for new migrants to the area.

The backlog of provision of adequate sanitation and safe water which the programme set out to address in 2002 was completed by the end of 2010. Currently, in 2011, the project is being reassessed and the implementation team is going back and providing facilities for new migrants to the municipal area, with estimates that on-going construction (taking in-fill houses into account) will be at 10% per year. The question remains what does this figure of 10% actually relate to in terms of UDDT unit numbers constructed? Is it 10% of 75,000?

5 Technologies applied

UDDTs are waterless toilet systems, where urine and faeces are separated at the source. In this project, urine is piped into a urine soak-away pit which is constructed below the ground (drawings and design specifications of this pit yet to be obtained). The urine diversion is useful – even if urine is not used as fertiliser – because it allows drying of faeces, hence less odour, flies and no faecal sludge production.

The double vault UDDTs have two faecal vaults: one is in use while the other full vault's faeces content is allowed to dry out and slowly decompose. Most of the pathogens die off due to the drying process. Thus, the handling of dry human excreta is relatively safe, provided that precautionary measures (such as use of gloves and hand-washing) are taken.

Several factors influenced the selection of UDDTs over other available sanitation options:

- **Financial:**
  - The provision of waterborne sewage infrastructure to rural areas is very costly. Similarly the cost of emptying ventilated improved pit (VIP) latrines is very high in this area (over 1,800 Rand per unit, approximately 188 EUR)[9]. In 2005 it was estimated that the eThekwini Municipality would have to spend approximately EUR 7.3 million for the 100,000 pit latrines which urgently needed emptying within the municipal boundaries.
  - There is no need to build a new pit and superstructure after a UDDT is filled.
- **Technical/Physical:**
  - Physical considerations (terrain configuration and inaccessible hilly locations) make VIP emptying by tanker trucks a daunting task, and the provision of a sewer system in the area impractical.
  - The volume of waste material handled in a UDDT is less than in a VIP latrine, where urine, faeces, cleansing material and possibly greywater are all mixed and collected in the VIP pit.
  - UDDTs can be built closer to the houses as they do not smell[10].
- **Health and environment:**
  - Manual emptying of VIPs is a dangerous task due to the health hazards for operators.
  - If appropriately used, a UDDT allows a safe on-site disposal of human excreta, with no need for municipal intervention.
  - The risk of environmental damage is limited as the waste is decomposed before exposing it to the outside environment, in contrast to the conventional VIPs, which allow seepage of human excreta into the soil and potentially into the groundwater (see Section 3 for details on the groundwater situation).
  - Due to low population density and no groundwater use for drinking purposes, the urine soak away pits posed no pollution risk to the groundwater.

Fig. 7: Back view of double vault UDDT showing access doors to two vaults and ventilation pipes (source: EWS).

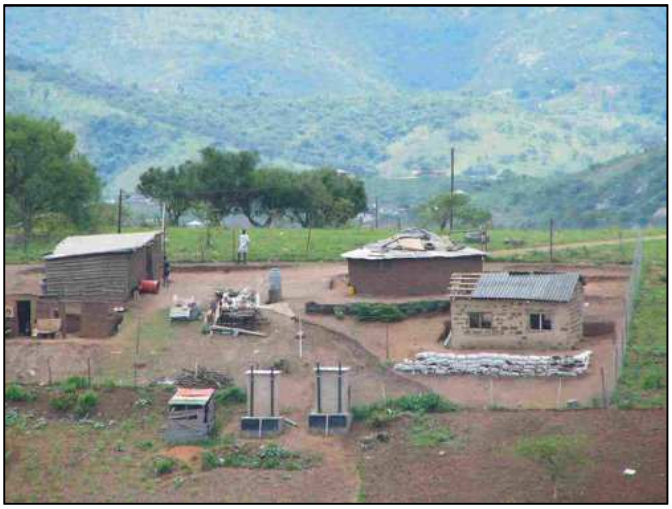

Fig 8: UDDTs' placement[11] (front middle) in a traditional homestead (source: WIN-SA, 2006).

[9] Exchange rate for South African Rands (March 2011): 1 EUR = 9.57 ZAR

[10] eThekwini Municipality did not yet offer the option of installing the UDDTs inside the houses, due to concerns that they might damage the house while constructing the UDDT.

[11] Some UDDTs were built closer to households, but it depended on the respective households' preferences. It was observed by Jacques

6 Design information

Water supply
Until July 2010, EWS provided each household 6 kL of drinking water, from the bulk Umgeni water supply system, per month free of charge. The household plastic water tank, which holds 200 L, is automatically filled with 200 litres of drinking water per day. Municipal mains are laid along district road reserves (this is the term used to describe public land between the plots). Communal mains are laid along tracks and paths, supplying between 15 and 30 consumers. As of 1 July 2010, the amount of free water provided to yard tanks has been increased to 9 kL of water per month, equal to 300 litres per day per household. The tank is filled by an electronic bailiff unit that automatically channels water to the tanks and cuts off the water when the tank is full. With the new and higher provision of potable water, traditional yard tanks are progressively being replaced by yard taps, whilst existing traditional ground tanks, are filled more than once per day.

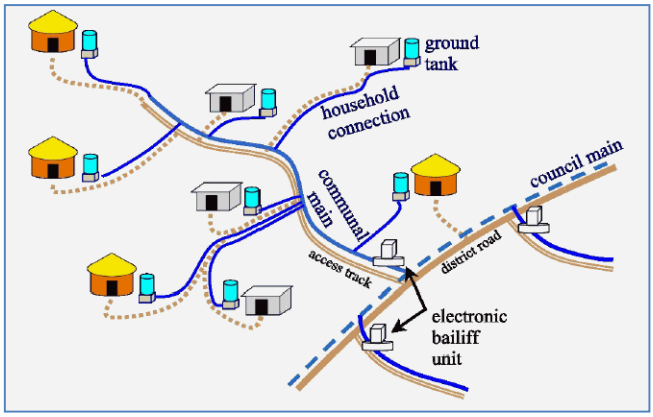

Fig. 9: Electronic Bailiff Unit

Sanitation provision with UDDTs
The UDDTs installed in this program present unique features that suit local conditions and characteristics. The system features a double-vault dry ventilated toilet based on separation of urine from faeces. The urine is diverted to a soak away located near the toilet. A wall-mounted waterless urinal, for male use, also diverts urine to the soak away.

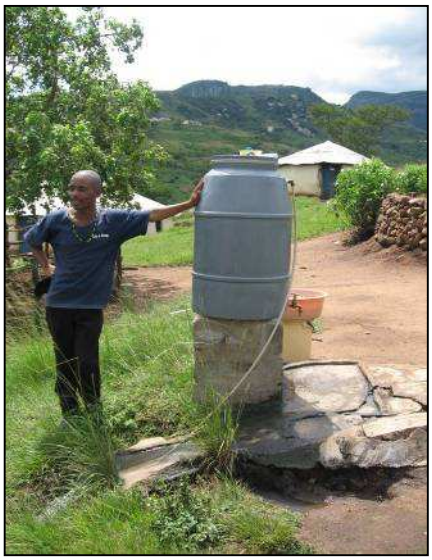

Fig. 10: 200 L yard water tank in Maphephetheni (source: EWS).

The natural slope of the ground is used so that no stairs (or only few steps) are needed and the vaults are accessible at the lower end of the slope. One disadvantage of this design is possible dampness and moisture in the vault coming through the front wall over time.

A urine diversion plastic pedestal is located above the first vault or chamber, which collects faeces, anal cleansing material and covering materials. Users were encouraged to add dry sand or ash after each defecation event in order to cover the fresh faeces so as to facilitate drying of the organic material and act as an odour and fly control measure.

Once the first vault is full, it is sealed and allowed to rest and dry, and the pedestal is moved over to be above the second vault. During the drying phase pathogen deactivation occurs, reducing the health hazards for the vault emptying process.

Once the second vault is filled, the first vault is manually emptied by a household member (trained by the municipality) or a local private vault clearing contractor, if the household prefers to pay for their vault to be cleared. Household members are told to bury the content of the first vault. The pedestal is then positioned back over the emptied vault, whilst the second vault is sealed and left to stand. Typically, one vault takes between **6 to 12 months** to fill, depending on household size and toilet use patterns.

Rust (Envirosan) that the households who did build their UDDTs closer to their houses appeared to be better informed about UDDTs. In more rural and traditional homesteads putting a UDDT inside one house is not an option as multiple households within the homestead share the one or two UDDTs built.

Fig. 11: Inside view of UDDT: urinal for men (left), bucket containing sand or ash, cover over second vault on the left side and urine diversion pedestal on the right (source: EWS).

Fig. 12: Interior of a UDDT with sand container on the bottom left and plastic urine diversion pedestal from Atlas company at the top (source: EWS).

The pedestal used initially was a plastic pedestal from the company Atlas[12] which was the supplier of pedestals to the eThekwini Municipality prior to Envirosan, the current supplier (see Section 11). The pedestal design was copied, with permission, directly from the concrete pedestals designed by Cesar Anorve from Mexico. The dimensions of the Atlas Plastic pedestal were kept when Envirosan designed their pedestal.

7 Type and level of reuse

This project does not involve a nutrient recovery strategy to date. Several studies have been conducted to provide a risk assessment of the reuse of faecal material from UDDTs:

The Pollution Research Group at the University of KwaZulu-Natal (UKZN) conducted a series of tests on pathogens in buried faecal matter from the UDDTs at a test site at the university (Buckley et al., 2008a; Buckley et al., 2008b).

Trönnberg *et al.* (2010) screened samples from the faecal vaults of 120 UDDTs in eThekwini and found a high occurrence of both protozoan and helminth infections: *Ascaris lumbricoides* (59% of samples), *Giardia intestinalis* (54%), *Trichuris trichiura* (48%), *Cryptosporydium* spp. (21%) and *Taenia* spp. (18%). The high pathogen load recorded in these areas suggests the need for further community health and hygiene education as a pre-requisite of human excreta reuse which is in line with WHO standards (WHO, 2006).

The "Valorisation of Urine Nutrients in Africa" (VUNA)[13] project is a collaborative project between the EWS, UKZN and the Swiss Federal Institute of Aquatic Science and Technology (Eawag) and is investigating the economic potential for recovering nutrients from urine. The project is funded by the Bill and Melinda Gates Foundation. By recovering nutrients from urine in decentralised reactors, the VUNA project aims to promote a dry sanitation system affordable to the poor, produce a valuable fertiliser, foster entrepreneurship, and reduce water pollution[14].

Although EWS is not advocating the use of dried or composted faecal matter or urine as a soil conditioner or fertiliser at this stage, this is something that could change in the future, through the completion of further studies and field tests in eThekwini as well as from sensitising and informing the UDDT users about the opportunities that reuse could offer them.

Gardening activities are apparently not very popular in this area. (Why ?)

8 Further project components

Training and Capacity Building

- Training of Institutional and Social Development (ISD) consultants (by EWS) on the project's aims and objectives.
- Training of community facilitators (by ISD consultants) on project information, health and hygiene education (with the focus on the employment of women).
- Building capacity of the Project Steering Committees (PSCs) by means of workshops. The PSCs act as communication channels between the project management team and the communities.

Education

ISD consultants liaise with local councillors and tribe chiefs to access the communities and provide appropriate education. Local facilitators who are selected, managed and trained by the ISD consultants, conduct house-to-house education.

During the project cycle, each household receives five visits from EWS health practitioners and education officers with the following activities:

1. Briefing on plans to provide water and sanitation to the household.

[12] See the following website for more information http://www.atlasplastics.co.za/category/sanitary_ware-7.html

[13] In the local language isiZulu the word "vuna" means harvest.

[14] See the Eawag website for more information http://www.eawag.ch/forschung/eng/gruppen/vuna/index_EN

2. Health and hygiene education.
3. Information on how to use the UDDTs.
4. Explanation on the water supply system.
5. Education on operation and maintenance of the systems provided.

The timing of these visits was carefully planned to align with the construction, usage and maintenance phases of the UDDTs, so as to optimise the knowledge transfer to the users of the UDDTs. See Appendix 1 for a detailed timeline.

Fig. 13: Street theatre for hygiene and health education (source: EWS).

Other ongoing education activities routinely undertaken by EWS include:

- Post-implementation educational visits carried out using the PHAST approach (Participatory Hygiene and Sanitation Transformation).
- Sanitation and hygiene education by means of street theatre performances in public areas, such as schools, shopping centres and taxi bays. The street theatre was used to reinforce the educational message around the correct use of toilets and the cycle of waterborne disease. Crowds were attracted in innovative ways to the street theatre, such as through the use of mobile entertainment lorries and giveaways to the crowd for correctly answered quiz questions.

Development of local job opportunities

The implementation of the rural water and sanitation project aims to also increase local job opportunities by:

- Recruiting local labour in construction and maintenance.
- Developing and supporting the emergence of local construction contractors.
- Developing local businesses for supply of bricks, sand, pre-packed dry and concrete mix.
- Setting up independent contractors to provide general operation and maintenance services.
- Training and employing local people as facilitators which created employment opportunities for women, young people and people with disabilities. A guideline for employing facilitators was that 50% should be women, 35% youth and 15% people with disabilities.

Related water and sanitation projects

Another system used by EWS to provide sanitation facilities to poor households in the municipality's informal settlements are the Community Ablution Blocks (CABs) in urban and peri-urban areas of Durban. These are communal water and sanitation facilities with flush toilets, hand wash and laundry basins in areas connected to the sewer system. For more information please see the separate SuSanA case study titled "Community ablution blocks with sewers or infiltration, eThekwini (Durban), South Africa"[15].

9 Costs and economics

The entire program since 2003 has been financed by the eThekwini municipality and is funded through the Municipal Infrastructure Grant[16].

The households do not have to contribute at all to the capital cost. This is due to the specific political situation of South Africa post-apartheid, where free provision of basic services is enshrined in the new constitution. There is a general expectation among all un-served poor households that they should receive basic sanitation and water services for free.

The cost break-down per household UDDT is shown in Table 1. The total cost of one double vault UDDT is **EUR 585** which is quite expensive compared to other UDDT projects[17]. It should be noted that the costs of the UDDTs varied depending on the density of the dwellings within the project boundaries, the topography, the transportation infrastructure and the distance from the project suppliers and accessibility of the household in terms of getting materials to the construction site. Also, the unit costs came down over time as the project was rolled out and the quantities ordered became larger (economies of scale).

The total investment cost (including both water and sanitation systems) up to 2007 amounted to EUR 62,179,000 for 75,000 households. This is equivalent to EUR 833 per household – slightly less than what is shown in Table 1. An update to the total investment cost up to 2011 will be made as soon as the information is available.

With regard to operation and maintenance costs, these are entirely incurred by the households, see Section 10. Dry sand or soil for covering the faeces after defecation is available for free in the area.

[15] http://www.susana.org/lang-en/library?view=ccbktypeitem&type=2&id=792

[16] The Municipal Infrastructure Grant funding comes from the central government and is administered by Cooperative Governance and Traditional Affairs (CoGTA); it is responsible for the provision of basic sanitation for the un-served, see http://mig.dplg.gov.za/Content/Documents/Guidelines/Annex%20B%20-%20MIG%20Introductory%20Guideline.pdf

[17] In the publication by WIN-SA (2006) a figure of ZAR 145 million for 35,000 UDDT was quoted, which would equate to EUR 475 per UDDT with an exchange rate of ZAR 8.7: EUR 1 for 2006.
See other SuSanA case studies on UDDTs for a cost comparison: http://www.susana.org/lang-en/case-studies?showby=default&vbls=7&vbl_7=28&vbl_0=0

Table 1: Cost break-down for the household double vault UDDTs and water supply systems (exchange rate for South African Rands (March 2011): 1 EUR = 9.57 ZAR)[18].

Item	Cost in EUR
Reinforcing and slabs	40
Structural work (foundations, superstructure, block work)	100
Carpentry and joinery	40
Earth works	25
Concrete work	80
Metal work	20
Ironmongery (door locks)	10
Roof work	25
Plumbing and drainage (plastic urine diversion pedestal, flanges, cover lid, urinal, urine pipe, vent pipe etc)	75
Local Labour	80
Managing Contractor (local)	90
Total for one household UDDT	**585**
Project management, Institutional and Social Development (ISD) consultants, facilitation and security	75
Water supply (water tank and pipe network)	400
Total water and sanitation system (per household)	**1060**

10 Operation and maintenance

The UDDT programme by EWS places the responsibility of maintaining the toilet on household members and empowers them to manage and maintain their own systems. Thus, household members are responsible for the following:

- Regular cleaning of the toilet.
- Provision and use of wood ash or sand and toilet paper.
- Checking for urine pipe blockages.
- Removal of dried faeces from the vault once full (every 6 to 12 months).

Maintenance duties for which households are responsible include minor repairs of the water tap (hand washing unit), vault doors (due to rusting, termites), roofing and occasional repainting. The municipality supplied each household with a rake and gloves for emptying of their UDDTs. In addition, local contractors were trained in emptying the vaults. This service is offered to those UDDT owners who do not want to empty their UDDTs themselves. It costs between 5 to 10 EUR per emptying event and the UDDT owner has to pay for this service.

Fig.14: Emptying a UDDT faeces chamber (source: EWS).).

11 Practical experience and lessons learnt

In order to benefit from the practical experiences of work being done on the ground, a good feedback system needs to be in place. eThekwini municipality put such a system in place by commissioning an independent research organisation called Human Sciences Research Council (HSRC)[19], utilising the University of KwaZulu-Natal (UKZN) and establishing a project steering committee, local facilitators and working closely with local constructors and the community.

Since the project began in 2003 EWS has documented the following lessons learnt:

1. Allocating responsibilities to a single unit within eThekwini municipality. Allocating responsibilities for water and sanitation service delivery into a single unit (EWS) increased the focus on outcomes as well as on quality rather than merely service provision. In addition, the full support of the municipal council provided the necessary political will. Moreover the use of available in-house capacity in conjunction with the emerging local contractors, which were trained by the programme, allowed for an on-going improvement of both construction design as well as the supporting programmes. The local contractors' skills remained in the community after the construction team had moved on.

2. Adoption of tried and tested methods. The UDDT technology and pedestal design had already been successfully used in other projects outside of South Africa, and designs were adapted slightly to suit local conditions in eThekwini. In addition the use of street theatre was adapted from successful use in other areas of community education.

3. Focus on users. EWS is committed to establishing a mutual trust relationship with UDDT users, rather than dealing with anonymous communities. Households are employed on various construction tasks related to the implementation of the water and sanitation systems.

[18] The cost break down in Table 1 is intended to give the reader a general idea of the costs. During the project there have been fluctuations in the costs due to exchange rate fluctuations, general inflation, economic depression and other factors that can be expected in a water and sanitation programme that is 9 years old and on-going.

[19] See their website http://www.hsrc.ac.za/index.phtml

4. Ongoing monitoring and evaluation of the implementation approach. Monitoring and evaluation conducted by EWS officers and independent institutions have provided valuable recommendations such as:

- A number of design faults were revealed in a site visit by Richard Holden in his capacity at the time as National Operations Support Manager for the Mvula Trust[20]. The site visit took place on 8 April 2004 in the Ehlanzini district, where for example it was discovered that the UDDTs' vault access covers were made out of cement and were heavy, easily broken and could not be re-sealed after inspection or emptying (Holden, 2004). This was later remedied with a new design namely a plastic sliding door that was then retrofitted to all UDDT installations.
- The HSRC was commissioned by the EWS to provide ongoing feedback on the impact of the initial UDDTs' rollout through a longitudinal study as an independent evaluator. HSRC surveyed a sample of 1,160 randomly selected households, examining the effectiveness of education activities, system acceptance and system maintenance by household members. Further design faults were discovered by the HSRC survey results.
- A monitoring research survey was commissioned by the Pollution Research Group and the School of Development Studies of the University of KwaZulu-Natal to assess the status and benefits of the existing UDDTs. The comprehensive survey, which began in January 2011, was completed by May 2011[21] and results will most likely be published by early 2012.
- As the greatest risk of spreading diseases is in the process of emptying the faeces vaults and burying their contents, vaults should be designed to ease the emptying process.
- Biological degradation and drying of the faeces in the UDDT vaults appear to be mainly dependent on contact with air so the design of the toilets should aim for good air circulation through the vaults.
- Aerobic biological decomposition of the faeces is a very fast reaction; there is a large reduction in biodegradable chemical oxygen demand (COD) in 24 hours. Drying is a much slower processes – occurring over weeks to months.
- Vent pipes covered only with mesh allowed rainwater to enter the vaults. This resulted in the bottom of the UDDT vaults being wet. A new model of flyscreen, supplied by Thermoplastic Concepts & Equipment (TCE), with an umbrella cap was thereafter introduced to solve this problem.
- The lugs on the original Atlas plastic pedestal were found to be too small and weak with the result that the pedestals sometimes collapsed through the hole in the base slab. This led to the pedestal supplier being changed to Envirosan[22]. Lugs are at the base of the pedestal and rest on the concrete. Envirosan uses a flange which is a lot more robust.
- The pedestal design was for adult users which made the UDDTs difficult to use for young children, resulting in parents discouraging their young children from using UDDTs. EWS together with Envirosan have developed a child seat adaptor[23], currently on trial, to achieve more child-friendly UDDTs.
- The willingness to retrofit existing UDDTs and to alter the design of the UDDT when design flaws were discovered illustrates the Municipality's commitment to the programme and has contributed to the ongoing sustainability of the programme.
- Where households showed a lack of understanding of operation and maintenance requirements, more information was provided on the emptying process. After the ISD intervention it was decided to reinforce the messages to the users by using media such as street theatre, and an educational initiative at the local schools was started as well.

5. Critical number of units. The fact that the programme provided demand for a large numbers of UDDTs, encouraged manufactures like Envirosan (for the pedestal) and TCE (for the flyscreen) to invest time and money into developing and adapting their product designs to function well and meet users' needs.

6. Addressing the expectations of rural communities. EWS recognises that social acceptance of the project and political will both constitute important factors for success of sanitation interventions.

- The HSRC study showed that while acceptance of water supply tanks was generally high, user satisfaction with the UDDTs was lower (Kvalsvig et al., 2003). Particularly people living in peri-urban areas close to the sewer system aspire to get flush toilets, considered a symbol of social emancipation[24]. Conversely, rural communities showed better acceptance of the UDDTs, as no households with flush toilets were nearby and thus no direct comparisons were made.
- The greatest challenge in terms of acceptance was the emptying of the vaults[25]. The establishment of local faecal vault clearing services by micro-enterprises in the respective communities was a method of mitigating this acceptance challenge.

12 Sustainability assessment and long-term impacts

A basic assessment (Table 2) was carried out to indicate in which of the five sustainability criteria for sanitation (according to the SuSanA Vision Document 1) this project has its strengths and which aspects were not emphasised (weaknesses).

[20] The Mvula Trust is one of South Africa's leading water and sanitation NGOs, for further information see http://mvula.org.za/.

[21] The survey made use of mobile phones and local people so as to increase the sample size, response rate and speed of conducting the entire survey.

[22] It is not known when the switch to Envirosan occurred but it was most likely around 2006.

[23] See photos by Envirosan (link details are given in Section 13).

[24] According to information by Richard Holden in April 2011: "Residential areas with access to in-house, full pressure plumbing and waterborne sewage are subject to strict credit control (enforcement of payment or else services are cut off). There were two court cases recently in South Africa, one involving residents from peri-urban Chatsworth, Durban and another from peri-urban Phiri, Johannesburg, where residents were claiming that they had a constitutional right to free water and sanitation. Both municipalities won their court cases and this sent the message that some people are not more privileged than others when it comes to basic water and sanitation but that people need to move to an area and service level that suits their financial means."

[25] With statements like "It is not in my culture to handle human waste" being made often by users prior to adoption (source: R. Holden, 2011).

Table 2: Qualitative indication of sustainability of system. A cross in the respective column shows assessment of the relative sustainability of project ("+" means: strong point of project; "o" means: average strength for this aspect and "–" means: no emphasis on this aspect for this project).

	collection and transport			treatment			transport and reuse[a]		
Sustainability criteria	+	o	-	+	o	-	+	o	-
health and hygiene	X			X					
environmental and natural resources	X				X				
technology and operation	X				X				
finance and economics		X			X				
socio-cultural and institutional	X			X					

[a] Not part of this project.

Sustainability criteria for sanitation:
Health and hygiene include the risk of exposure to pathogens and hazardous substances and improvement of livelihood achieved by the application of a certain sanitation system.
Environment and natural resources involve the resources needed in the project as well as the degree of recycling and reuse practiced and the effects of these.
Technology and operation relate to the functionality and ease of constructing, operating and monitoring the entire system as well as its robustness and adaptability to existing systems.
Financial and economic issues include the capacity of households and communities to cover the costs for sanitation as well as the benefit, such as from fertiliser and the external impact on the local economy.
Socio-cultural and institutional aspects refer to the socio-cultural acceptance and appropriateness of the system, perceptions, gender issues and compliance with legal and institutional frameworks.

For details on these criteria, please see the SuSanA Vision document "Towards more sustainable solutions" (www.susana.org).

The *expected* impacts of this project were the following:

- Access to water and sanitation services, which require no operation and maintenance from the municipality and place responsibility on users.
- Reduction of cholera episodes and incidence of waterborne diseases, as well as general improvement of the population's health.
- Higher awareness of health and hygiene issues.
- Infused sense of dignity for local communities and improvement of people's privacy and safety.
- Creation of job opportunities related to UDDTs.
- Beneficial impacts on the environment since human excreta is collected and disposed of safely.

The *verified* impacts of this UDDT project are as follows:

- A study conducted by the University of KwaZulu-Natal (Lutchminarayan, 2007) investigated the health impacts of UDDT use, comparing users with non-users. The research was conducted on 45 household clusters (total 1337 households) in rural and peri-urban areas of Durban, subdivided into three intervention areas (which had received UDDTs and water tanks) and three controls areas, which had not received the intervention. Significant improvements in the health conditions of the population receiving UDDTs and water tanks were measured. Specifically, the diarrhoea incidence in the serviced areas (incidence rate of 1.9 per 1000 persons per day) was significantly lower than for the non-serviced areas (incidence rate 3.3 per 1000 persons per day). Furthermore the health benefits gained were measured to be three times greater in children under the age of five compared to adults.
- The extensive communication efforts at all levels of the eThekwini basic water and sanitation programme have achieved a better alignment between officials, councillors and the end-users in the community. The established open communication channels are a significant contributing factor to the success of this programme and shall continue to ensure its sustainability.

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More photos:

- http://www.flickr.com/photos/gtzecosan/sets/72157623278033491/
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Video:

10-minute video about eThekwini's innovations in supplying water and sanitation to informal settlements and rural areas: http://www.youtube.com/watch?v=WZjHnkapRgg

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Photos of these pedestals from Envirosan catalogue: http://www.flickr.com/photos/gtzecosan/sets/72157626528442017/

Case study of SuSanA projects

Large-scale peri-urban and rural sanitation with UDDTs, eThekwini (Durban), South Africa

SuSanA 2011

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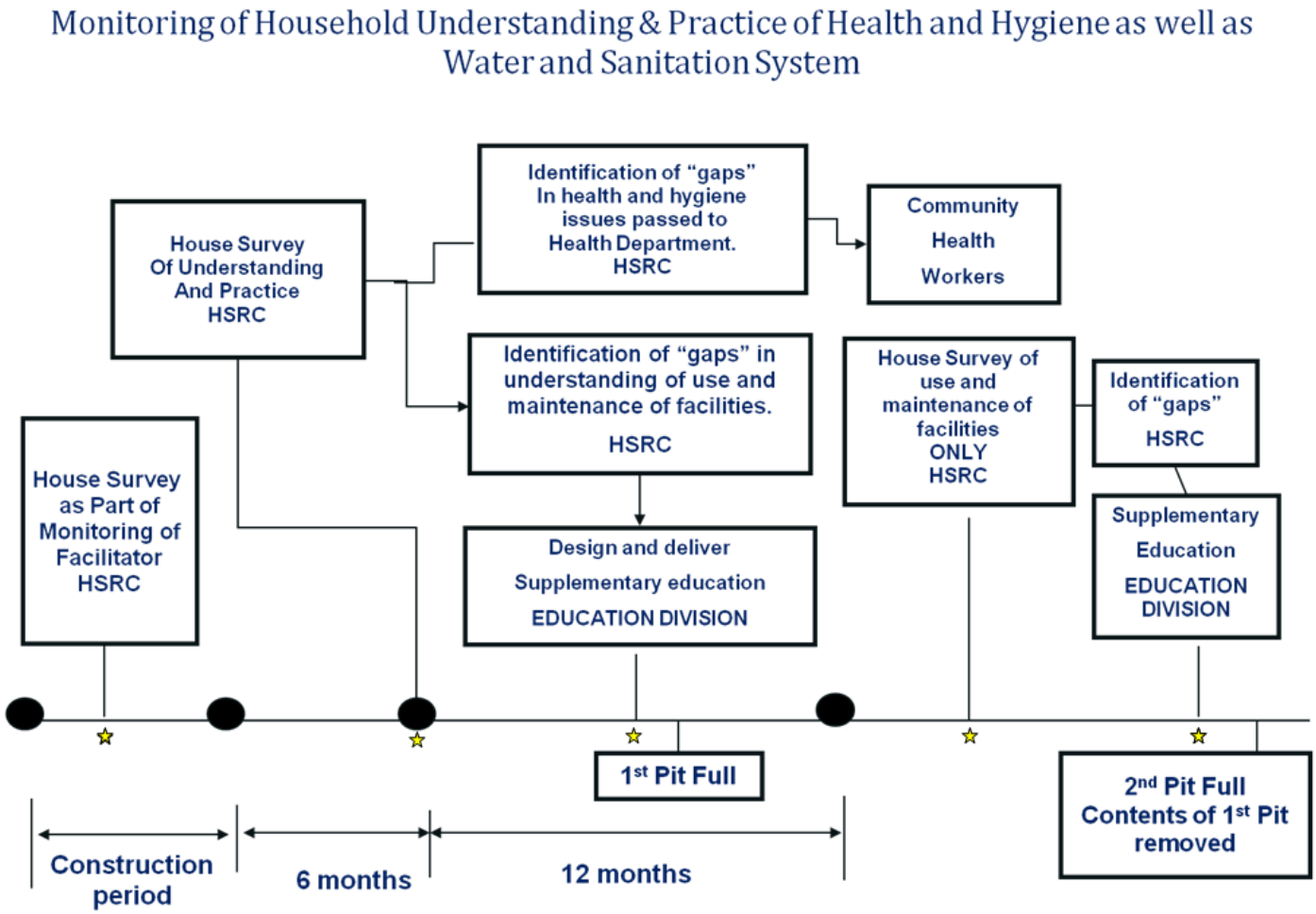
This document is available from:
www.susana.org

Appendix 1: A detailed timeline showing the project cycle and the timing of each household visit from eThekwini Water and Sanitation (EWS) health practitioners and education officers



(source: Gounden, 2008)

The stars mark the timing of each of the five visits from the EWS health practitioners and education officers to the UDDT users' households. The larger dots mark the respective time periods. Note that only the first 12 month period is demarcated, but the timeline represents a 24 month period in total. "Pit" in the diagram actually refers to UDDT vault.