WIN-SA
WATER INFORMATION NETWORK
- SOUTH AFRICA -

Sanitation MATTERS

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Issue 6 - 2014

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Sanitation Matters is a knowledge sharing publication of the Southern Africa knowledge node on sustainable sanitation (SAKNNS). The purpose of the publication is to share information and knowledge on sustainable sanitation within the Southern Africa region.

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THE SANITATION TECHNOLOGY

DEMONSTRATION PROGRAM

The Department of Science & Technology has partnered with the Bill & Melinda Gates Foundation and the Water Research Commission to pilot alternative, off-the-grid sanitation solutions to schools in the Eastern Cape Province and selected areas within rural district municipalities. Known as the "San Tech Demo Programme", it aims to pilot cutting edge sanitation technologies developed through the Gates Foundation Re-Invent the Toilet Programme into areas where basic infrastructure and resources for sanitation are lacking.

Sanitation coverage in South Africa has grown over the past ten years. During this period, new challenges around servicing and maintaining sanitation have emerged. Due to the lack of good technology alternatives, most solutions have revolved around on-site sanitation in the form of VIPs and its derivatives, and conventional waterborne for those areas in close proximity to the waterborne network. Rural and peri-urban based schools/institutions in South Africa, which are mostly off-the-grid, have never been afforded appropriate sanitation solutions. Where water is not available, vault based pit toilets have been the norm. Operational, maintenance, safety and many other issues have arisen with regard to problems with sanitation in schools. The opportunity therefore exists to demonstrate innovative sanitation solutions in these areas which link to Government's long term plans and goals. The Department of Science & Technology (DST) together with the Bill & Melinda Gates Foundation (BMGF) signed a Memorandum of Understanding (MoU), in March 2014, to field test the latest cutting edge sanitation technologies where sanitation provision has failed.

Photograph of school toilet in the Eastern Cape Province.
Photo by Oliver Ive (Amanz'abuntu).

Photo by Oliver Ive (Amanz'abuntu).

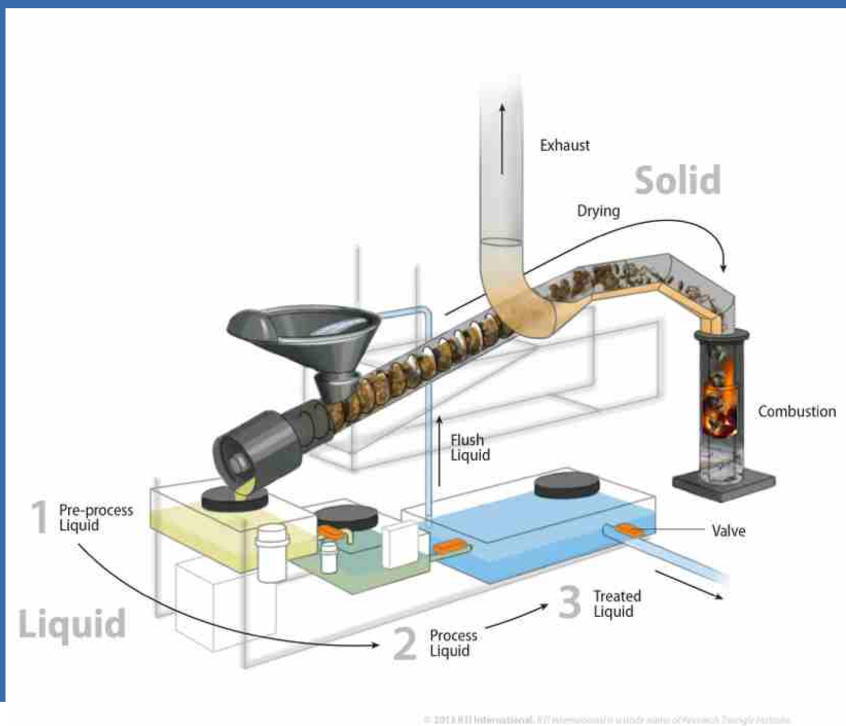
As outlined by this MoU, DST has committed R 30 million towards a demonstration programme for new sanitation technologies (San Tech Demo Programme), with the BMGF committing R 10 million towards support of the programme. A selected few demonstration-ready technologies from the BMGF's Re-invent the Toilet Challenge (RTTC) Programme (Box 1) will be piloted in selected areas within the Eastern Cape Province and rural district municipalities. The technologies have been recommended through consultation of the various stakeholders involved in the San Tech Demo Programme.

These technologies developed through the RTTC Programme incorporate new processes to the field of sanitation including: pyrolysis, the thermal decomposition of human solid-waste in an oxygen-free environment to produce biochar, electrolysis; using electrical currents to break down the chemicals in human liquid-waste; pasteurisation, a heat treating process which thermally sterilises human waste; plasma gasification, using microwave technology to gasify human waste; hydrocyclone toilet bowl technology, for separation of solid and liquid wastes; and on-site membrane technology, to purify liquid waste through filtration.

THE BMGF RE-INVENT THE TOILET CHALLENGE

In 2011, the Bill & Melinda Gates Foundation (BMGF) announced their RTTC Programme to promote research into new generation sanitation solutions that are innovative, off the grid, affordable for poor users and sustainable (http://www.gatesfoundation.org/What-We-Do/Global-Development/Reinvent-the-Toilet-Challenge). The technologies funded needed to have low operational and maintenance requirements and encourage beneficiation of waste streams through conversion of waste streams into potentially valuable products. Sixteen research institutions received funding to participate in the RTTC Phase I, based on their proposals to incorporate innovative technologies to produce the ultimate sanitation solution. After the best designs advanced to Phase II, candidates now have prototypes that have demonstrated proof of concept. However, none of these new generation sanitation solutions have been proven in the real world. The SanTech Demo Programme will provide an exciting opportunity to demonstrate these cutting edge technologies in areas lacking basic infrastructure and resources for operation of sanitation systems.

The Caltech sanitation unit. The unit is powered by solar panels and breaks down water and human waste into fertiliser and hydrogen. The hydrogen can be stored in fuel cells to be used for other purposes and around 90% of the water can be recovered. From: Reinvent the Toilet Fair: Technical Guide. Available online: http://docs.gatesfoundation.org/documents/Reinvent%20the%20Toilet%20Fair%20India%202014%20Technical%20Guide.pdf



The RTI toilet. The unit separates solids and liquids using an auger, produces pathogen-free ash and the liquid can be reused for flushing. Source: http://abettertoilet.org/tag/rti/

DST has also partnered with the Water Research Commission (WRC) to select, evaluate and develop procedures for appropriate new sanitation technologies. The DST and WRC have identified several district municipalities throughout South Africa and schools in the Eastern Cape Province as priority candidates to host the new technology prototypes, due to their critical need of all municipal services, including sanitation intervention. The WRC, as the implementing agent, will supervise the deployment of the new prototype systems to these municipalities and schools as agreed upon with the DST.

During piloting and demonstration trials, the new technology prototypes will be evaluated on a variety of factors such as unit performance, user preferences, social acceptance, operational and maintenance requirements, and business opportunities for local entrepreneurs. The project is planned to run over two phases, where prototypes of each selected technology are implemented in select locations and scrutinised in the first phase. After evaluation of the first phase implementation, the lessons learnt will be incorporated to O&M strategies and design, and the technologies scaled up and deployed more broadly in the second phase.

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BILL & MELINDA GATES foundation

WATER RESEARCH COMMISSION

THE SPLASH
URBAN SANITATION RESEARCH PROGRAMME WORKSHOP
IN KAMPALA, UGANDA

Anne Blenkinsopp (centre of photo) welcomes SPLASH members and invited delegates to Kampala (above). Delegates visit a pilot site (insert below). Photos by Sudhir Pillay.

On 20th June 2014, the SPLASH Urban Sanitation Research Programme held its final workshop meeting at the Fairview Hotel in Kampala, Uganda. The aim of the workshop was to share and discuss the major findings from the Programme with invited sector stakeholders. Sanitation Matters spoke to Anne Blenkinsopp, SPLASH Programme Manager from WEDC (Water, Engineering and Development Centre, Loughborough University) who supported the overall management and co-ordination of the SPLASH Research Programme.

Tell us about the SPLASH Urban Sanitation Research Programme and what it is about?

The SPLASH Sanitation Programme funded five research projects which aim to improve knowledge and understanding in key areas affecting the effective delivery of sanitation services in urban areas, from household level to final disposal. Projects examine different aspects of the urban sanitation management chain, from factors affecting the demand and construction of new toilets to exploring possible disposal routes for faecal sludge (Table 1). Some of the research projects were intrinsically linked to each other (Figure 1). Collaborative teams of European and African researchers from Cameroon, Ghana, Kenya, Uganda, Rwanda, Mozambique and Senegal, shared funds equally between the two continents. By doing so, it was envisaged that local capacity would be built in the area of study and that the solutions proposed would have greater relevance if jointly developed.

Title	Lead Organisation
3K-SAN: Catalysing self-sustaining sanitation chains in informal settlements	University of Surrey, Robens Centre for Public and Environmental Health Guildford, Surrey, United Kingdom
U-ACT: Economic Constraints and Demand-led Solutions for Sustainable Sanitations Services in Poor Urban Settlements	Swiss Federal Institute of Technology, Zurich Centre for Development and Cooperation Zurich, Switzerland
FaME: (Faecal Management Enterprise): Providing Sanitation Solutions through Value Chain Management of Faecal Sludge	Swiss Aquatic Research Institute, Department of Water and Sanitation in Developing Countries (Sandec) Dübendorf, Switzerland
MAFADY: Maîtrise de la filière assainissement dans un écosystème côtier à Douala et les quartier populaires de Yaoundé au Cameroun	Ecole Nationale Supérieure Polytechnique de Yaoundé Yaoundé, Cameroun
CLASS-A: Sustainable and resilient sanitation service chains in Maputo province, Mozambique – action research and piloting for benefit of the urban poor	International Water Association The Hague, The Netherlands

Table 1: Specific research projects within the SPLASH Programme and lead organisations. From: http://www.splash-era.net/san_res.php

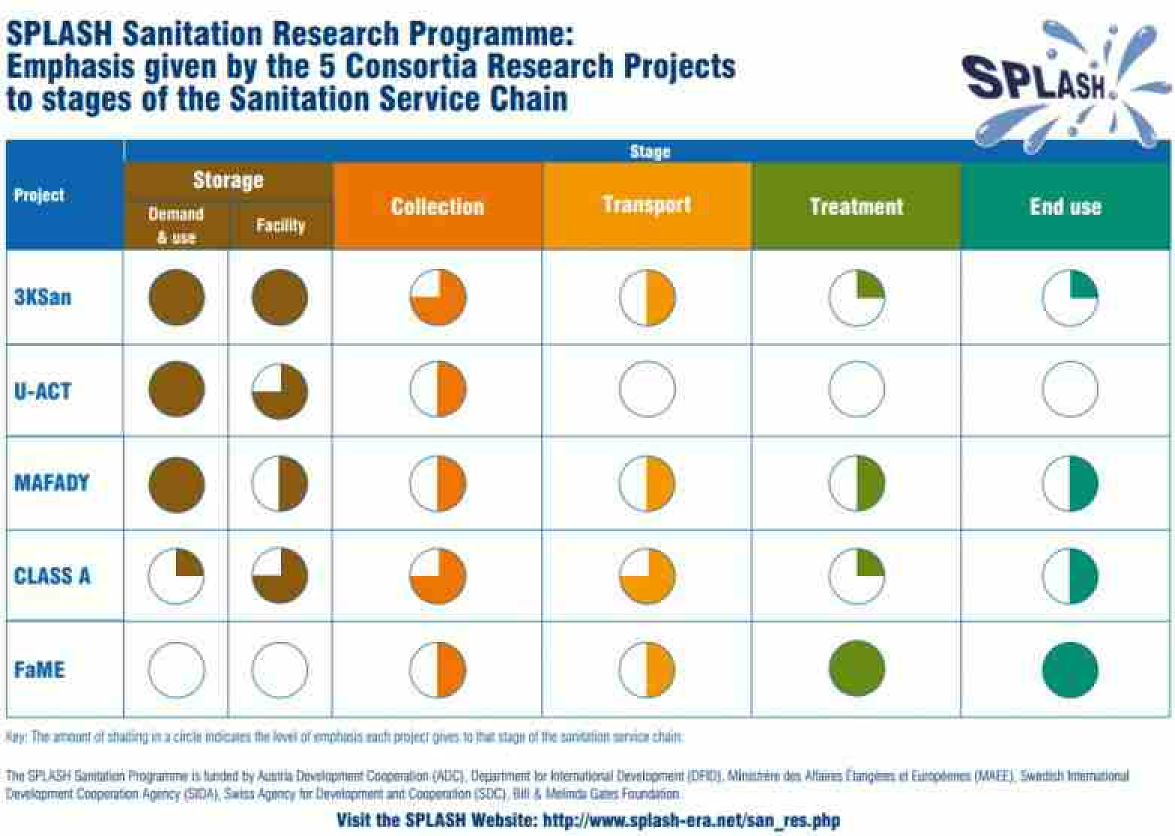


Figure 1: The linkage between the 5 different projects across the sanitation chain in the SPLASH Programme. From: http://www.splash-era.net/san_res.php

How is the SPLASH Programme different to other sanitation research programmes?

The SPLASH Programme considered the entire sanitation chain, not just one aspect, and encouraged all project teams to consider the implications of their work throughout the service delivery chain. The wide range of locations in which the Programme was implemented also enabled the proposition of solutions that could potentially cover a range of conditions, user behaviours, and so forth. The Programme was designed taking account the SPLASH lessons in good research management practice (see: http://www.splash-era.net/downloads/SPLASH_Briefing_note_01.pdf). In addition to equality in partnerships between northern and southern research teams (as previously mentioned), these also included an emphasis on stakeholder engagement throughout the research process, to encourage ownership of findings within communities. Finally, projects committed to spend at least 10 percent of funding on outreach and dissemination activity consistent with a dissemination strategy defined early in the process.

How was the Programme funded?

The programme was financed through pooled funding from ADA (Austria), MAEE (France), SIDA (Sweden), SDC (Switzerland) and DFID (UK) and the Bill and Melinda Gates Foundation's Water, Sanitation and Hygiene Programme.

What was WEDC's role in the SPLASH Programme?

WEDC's role as programme managers aimed to maximise the impact of the research. The role predominantly included technical review, coordination and global level dissemination. With multiple researchers involved - co-ordination has facilitated mutual learning and thus less duplication between research teams. The organisation of global level dissemination initiatives such as side events at international conferences (WEDC, Stockholm Water Week etc), and the regular distribution of an e-newsletter throughout the Programme has ensured that the Programme is well known within and beyond the sector. This also aimed to reduce potential duplication within the research community, and encourage discussion, understanding and use of findings with practitioners and policy makers, beyond what might have been achieved by individual project teams. In the final stage, WEDC is involved in overall analysis and synthesis of results in order that the SPLASH Programme level findings and sector contribution will be articulated.

What were some of the challenges in co-ordinating such a programme?

The SPLASH Programme has involved researchers from a wide range of countries in both Europe and Africa, this presented language and connectivity challenges for coordination. However, the SPLASH teams have constructively participated in regular webinars to share updates on their progress and plans to support the smooth running of the Programme.

A challenge to any research programme is to achieve the dissemination of findings beyond the traditional scientific literature (which is important for career progression of researchers). The SPLASH teams recognise the importance of their work to policy makers and practitioners. They have proactively and innovatively engaged with these audiences, both face to face at events and through other media throughout the Programme.

Finally - it has been important for researchers to consider the implications of the SPLASH programme as a whole, beyond the scope of their specific projects. This involves a shift in mind set to work as a single team as opposed to 5 project teams. SPLASH teams demonstrated their willingness and ability to do this on numerous occasions, which was been a great strength and a very rewarding programme to work on as a result.

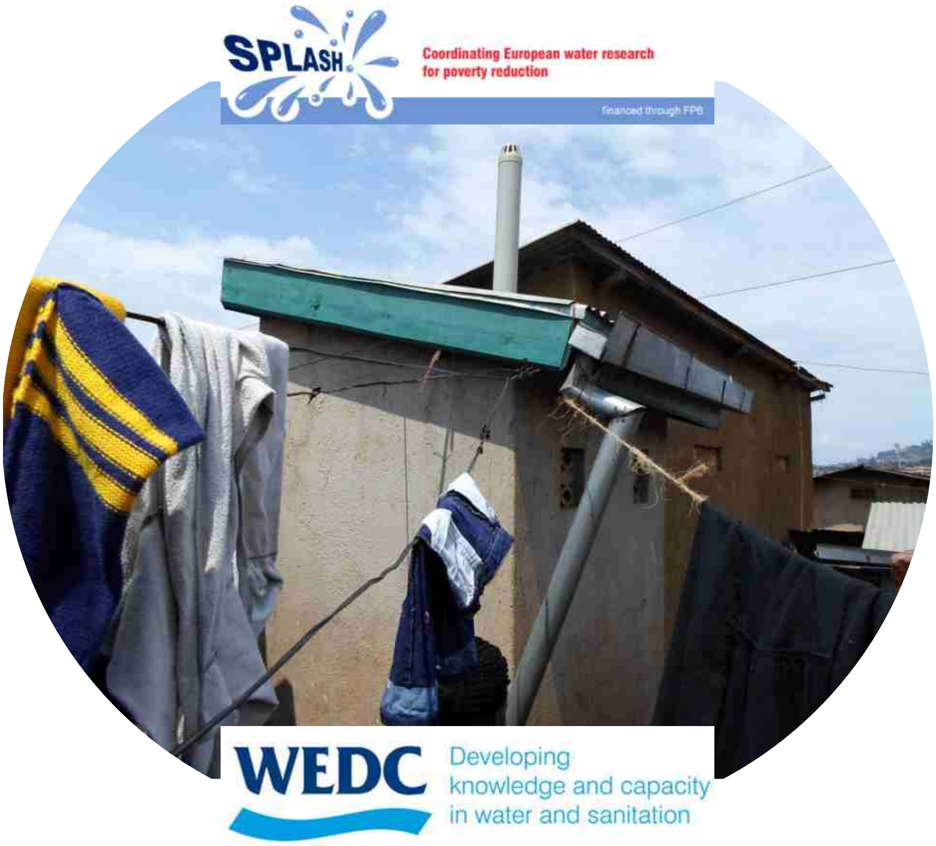
What were the major outputs from the workshop?

The main contributions of the workshop include: the increased awareness of the SPLASH Research Programme; very constructive discussion of the findings of our work; and an increased understanding of where these findings fit within the current landscape of the sector and where the challenges and knowledge gaps remain.

What is next for the SPLASH Programme?

Our current challenge is to ensure that we articulate the programme level findings effectively to the sector. We plan to achieve this through the presentation of both papers and a side event at the forthcoming WEDC International Conference in Hanoi, Vietnam 15-19th September 2014 and also hopefully at Africasan. We also plan to produce and disseminate synthesis outputs as hard and electronic copies later in the year. Finally, we will explore the potential for a second phase of the programme through an ongoing discussion with our donors.

If anyone would like to receive further updates, they can subscribe to the e-newsletter through the SPLASH website http://www.splash-era.net/san_res.php



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INDUSTRIAL USE OF FAECAL SLUDGE FOR FUEL:

PILOT STUDY IN KAMPALA

At the final dissemination workshop of the SPLASH Sanitation Research Programme in Kampala, Uganda, research findings of the project were disseminated to stakeholders through field visits. One of the visits was to the Bugolobi wastewater treatment plant where the FaME project piloted using dried faecal sludge as a fuel for brick production. Such industrial-scale end-use of faecal sludge could provide revenue for the currently financially unstainable faecal sludge management service chain.

Main photo: Labourers feeding dried faecal sludge into a pilot-scale Hofmann kiln at Bugolobi wastewater treatment plant. Photo by Sudhir Pillay.

The FaME Project

In Sub-Saharan, sanitation needs for the majority of the urban population are met by onsite sanitation technologies. Currently, the large quantity of faecal sludge collected in these technologies lack management and are directly discharged untreated into the urban environment. The FaME (Faecal Management Enterprises) Project (www.sandec.ch/fame) was funded through the SPLASH Sanitation Research Programme (www.era-splash.net). With field research in Uganda, Senegal and Ghana., FaME researched innovative resource recovery from faecal sludge, to provide a financial driver for sustainable faecal sludge management (Gold et al., 2013 and 2014). In Kampala (Uganda) and Dakar (Senegal), pilot-scale kilns were constructed to investigate whether dried faecal sludge can be used as an industrial solid fuel. The pilot-scale kiln (see Fig.4), designed in collaboration with a brick company, was demonstrated to key stakeholders at the final SPLASH workshop in Kampala (Fig.1-4).

Given its low solid content, faecal sludge has to be dried before combustion. In general, a dryness of 90% was requested by interviewed industries. In Kampala, faecal sludge was collected by vacuum trucks and dried on drying beds located at the Bugolobi wastewater treatment plant. Once dried to 90%, the sludge was removed and stored in a dry place before combustion.

A market demand study conducted in Kampala (Diener et al., 2014) indicated a high use of solid biofuels in Kampala. Brick manufactures in Kampala already use large quantities of coffee husks which could potentially be substituted or supplemented by dried faecal sludge. Years ago, coffee husks were seen as a waste product with little or no value. Over the years, it has become a valuable fuel for brick manufacturers in Kampala, delivered from as far as Tanzania. The FaME calorific value study (Muspratt et al., 2014) demonstrated that dried faecal sludge has a calorific value of 17.3 MJ/kg TS, comparable to the value of coffee husks. The success story of coffee husks highlights the potential of dried faecal sludge in becoming a valuable product instead of being perceived as a disposal problem.

To be used in the pilot-scale Hofmann brick kiln, the dried faecal sludge was milled (see Fig.1-2). Following milling, the fuel was loaded into the kiln from the top (see main photo above). Compressive strength tests of the bricks fired by dried faecal indicated that similar strengths can be achieved compared to using coffee husks (see Fig.3). Moreover, temperatures met industries requirements. Further tests are underway to optimise fuel production (i.e. sludge drying and milling) and feeding into the kiln (automated feeding) to increase brick quality.

Fig. 1. FaME researcher Daniel Dhiba demonstrating milling of dried faecal sludge to workshop participants.

Fig.2.
Fuel sources for the pilot-scale kiln: coffee husks (right), dried and milled faecal sludge (centre) and dried faecal sludge (left).

Fig.3. FaME partner Dr. Charles Niwagaba from Makerere University holds up bricks fired with different solid fuels.

Fig.4 FaME pilot-scale kiln for brick production at Bugolobi wastewater treatment plant.
Photo by Mortiz Gold, Sandec/EAWAG

The FaME project demonstrated that using dried faecal sludge as a solid fuel and end-use as a fertiliser replacement is technically viable. Depending on the local market, using dried faecal sludge could provide higher revenues (Gold et al., 2014, Diener et al., 2014). The generated revenue could fund improvements throughout the service chain, reduce dumping of faecal sludge into the environment, and increase public and environmental health.

Sandec and its partners will continue research on energy recovery from faecal sludge through the SEEK (Sludge to Energy Enterprises in Kampala) Project. The aim is to study co-processing of faecal sludge and other urban organic waste streams to produce fuel pellets and with these generate electricity through gasification.

Compiled and Edited by Sudhir Pillay and Moritz Gold

Further reading:

www.sandec.ch/fame and http://www.eawag.ch/medien/publ/news/2014_na_32/index_EN

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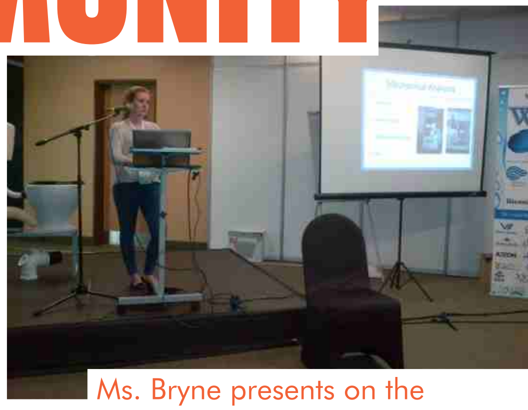
eawag aquatic research

SPLASH Coordinating European water research for poverty reduction

financed through FP6

SANITATION COMMUNITY OF PRACTICE WORKSHOP:

WISA BIENNIAL CONFERENCE 2014



Ms. Bryne presents on the characterisation of low flush toilet sludge

On the 28 May 2014, the WRC hosted the "Sanitation Community of Practice Workshop". The first of its kind at a WISA conference, the purpose of the workshop was to share new advances in sanitation technology, evidence-based research, and finally learning experiences and practice among different stakeholders. The workshop served the following purposes: 1) showcase gap technologies along the sanitation chain ranging from low flush systems to novel faecal sludge disposal and beneficiation mechanisms; and 2) to bring together past and current research to have a better understanding of complexities of on-site sanitation.

Mr. Harris presents the low flush pilot from the W. Cape

Four presentations were made by keynote speakers. Dr. Sudhir Pillay from the WRC presented on the WRC sanitation strategy and current outputs from the Sanitation Research Fund for Africa Project. A series of keynote presentations were made on the low flush unit developed through the WRC; Mr. Dave Still (Partners in Development) presented on the development of the prototype, Mr. Jonny Harris (Maluti GSM) presented on the Western Cape pilot and Mz. Aoife Byrne (Pollution Research Group) presented on the characterisation of the sludge from the low flush units. Mr. Dave Still also presented the research findings from the entrenchment of faecal sludges in South Africa. Discussions were held around the different presentations and other issues related to on-site sanitation. The workshop also gave an opportunity for interested persons to bring along different sanitation technologies for demonstration.

Mr. Dave Still presents on the development and pilot of low flush in KZN

Presentations can be viewed on SuSanA website:

http://forum.susana.org/forum/categories/21-events/8528-sanitation-community-of-practice-workshop-wisa-28-may-2014-nelspruit-south-africa-pour-flush-toilets-in-south-africa

Envirosan's new flush pedestal and pan

FROM RESEARCH TO PRACTICE:

THE LOW FLUSH TOILET FOR ANAL WIPERS:

HOW DID WE GET HERE AND WHERE TO FROM NOW?

In 2009, the Water Research Commission (WRC) sought to develop an off-the-grid flush toilet that could meet South African conditions i.e. use low flushing volumes and handle different anal cleansing paper. The success in demonstration trials saw the technology being further refined and quickly moved to piloting phase in various parts of South Africa. Over 600 of these units will be installed in KwaZulu-Natal in the near future as the technology gains impetus. In this issue of Sanitation Matters, we take a look at the development of the low flush unit and the future of the technology in South Africa.

Background

Low volume, hand poured flushing systems are common in Asia. However, in South Africa, where the majority of users are wipers, the technology has gained a reputation as being unreliable due to the blocking of the toilets from anal cleansing material. In 2009, the Water Research Commission tasked Partners in Development to develop a low flush unit under WRC Research Project K5/1887. The design considerations imposed on the research team were: replacement parts must be easily sourced, components standardised, must have a proper water seal, the toilet must be able to handle newspaper and / or toilet paper, and must use low flushing volumes to clear the pan of stools and wiping material. Previous installations of low flush units in South Africa have been unsuccessful due to the toilets not meeting the above requirements.

Prototype Development and Evaluation

A fibreglass prototype was developed, fabricated and tested based on the design considerations. Flushing was achieved through a dumping pouring action from a jug or other vessel i.e. in a manner similar for Asian toilets. The prototype developed was made for 'sitters' as the majority of South African sit on a pedestal while defaecating. Externally, the prototype appeared no different to that of a standard flush pedestal. Internally, however, the prototype was more funnel shaped. The greater angle of the front slope of the pan and the 45° angle of the pipe exiting the pan (compared to 90° of other low volume units) was required to facilitate the clearing of blockages from the S bend (see Fig.1-2 below).

Fig.1. The low flush pedestal prototype. The pan funnels steeply to a 70 mm diameter outlet, which is angled at 45° to the horizontal

Fig.2. The water seal was made up using three standard 65 mm diameter PVC pipe fittings – a reducer, a long radius 90° bend, and a 45° bend

The prototype was tested according to the MaP (Maximum Performance) protocol. According to the protocol, a toilet must completely flush down the bowl 250 g of synthetic stools (Fig.3) and toilet paper in a single flush without clogging or plugging in at least 4 out of 5 attempts (Fig.4). Although the protocol is mostly applied to evaluate standard flushing units, it was adapted for the low flush prototype with the volumes of flushing water and type of anal cleansing material varied. The research team found that the toilet performed well at 1 litre with toilet paper, while the addition of newspaper sometimes necessitated a second hand poured flush. Newspaper that was folded was more difficult to flush than that which was crumpled. This finding was communicated to users once the household pilot started.

Fig.3. Replica faecal samples as described by the MaP test protocol. Each sample contains 50 grams of soy paste, and is contained in a latex sheath.

Fig.4. The MaP test was perfromed using up to six 50g replica stool samples and a prescribed amount of toilet paper (20 squares of single ply).

Household Pilot

Following demonstration of proof of concept, two test toilets were installed at local households and monitored weekly for the first month and monthly thereafter. After three months, no difficulties were reported, which led to the construction of additional pilot units. Eighteen additional units were built in four communities in the uMsunduzi and uMgungundlovu municipalities in KwaZulu-Natal (Fig.5). Existing toilet systems, which ranged from VIP units to Hungerford Schroeder low flush units, were replaced with the new hand poured low flush unit. Eleven systems were installed in outdoor structures and 9 were installed inside homes. Sewers equipped with a rodding eye were laid, leading to two 1 m x 0.8 m pits lined with cement blocks with open joints (leach pit). Care of the toilets was discussed with users and an educational poster was mounted on the door of each. Each household was provided with a jug and bucket for flushing. Pit filling rates were investigated at the end of the study and householders were surveyed regarding their experience, behaviours and

Fig.5. Hand pouring low flush units. A bucket and jug was supplied to each household together with user education.

attitudes with regard to the low flush unit. The main findings are summarised in Table 1 below.

Table 1. Main findings of household pilot study. Summarised from Research Project K5/1887

User satisfaction	Satisfaction among users was high. Responses indicate that the low flush system adequately addresses the wish of many dry sanitation users for a flush toilet. Some users expressed a strong preference for locating the toilet outside due to their homes being too small to afford privacy or due to experiences with low flush systems in the past having an unpleasant smell. Some users expressed a willingness to pay in order to have their existing systems replaced with new unit.
Pit filling rate	Pits filling at a rate ranging from 114 to 392 litres per year. When calculated based on the number of householders, filling rates ranged from 26 to 57 litres per person per year, with a median filling rate of 35 litres per person per year. A probable life span of approximately 5 years before the pits needs to be emptied. The sludge appeared to be of a consistency which could be extracted by vacuum. Research Project K5/2137 was commissioned to evaluate the sludge characteristics from this unit.
Blocking	Only once incident was reported as a result of a child placing a plastic bag into the toilet. The toilet proved robust enough to handle newspaper without blocking. Users were taught how to use newspaper in case they run out of toilet paper. Two households used newspaper without difficulty.
Rubbish	The pipe leading from pan prevents trash being dumped directly into the pit.
Cost	This technology is considerably less costly than installing a full flush toilet connected to a sewer or a standard septic tank. In addition, it is not dependent on a piped water supply and can be used even if the water supply is cut off occasionally, as a small amount of water is required and greywater can be used.

From KZN to Western Cape

The success of the household pilot led to a short-term WRC Research Project (K8/1018/3) led by Maluti GSM Consulting to field test 15 hand poured low flush prototypes in four sites in the Western Cape (Table 2). The project aimed at testing the suitability of the prototype in a variety of settings where the number of users, user preferences and behaviours are expected to be different. Prototype installation began in March 2013.

The key findings from the study were that 1-2 litres were required to flush and users were enthusiastic about the technology. In Enkanini informal settlement (high-density, shared toilet), residents paid for the operation and maintenance of the system (around USD2.5/month); an achievement given that most citizens expect the local water service authority to oversee these costs. In Klipheuwel, the prototypes were well looked after and the community expressed a sense of pride in the unit as evidenced by them "dressing" their new toilet (Fig.6). The pilot studies were however not without challenges. Evidence of neglect was observed in Klein Begin (private land with communal system) but the toilets continued to work even after conventional flush toilets in the same communal ablution block became blocked. One of the toilets in Enkanini also reported a blockage from unripped newspaper. After the completion of this pilot, the WRC commissioned Research Project K5/2198 to look at incorporating a low volume, flushing cistern to the prototype.

Fig.6. Dressed toilet

Table 2. Site description of communities which were given low flush prototypes

Location	Description	
Sustainability Institute, Stellenbosch	Educational facility. Prototypes installed with water meters connected to data loggers. Interviews held with cleaners to determine the no. of blockages	
Klipheuwel informal settlement	Five prototypes installed replacing existing AfriSan toilets and connected to soakaway.	
Klein Begin Community, Grabouw	Private land with borehole access to water. Existing communal system connected to septic tank and in poor state. Seven prototypes were installed with four replacing damaged infrastructure at the communal facility and another prototype installed at a crèche on the site. Prototypes connected to either biodigester or septic tank with soakaway.	
Enkanini Informal Settlement, Setllenbosch	High density informal settlement. Communal block toilets available at selected positions and connected to a municipal sewer which often surcharges due to blockages and stormwater ingress. Five prototypes installed together with biodigester and shared among 3 to 5 households.	

The School Pilot

Partners in Development undertook this research project to modify the hand pouring flushing system that they had developed earlier to include a cistern in order to provide a new option for institutional as well as domestic sanitation. A prototype was developed and tested after using the same protocol described for the earlier hand pouring flushing unit (more information on the development of this new prototype can be viewed in Research Project K5/2198). The prototype with a cistern needed more water (2.5 L) to flush than the pour flush unit (above 1 L) due to the latter having a strong "dumping" action that allowed effective flushing.

After testing, fibreglass pedestals were produced and 6 units were installed in 2 schools (3 each). A health and hygiene presentation was made to learners and staff at both schools, Educational materials were also distributed to those in attendance. In addition, pour flush systems that had previously been installed in 2 private homes were converted to low flush systems with a cistern (Table 3). The low flush toilets were monitored for 2-3 months during which time all 8 units performed well and experienced no blockages or other problems.

User acceptance of the system was good, with staff and learners at two schools making no distinction between low flush and standard toilets installed in the same blocks. The low flush toilet performed well with a 2.5 litre flush, representing a 40% to 70% saving of water over standard toilets. In the next section, the results from a recent WRC commissioned study to investigate the physical, chemical and mechanical properties of the faecal sludge from these systems is presented. The research aimed at understanding what emptying and / or re-use strategies may be required from these units in comparison to other dry sanitation systems.

Table 3. Pilot site description

Pilot area	Description
Sizimesele Primary School 125 boys 114 girls 10 staff (3 men, 7 females)	The school was serviced by VIP units. These were demolished. The new toilet block was constructed with 3 prototypes (2 female, 1 male) installed together with conventional flush toilets (9 April 2013). Chemical toilets were used during the interim. Toilets in use since 15 May 2013.
Thandaza High School 364 boys 522 girls 37 staff (29 females, 12 men)	Inadequate no. of toilets for learners. Blockages and unpleasant smells due to high volume usage. Vandalism common especially in boys' toilet. Cleaner in charge of maintenance through own school funds. New toilet block constructed. The girls' block was fitted with 11 toilets, the first two of which were low flush units. The boys' block was fitted with 3 toilets, the first of which was a low flush unit. Sinks and urinals for boys were also installed (handover to Dept. Education on 10 April 2013).
Msunduzi Municipality Two private homes upgraded from pour flush to unit with a cistern (March 2013)	

How Fast Does Sludge Accumulate, What Is Its Characteristics? Does the Leachate Migrate?

The characteristics of the sludge produced from this technology are of interest because of the general lack of information about sludge from low flush systems, and how it compares to the VIP sludge. The rationale behind the research was to provide guidance on how the sludge from the new technology can be managed; something which is often overlooked in the sector as evidenced by the challenges the country is facing with regards to pit emptying and disposal. Research Project K5/2137 was therefore commissioned by the WRC to enable a clearer understanding of the environmental impact of the system, mechanisms for emptying the pits once they are full and disposal / reuse of the sludge. The research was undertaken by the Pollution Research Group, University of KwaZulu-Natal, on prototype toilets that were installed in Research Project K5/1887.Sludge samples were taken from the toilet pits of four different households repeatedly over a period of 11 months. The prototypes have been in use for around 4 years. Two of the households had double pit units linked by an off-set pipe. When one of pits is nearly full, the off-set pipe is moved to the empty pit. Samples were taken from both the "active" pit – the one still in use – and the "inactive" pit – the pit that has been left to stand or has been emptied (Fig.7). The other two households had single pits which were in use for nearly four years. Samples were also taken from these pits.

Fig.7. Pits of the low flush unit.

The research team had to fabricate specialised tools for sampling the pits of these toilets due to the varying wetness of the sludge (especially from active and inactive pits) (Fig.8-9).

Fig.8.

One of two sampling tools developed by the research team. The sampling "pole" consists of a clear PVC column with a bung and a cap at the other end. This tool was used for more viscous sludge and did not work efficiently for wetter samples. More on the development of the sampling tools can be viewed in Research Project K5/2137: Interim Report on Pour Flush Toilet Sludge Characterisation (contact Mr Jay Bhagwan: jayb@wrc.org.za).

Fig.9. The "bucket" sampling tool for wetter sludge. The tool had a movable base and the length of the metal rod could be adjusted to different lengths.

The sludge was analysed chemically, physically and biologically to provide a base understanding of the sludge characteristics and possible mechanisms occurring in the pit. The filling rates of the pits were also monitored, as this is important information for planning future pit-emptying schemes and pit design. It was found that the low flush and VIP sludge had minor differences in terms of the chemical composition. However, physically, the pour-flush sludge is more homogeneous with small amounts of non-faecal material in the pits. This means filling rates are slower as there is less non-degradable material in the sludge. Also, mechanical pit emptying is easier (provided the sludge is wet enough) without the presence of non-faecal material, which is often the cause for blockage or damage of pit emptying equipment. The pit filing rates were estimated to less than that of VIP units and similar to that first estimated by Partners in Development during the home piloting.

Fig.10. Photographs of pits from hand pouring low flush units.

The pollution plume from a single low flush unit was evaluated as part of WRC Research Project K5/2115 “Investigation of pollution from on-site dry sanitation systems”. The study was carried out jointly by the Centre for Water Resources Research, UKZN and Partners in Development. The site was one in which a household hand pouring low flush unit with a single pit was installed. As the site was close to a stream, the research team wanted to investigate whether the pollution from the leach pit migrates from the source and to the stream. Six piezometers were established downslope of the latrine sump and six cross-slope piezometers were established some 17.5 m downslope of the latrine sump. Two background piezometers were established upslope of the pit and on was established adjacent to the pit. The site layout, with a single house leach pit, is shown in Fig.11.

The research team made the following observations with regards to the pollution plume from this unit. First, general elevated concentrations of nitrate, phosphate, sulphate, chloride, calcium, magnesium, sodium and potassium exist within 1m of the leach pit. E. coli counts are generally high below the ground level in close proximity of the pit. However, counts seldom exceed 1000 CFU/100mL further than 3 m from the pit. Although specific to environmental, soil and rock conditions in KZN, the results indicated that there is no pollution plume from the leach pit of this system.

Fig.11. Location of piezometers and indication of soil types (mostly dolerite underlying geology) at the Azalea site.

Timber frame low flush units

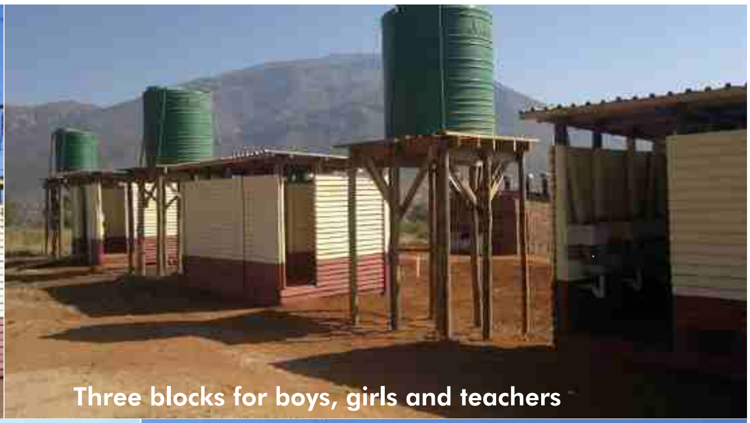
Following the success of the low flush units in the school pilot, Partners in Development were recently commissioned (Research Project K5/2407) by the WRC to explore the use of timber frame structures to house low flush units, with the specific application being school toilet blocks. The application of timber, although not common in South Africa, in construction of superstructures allows quick turn-around; the structures can be pre-fabricated and also moved at a later stage. The timber was sourced from the Department of Environmental Affairs' invasive plant clearing programme. Timber frame toilets with low flush units were constructed at six Limpopo schools, including one toilet for the disabled (Fig.12). The 6 schools were all provided toilets in 3 months; quite an achievement given that there were delays in the supply of CCA treated timber, and the construction team had little prior knowledge of constructing timber frames (brick and mortar is common in South Africa). With a reliable supply of timber and the construction team becoming more efficient in timber frame construction, the team managed to complete one school toilet block in 3 weeks.

Where to next?

This technology may provide a viable option to municipalities under pressure to provide flushing toilets where laying sewers is not feasible or affordable. In addition, it could provide an option for householders desiring a flush toilet to upgrade their existing VIP system. The unit can be installed indoors, reducing the costs of building a separate structure, or it can be installed in an existing VIP structure with the addition of a leach pit built beside the structure. The ability of the low flush system to accommodate newspaper makes this a technology which municipalities could specify even for poor communities and which poor families could opt for with a one-time expense of upgrading their system but without incurring the long-term expense for toilet paper which they may not be able to afford.

Low flush technology shows the potential for overcoming one of the thorniest problems facing municipalities: the difficulty of removing sludge from pits. While VIP sludge is often too dry and contains too much rubbish to be removed with a vacuum tanker, the low flush system is far more conducive to emptying as it contains less rubbish.


Front view of a toilet block


Three blocks for boys, girls and teachers


Wheelchair access


Separate girls and boys' toilet blocks

Fig.12. Timber frame toilets housing low flush units.

It is essential that spare parts be available wherever low flush systems are installed. At the recent WISA Biennial Workshop, Envirosan, a plastics company in Durban, produced an injection moulded low flush pedestal, which will bring the cost of a low flush unit down to the same range as that of a VIP pedestal. There are also plans underway to piloting the unit on a larger scale in both residential and institutional contexts. The WRC together with Ethekwini Municipality plans to implement around 600 units in the near future.

This article was prepared from the list of WRC Reports below. Text, figures, tables and photographs presented have been extracted from the following reports:

WRC Report No. K8/1018/3 "Pour Flush Trials in the Western Cape" by Maluti GSM Consulting Engineers

WRC Report No. K5/2115 "Investigation into Pollution from On-Site Dry Sanitation Systems" by Simon Lorentz, Bruce Wickham and David Still

WRC Research Report No. K5/2137 "Characterisation of on-site sanitation material and products: VIP latrines and pour-flush toilets" by Pollution Research Group, Chemical Engineering, University of KwaZulu-Natal.

WRC Report No. K5/2407 "Development and testing of timber frame pour flush sanitation blocks" by Partners in Development.

Compiled by Sudhir Pillay.
Edited by Lani van Vuuren.

IS ENTRENCHING OF FAECAL AND SEWERAGE SLUDGE A VIABLE OPTION FOR DISPOSAL?

RESULTS FROM WRC RESEARCH PROJECT K5/2097

The need for appropriate and cost effective disposal mechanisms for faecal sludge became apparent after the Ethekwini Municipality began its pit emptying programme. Transport and disposal to a conventional wastewater treatment plant was found to be extremely limited due to the high concentration of pollutants which disrupted the wastewater treatment process. Furthermore, the plants had their own challenge of dealing with the accumulation of secondary sludge from their processes. With the number of landfills prepared to accept sludge diminishing and the cost of transporting to authorised landfills prepared to accept sludge high, new ways to disposing of sludge are required. Partners in Development were commissioned by the WRC to evaluate the use of entrenchment or burial of sludges as a means to dispose of both faecal and sewerage sludges. The technique has been in use since 1970s in Maryland, U.S.A but only for sewerage sludges. Partners in Development were commissioned by the WRC to determine whether this technique could also be applied to faecal sludge disposal.

Background

Investigation into the entrenchment of sludges started in the 1970's in Maryland, U.S.A. The research was initiated by several co-operating agencies as a result of high tonnage (200-300 tonnes per day) of sewerage sludge produced by the Blue Plains wastewater treatment facility which served two million people. Entrenchment or burial of sewerage sludges in rows was considered as potential disposal route with a series of investigations performed to evaluate the technique as a means of beneficiation for the forestry industry and for wildlife habitat rehabilitation. From nearly three decades of research, the following benefits were observed with respect to entrenching sewerage sludges: 1) more sludge could be applied than surface application, 2) it improves structure and organic content of soil, 3) nutrients are released at a slow rate reducing frequency of application, and 4) reduces vector disease transmission and sludge contact with human and animals. Although the research that has been conducted to date on sludge entrenchment has shown positive results, it was considered appropriate to run similar trials in South Africa to see if the results could be replicated. While the American trials focussed exclusively on the entrenchment of treated sludges from waste water treatment works, in the South African context the VIP pit latrine is the norm for basic sanitation provision. Therefore, it was of relevance to investigate entrenchment as an option for the beneficial use of sludge derived from pit latrines as well as that from wastewater treatment works. Partners in Development were commissioned by the WRC to investigate the entrenchment as a potential disposal and beneficiation mechanism for faecal and sewerage sludges.

Pilots: From Household to Large-Scale Application

The study was performed at various scales with a total of five pilot experiments being conducted. In the first two, pit latrines were manually emptied at Inadi near Pietermaritzburg and the sludge was used to fertilise and condition the soil around new fruit trees which were planted at two homesteads. Citrus and peach trees were the trees selected by the families. In the case of the citrus trees, those which were planted with sludge grew noticeably larger and had more abundant fruit. The size of this experiment was too small to be of much scientific significance, but perhaps the most important finding was that the planting of trees over faecal sludge and the consumption of the fruit that grew on those trees was not considered taboo.

“the planting of trees over faecal sludge and the consumption of the fruit that grew on those trees was not considered taboo.”

In the second experiment, controlled tree tower experiments were conducted at the University of KwaZulu-Natal (Fig.1). For the study, two types of trees were used in the experiment; eucalyptus and wattle. For each plant species, 12 trees were grown in concrete towers (1 m high and 0.75m wide), 6 with sludge (experiment) and 6 without (control), and the growth characteristics monitored. In the case of the experimental trees, a core of pit latrine sludge was placed at the centre of the tower directly below 250 mm layer of river sand. For the control trees - those without grown without sludge – a liquid fertiliser solution was administered while the experimental trees were given just water (the same amount as that given to the controls).

At the end of the six months, the towers were broken up and the total tree mass for each tower was measured. The pattern and density of the roots were also studied. The growth response of the experimental eucalyptus trees was strikingly better than the controls, while that for the wattle trees was less so. In the case of the experimental trees, the tree roots were denser around the outer edges of the soil where they were turned by the concrete wall, but the roots also grew into the sludge core below the trees.

In the third experiment, over a 1 000 m^3 of pit latrine sludge was buried on the site of an old oxidation pond in Umlazi, south of Durban (see insert above). Eucalyptus and wattle trees were planted over the sludge and five monitoring boreholes were drilled between the site and the nearby Umlazi river. No significant changes were detected in the groundwater over a two year monitoring period. Samples of the sludge were taken from time to time and assessed for physical properties and pathogen content. After three years the sludge was hard to distinguish from the surrounding soil, the organic matter had virtually all decomposed and the pathogens (using *Ascaris* as a marker) had all died (Fig.2 next page).

Fig.1. Controlled tree tower experiments carried out at the University of KwaZulu-Natal.

Fig.2.
After four years, the sludge is hard to distinguish from the surrounding soil. The presence of plastic is a good clue as where the sludge was buried.

In the fourth experiment, Partners in Development investigated whether sewerage sludges could be entrenched in a similar manner to those reported in Maryland, U.S.A (Fig.3). Around 360 m^3 of wastewater treatment works activated sludge was buried in a eucalyptus plantation near Howick in the KwaZulu-Natal midlands. The two hectare experimental area was provided by a local paper manufacturing company, Sappi, and was divided into 30 plots, each 30 by 30 metres in extent, and in 18 of these plots sludge was buried in a 20 by 20 metre section in the centre of the plot. Five treatments were compared: T1 had one 10 m^3 load of sludge, T2 had two loads, T3 had three loads, T4 had no sludge but it did have trenches, and T5 had no sludge and also no trenches (negative control) (Table1).

Treatments	Blocks (20 x 20mm)	Dimensions	
T1	6	6 trenches, 3 m apart 20m length x 0.6m width x 1.5 m depth	250 mm sludge depth
T2	6	6 trenches, 3 m apart 20m length x 0.6m width x 1.5 m depth	500 mm sludge depth
T3	6	6 trenches, 3 m apart 20m length x 0.6m width x 1.5 m depth	750 mm sludge depth
T4	6	6 trenches, 3 m apart 20m length x 0.6m width x 1.5 m depth	Trench with no sludge buried
T5	6	6 trenches, 3 m apart 20m length x 0.6m width x 1.5 m depth	No trench, no sludge

With the growth of 900 trees (30 at the centre of each plot) having been observed from planting in January 2010 until May 2014, a period of 52 months, the plots with sludge show a 50% increase in timber volume compared with those without. This site was also closely monitored for groundwater impact, using a number of piezometers for near surface flow and two 60 metre deep boreholes at the bottom of the site for groundwater monitoring. Only a small difference (2 mg/ℓ) in nitrate levels was detected in the downstream borehole compared with the upstream borehole over the first year after planting, and after four years the nitrate content in the water sampled from the site rain gauge was significantly higher than that sampled from the boreholes or the piezometers.

Samples of soil taken after 3 years from around the buried sludge and from the sludge itself show that nitrogen is not retained in the sludge or in the surrounding soil, whereas potassium, phosphorus and other elements such as calcium and zinc are retained.

Fig.3. Entrenchment of sewerage sludge at the Sappi test site.

Appearance of sludge 38 months after entrenchment

The final experiment, which is ongoing, is looking more closely at the leachate emanating from buried WWTW sludge in a set of 15 one metre square plots, 12 of which have a layer of either 250 mm or 500 mm of sludge. Six of these plots have been constructed with pan lysimeters buried some 500 mm below the sludge, which means that all the leachate which seeps downwards from the sludge (and in this case instrumentation detects no lateral seepage) is captured and can be analysed. After four months of monitoring through the rain season of 2013/2014 less than 0.2% of the nitrogen and less than 0.004% of the phosphorus has been detected in the leachate. As the fourth experiment described above showed that within three years the nitrogen in the sludge is no higher than background soil levels, this evidence supports the hypothesis that most of the nitrogen that is buried in sludge returns to the atmosphere through the natural processes of nitrification and denitrification.

Key Questions

The research provided and / or suggested answers to questions regarding the entrenchment of faecal and sewerage sludges.

Has this method of sludge disposal been tried before?

Research conducted since the 1970's in the U.S.A have indicated that entrenchment is a safe option for sludge disposal. Repeated trials over more than 20 years have not detected a significant impact on the groundwater, despite very heavy application rates (up to 660 dry tons per hectare). Trials with fast growing poplar trees indicate that tree growth is significantly enhanced when these trees are planted in close proximity to the entrenched sludge.

What is the fate of pathogens which are buried in the ground?

Ascaris infestation is rife in Durban and faecal sludge removed from pit latrines typically has average egg counts of several hundred ova per gram of sludge. The presence of Ascaris has been monitored in buried sludge over a period of 48 months. The results show a complete die off over a period of three to four years. Tests for the presence of Ascaris on surface soil samples after 48 months indicated no significant difference between the soil in the entrenchment area and background soil samples from a similar area where no sludge had been handled.

How does sludge change after it is buried in the ground?

After several years it is difficult to distinguish the sludge layer from the surrounding soil. Over the course of four years, the pit sludge buried at Umlazi changed as follows: median COD decreased from 0.25 g COD/g dry sample to 0.05 g COD/g dry sample; the median volatile solids decreased from 60% to 3%; and the moisture content reduced from 75% to 13%. The data indicated that the organic matter has largely decomposed over the four year period.

What is the fate of the nutrients in the sludge after it is buried in the ground?

High concentrations of nitrogen and phosphate have been observed in the leachate in the immediate proximity to the sludge, and occasional spikes of high nitrate and phosphate have been observed in the subsurface flow at drainage lines below the Sappi site, which has a fairly shallow soil over a shale layer with low permeability. However, no significant increases in nitrate or phosphate have been detected over the monitoring period in any of the boreholes located between the sludge entrenchment sites and the nearest downslope streams. After three years the phosphorus and potassium levels in the soil immediately around the sludge are raised, but within less than a metre are no different to background levels.

After three years there is no significant difference between the nitrogen levels in the sludge, in the soil around the sludge and in the background soil. A set of very well controlled leachate monitoring trials on different soils on sloping ground (which are ongoing) show that after four months less than 0.2% of the nitrogen has leached out of the sludge, and less than 0.004% of the phosphorus has leached. While some of the N and P have been taken up in the trees, this will only account for a small percentage of the nutrient loading. It is probable that much of the P has bonded with clay particles in the soil in the immediate vicinity of the sludge and has not moved far, while it is probable that much of the excess N introduced to the soil has been recycled back to the atmosphere by nitrifying and denitrifying bacteria. Further work is required to better understand these natural processes.

Can one make use of the nutrients in the buried sludge, and what might such use be worth?

In the trials conducted as part of this research the results indicate that timber tonnage will increase by up to 50% for plots with entrenchment relative to those using conventional methods of fertilisation. Over a 10 year growing cycle this would translate into increased revenue of ZAR25 000 at current prices. This is less than the cost of entrenching the sludge, but it does nevertheless offset the cost of the sludge disposal.

How should one go about burying sludge in the ground and what will this cost?

Although the Umlazi and Sappi trials have not detected any negative environmental effects, it would make sense to apply smaller amounts of sludge more often if one is to maximise the nutrient uptake in the crops which are intended to benefit from the process. However, that said, it would be inefficient and expensive to bury very small amounts of sludge.

Sludge entrenchment lends itself to labour intensive methods, which maximise employment. The sludge should be transported in sealed drums to prevent spillage and wastage. These drums should be sized appropriately for labour intensive loading, offloading and haulage methods (i.e. not more than say 70 litres of sludge per drum). Trenches should be dug no more than a spade width (300 mm) and 400 mm in depth. These trenches should be filled with sludge to a depth of 300 mm and then backfilled. The surplus soil should be mounded over the trench as the sludge will reduce approximately 50% in volume as it dewaters and decomposes. If trenches of these dimensions are dug between all rows in a plantation (assuming a spacing between rows of 3 metres) the total amount of sludge buried will amount to approximately 140 dry tons/hectare.

The cost of sludge entrenchment can be expected to cost approximately ZAR 60 000 per hectare, assuming an entrenchment rate of 300 m^3 of wet sludge per hectare and a haulage distance of 30 km, i.e. ZAR200/m^3. At approximately ZAR3.20/m^3.km transport quickly becomes the dominant factor in the cost calculation. Further costs will be incurred establishing leachate and groundwater monitoring well points, which might amount to several hundred thousand South African rands. A monitoring establishment cost of R10 000 per hectare is a reasonable budget figure (assuming that one monitoring well will cover at least 10 hectares).

Other methods of sludge disposal, for example using landfills, incineration, pelletising and composting can be considerably more expensive.

For more reading:

Text, figures and photographs in this article were extracted from WRC Research Report K5/2097 by Partners in Development.

References:

Still, D., Lorentz, S. and Adhanom G. (2014) Entrenchment of Pit Latrine and Waste Water Sludges – An Investigation of Costs, Benefits, Risks and Rewards. WRC Research Report K5/2097, Pretoria, South Africa.

The full report can be downloaded from:

http://www.wrc.org.za/Pages/KnowledgeHub.aspx

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IN THE SPOTLIGHT

WATER FOR PEOPLE UGANDA

Water for People (WTF) is a United States of America registered non-profit organisation that started in the 1990's. The organisation has grown to include several branches in the developing world including three in Africa (Uganda, Rwanda and Malawi). The organisation aims to “bring together local entrepreneurs, civil society, governments, and communities to establish creative, collaborative solutions that allow people to build and maintain their own reliable safe water systems. Empowering everyone transforms people's lives by improving health and economic productivity to end the cycle of poverty”(see: https://www.waterforpeople.org/).

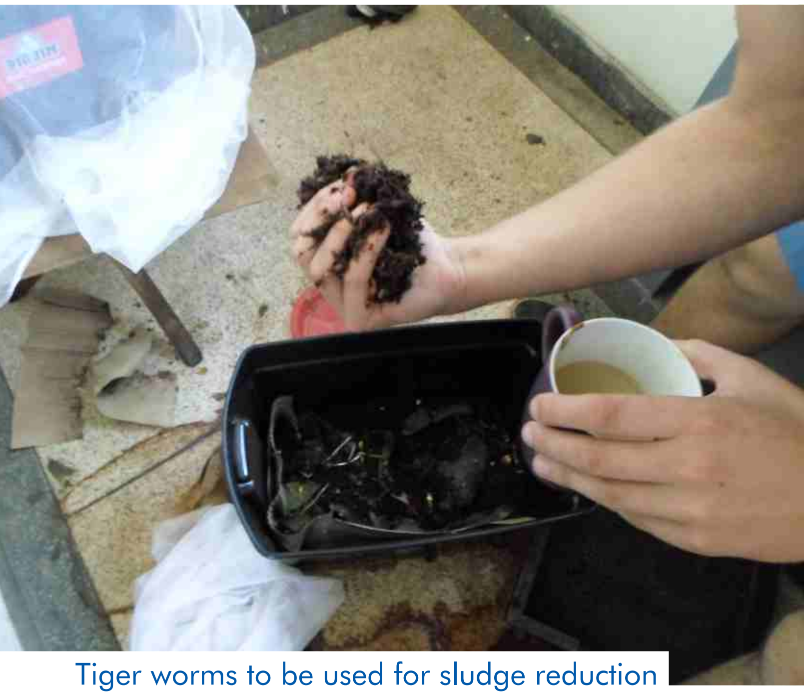
WTP Uganda was awarded a research contract for the “SaniHub Project” by the Water Research Commission (WRC) in South Africa. The research project falls under the Sanitation Research Fund for Africa (SRFA) Project established by a grant to the WRC by the Bill & Melinda Gates Foundation's Water, Sanitation and Hygiene Programme. The SaniHub Project through its Sanitation as a Business Programme is developing micro-enterprises offering semi-manual pit emptying using the simple, but not very effective, Gulper technology. These enterprises charge householders USh 30,000 ($11.5 USD) to remove 250 L of sludge which equates to $46 per ton. Removing 90,000 tons of pit sludge per year would have a value of $4,140,000. WTP have been slowly working on developing new pit emptying and treatment technologies in Kampala for the last eighteen months and have learnt, through experience, how to integrate technology development into sanitation businesses. To be successful a new technology, not only has to empty thick sludge from the bottom of a pit, it also has to be made and supplied locally, marketed, and also enable entrepreneurs to run commercially viable business.

Semi-mechanised pit emptying device being put together by WTF team member.

Through the project, simple sludge removal and treatment technologies are being developed and optimised. The aim is to refine this model by offering services to unplanned areas in Kampala before expanding it to other urban areas of the country. By doing, it envisaged that the improved pit emptying equipment and disposal technologies will allow pit emptying enterprises to service a larger number of households at a reduced cost and therefore make sanitation entrepreneurship more attractive in high density slum areas.

> *“service a larger number of households at a reduced cost”*

A pilot decentralised dewatering plant under investigation by the WTF team.



Tiger worms to be used for sludge reduction

Black soldier fly larvae are being grown

This project has been designed to overcome pitfalls of traditional academic based research projects that tend to develop new technologies in isolation of the market and then attempt to hand-over the results to often unwilling recipients. It aims to design technologies that are both more inclusive and closer to the customer. It will follow an action based research methodology which has the advantage in that the recipients are included from the outset and therefore have more buy-in and understanding of the development process.

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SNAPSHOT

RECENT HIGHLIGHTS FROM THE SRFA PROJECT

Snapshot is a new segment of the Sanitation Matters Magazine. It presents the most recent highlights emanating from the Sanitation Research Fund for Africa (SRFA) Project – a joint initiative between the WRC and the Bill & Melinda Gates Foundation to develop local solutions and capacity for faecal sludge management. Twelve research teams from 8 different African countries have been selected for the SRFA Project. Snapshot aims to provide the sanitation community with the most up-to-date highlights from this initiative.

SRFA Project

The Ubuntu-San Project

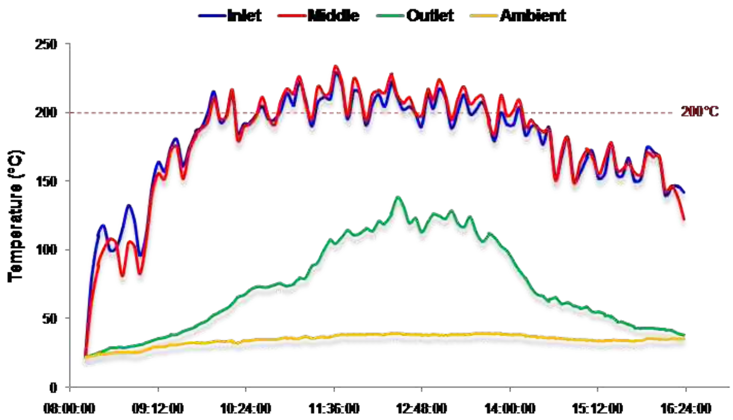
The 'UbuntuSAN' Project was commissioned by the WRC under Research Project K5/2294/11. The Project is led by ATL-Hydro, a water and wastewater consultancy based in the Western Cape, and also involves academics and post-graduate students from the Cape Peninsula University of Technology.

Fig.1. Research team engaging with community members. The smokeless, top-lit updraft stoves that would eventually use biochar can be seen in photo.

The UbuntuSAN concept is centred on the development of a decentralised mobile parabolic solar pyrolysis unit, the design of which will be refined to be user friendly to non-educated personnel and to optimise the process. The research team aims to sanitise faecal sludge and convert it to biochar which can then be utilised for community stove fuel, agricultural compost and / or low voltage electricity generation. The Project Team will test the sanitising unit in satellite community ablution blocks and have already started evaluating community uptake of technology add-ons such the pyrolysis stove.

The first solar prototype has been constructed and was made from an aluminium frame with PVC solar panels. Sunlight is reflected onto an extruder tube through which sludge passes through. Thermocouples have been added onto different points on the extruder tube to record the temperature profile of the unit. The research team have developed an operating protocol for unit which will be further refined as the research progresses. So far, the team has produced the best results when the unit is rotated around the wheel base (Fig.1). Temperatures of around 200°C can be achieved for about 6 hours on a sunny day with no cloud cover.

Unit being rotated around wheel axis



Temperature profile on the extruder tube onto which is reflected onto.

Fig.1. Solar sanitising unit developed by ATL-Hydro.

Experiments testing different extruder designs have also been completed. A batch of synthetic sludge was made up and the efficiency of the extruder designs evaluated (Fig.2).

First extruder design blocked from cellulose

First (left) and second extruder (right) plate designs

The extruder plate with large holes extruded x5 more slurry

Fig.2. Extruder testing and modification for solar sanitatising unit.

More information: http://www.facebook.com/pages/Ubuntu-SAN/606064576099341

The SaniHub Project

Profiled earlier in the magazine, Water for People Uganda was commissioned by the WRC to investigate a variety of technological options across the sanitation chain and linking this to community entrepreneurship. The research team have recently completed the evaluation of different semi-mechanised pit emptying tools by gauging the time and number of operators required to prime the devices, the mass of sludge pumped in a specific time using synthetic sludge of different shear strengths (Fig,3), and finally gaining feedback from pit emptiers that operate in Kampala (see insert). The research team have submitted an abstract to the FSM3 Conference in Hanoi, Vietnam, based on the findings observed and plan to publish a journal article if the abstract is accepted. The research team have

also recently commissioned a pilot decentralised dewatering faecal sludge treatment plant and have begun performance evaluation of the plant.

Fig.3. The research team testing each semi-mechanised device using synthetic sludge of different shear strengths. After testing, they field tested the devices with local pit emptiers to gain feedback on which technology they preferred.

Pit Characterisation in Malawi

The University of Malawi – Polytechnic are investigating the pit process in peri-urban areas in Malawi through Research Project K5/2300. Comprehensive mechanical, biological and physical tests will be performed on the faecal sludge from different pit toilets to better understand the degradation process in these toilets, how fast they fill up and guide pit emptying policies and/or strategies.

The Project Team recently completed a pit characterisation campaign in Blantyre, Malawi. One of the major hurdles experienced by the team was obtaining samples from pit toilets. The team planned on working together with pit emptying institutions but encountered a series of challenges which made collection of representative samples difficult. First, many of the pit emptiers added chlorine to the pits before emptying. In addition to chlorine, large volumes of water were added to pit to fluidise the sludge for emptying purposes, and the pit sludge was often mixed during the removal of non-faecal matter. And lastly, the unplanned nature of the settlements often made it difficult for the team to access pit toilets using vacuum tankers. Due to these challenges, the research team looked at fabricating their own suction-based sampling tool but found that the tool was not robust enough to handle the varying wetness of sludge encountered. Eventually, the team used a trailer mounted motorised vacuum pump that was hired from a private pit emptying; this

option seemed to work the best (Fig.4). Around 20 pits toilets sampled. The pits were generally 1.5 to 1.7 m deep, and were either lined or unlined.

Pressure washer used by emptiers

Suction sampling tool fabricated by team

Vacuum pump hired from private company worked the best

Fig.4 Array of sampling tools tested.

The results from the campaign in Blantyre showed a decline in *E.coli* count with pit depth (Fig.5). The COD increased with pit depth and variations in volatile solids, moisture and ammonia did not compare well with trends obtainable in literature. The preliminary results suggest that local conditions do impact on the degradation that occurs in faecal sludge.

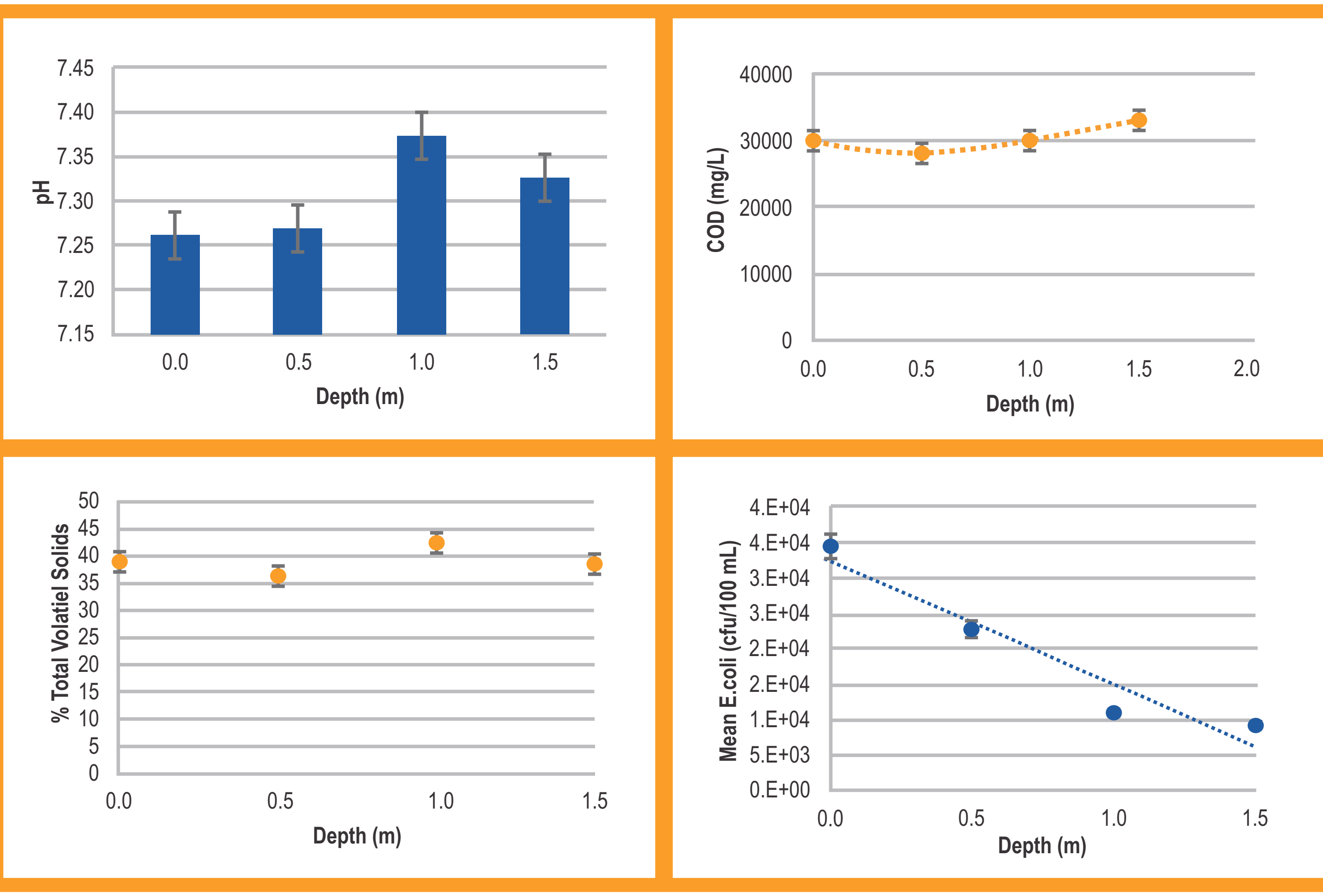


Fig.5. Selected measured parameters from the pit characterisation studies in Malawi.

For more information:

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Web: http://forum.susana.org/forum/categories/99-faecal-sludge-transport/3109-sanitation-research-fund-for-africa-srfa-managed-by-wrc-in-south-africa-pit-characterisation-and-pit-emptying-updates#3109

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