



The Newlands Mashu Research Site

Introduction

As far back as 2003 eThekweni Municipality recognised the need to work with local tertiary organisations and a Memorandum of Understanding (MOU) was signed with three tertiary educational institutions (the University of KwaZulu-Natal, the Durban Institute of Technology and Mangosuthu Technikon).

The aim of this MOU was to strengthen collaboration on research and development, capacity building and knowledge management, in order to achieve growth and development, in keeping with the Municipality's Integrated Development Plan (IDP). Following on from this MOU, a number of Memoranda of Agreement (MOA) have been signed between the Municipality and the University of KwaZulu-Natal outlining specific collaboration undertakings within various departments in the University. The first MOA specific to

the Water and Sanitation Unit (EWS) and the Pollution Research Group (PRG) was signed in February 2006 and formalised the desire of both parties to promote the knowledge base in water and sanitation delivery and to expand research capacity and expertise in this field.

There have been a number of research projects undertaken, the results of which have assisted EWS in their service delivery. These projects include not only technical issues, but also social and economic aspects. In some cases, these projects are funded solely by the EWS, while in others, joint funding from the South African Water Research Commission (WRC) and other international sources such as the Bill & Melinda Gates Foundation (Gates foundation), BORDA (Bremen Overseas Research and Development Association) and Eawag (Swiss Federal Institute of Aquatic Sciences and Technology) is sourced.



The Newlands Mashu Research Site

OVERVIEW

The **Newlands Mashu Agricultural Hub** situated in Newlands (north of Durban, South Africa) forms part of the Agricultural Management Unit (AMU) in the Parks Department of eThekweni Municipality. It was established in 2010 and it functions as a bio-intensive vegetable production hub. It follows the agricultural service delivery model of promoting household food security, enabling people to create commercially sustainable economic opportunities through agriculture, and the redressing of imbalances. Training is provided on-site to members of the community in aspects such as the correct handling of tools, sowing of seeds, mulching, and production of compost. The Agricultural Hub was felt to be the ideal site

for integrated research on sanitation, decentralised wastewater treatment, nutrient recovery and recycling, and agricultural trials and resulted in the establishment of the Newlands Mashu Research Site. The Newlands Mashu Research Site provides a controlled and safe environment where sanitation systems, resource recovery, and agricultural recycling of recovered resources can be evaluated and developed. Trials at the site are part of the eThekweni Municipality's long term strategy for the development of sanitation systems for both existing and new housing projects. The research focus encompasses several important life cycle considerations that support planning for services that extend beyond a single goal of providing sanitation.



The Newlands Mashu Research Site

CONTENTS

Overview	3
Main focus	5
DEWATS	6
VUNA	8
Use of waste products	9
Facilities	10
Laboratory	10
Toilet design	11
Urine diversion toilet	11
Low flush toilet	11
Contacts	Back page



MAIN FOCUS

The main focus areas of research at the Newlands Mashu Research Site are to:

- Explore and test new sanitation technologies
- Close the nutrient loop by recycling and returning nutrients to soil from properly sanitised waste streams (urine, faeces, wastewater) for use in agriculture
- Test and evaluate the use of sanitation-based fertiliser products in agriculture in a controlled and safe environment

This is achieved through collaboration with various organisations that conduct research activities and operate pilot plants at the site:

- **University of KwaZulu-Natal**
Pollution Research Group (PRG)
- **University of KwaZulu-Natal**
School of Life Sciences
- **University of KwaZulu-Natal**
Crop Sciences Department
- **BORDA** - Bremen Overseas Research & Development Association
- **Eawag** - Swiss Federal Institute of Aquatic Science & Technology
- **Durban University of Technology**
Institute for Water and Wastewater Technology

The research focus at the Newlands Mashu Research Site is holistic, yet does not incorporate all elements of a sanitation-recovery-and-reuse system. Related questions concerning user satisfaction, operational costs for collection, delivery, and maintenance, and safety for occupational workers and end users are other research projects that are underway with partners located both in South Africa and abroad.

The results from the research that is conducted on the site form a part of the city's bigger strategy to support planning for greenfield housing projects outside the waterborne edge, which is a major priority, and for the provision of sanitation in informal settlements.

The Newlands Mashu Agricultural Hub and Research Site support the need to ensure that the City has all the necessary resources to test various sanitation systems and related activities before going to scale. This is vital for sustainable service delivery. Equally, trials at the research site will help the City with long-term planning and budgeting to ensure demands can be met not only with respect to project roll out, but also from a maintenance perspective.



DEWATS

The Decentralised Wastewater Treatment System (DEWATS) , was constructed in 2010 as a demonstration and research plant. The design of the small wastewater treatment system was informed by practical experiences of BORDA, and knowledge gained from extensive sanitation research conducted by the PRG.

Decentralised, modular approach to sanitation

DEWATS philosophy incorporates flexible sanitation solutions with many possible applications. They are modular, adaptable systems that combine low-technology treatment components that can be locally engineered, supplied, built, operated, and maintained. DEWATS can be designed to manage and treat domestic wastewater, pit latrine sludge, and organic industrial and institutional wastewater. DEWATS consider not only the technical hardware (i.e. DEWATS modular system), but the local economic and social conditions as well.

DEWATS components

Settler - The settler is the primary sedimentation chamber, where solid particles are separated by gravity.

Anaerobic Baffle Reactor - The Anaerobic Baffle Reactor is an improved septic tank with baffles to separate the tank into 4 or 7 chambers. The baffles force the wastewater to flow up and down through the chambers, increasing contact with the anaerobic sludge, which digests a large portion of the organic matter.

Anaerobic Filter - The Anaerobic Filter consists of a bed of coarse stones which retain the remaining solid particles and further degrades organic matter.

Vertical Planted Gravel Filter - The Vertical Planted Gravel Filter provides secondary wastewater treatment which takes place in the root zone of wetland plants. The pre-treated wastewater is released onto the surface of the gravel filter several times each day, where it flows vertically through the planted sand filter. The aerobic conditions further degrade organics and provides some nutrient and pathogen removal.



Horizontal Planted Gravel Filter - The Horizontal Planted Gravel Filter provides additional treatment as the wastewater flows horizontally through the planted gravel bed. Organics are further degraded, and more nutrients and pathogens are removed.

Key benefits of DEWATS

- No energy input required;
- Simple to operate and maintain;
- Semi-centralised technology and small footprint;
- Complies with SA effluent discharge standards;
- Fails safely;
- Can be placed in or near the community;
- Minimal equipment with a scrap value to reduce the likelihood of theft; and
- Potential to produce biogas and to reuse treated effluent for irrigation.

Ongoing Research

Designed for demonstration and research purposes, the DEWATS is a focus of ongoing wastewater treatment and agricultural research. Researchers from PRG and other institutions are investigating the optimisation of the treatment processes and the utilisation of nutrients from the effluent for agriculture. Results from this research will impact the design, construction, and maintenance of DEWATS in Durban and throughout southern Africa.





Valorisation of Urine Nutrients in Africa (VUNA)

In 2010, eThekweni Water and Sanitation (EWS), teamed up with Eawag to develop a new and improved sanitation system that allows for nutrient recovery from urine in order to promote toilet use.

The project had three basic objectives:

- Promote the use of toilets by giving urine a value;
- Produce a valuable fertiliser; and
- Protect the environment by reducing pollution.

Before the start of the VUNA Project, the urine from urine diversion toilets in eThekweni was not collected but was left to infiltrate into the ground. To provide urine for the research on urine treatment a urine collection system had to first be established. Once this was established, the urine was processed into two types of fertilizer: a solid, phosphorus rich fertiliser (struvite) and a concentrated liquid containing all the nutrients. The process of producing struvite is initiated by adding a soluble magnesium source. The precipitation process produces solid struvite ($\text{MgNH}_4\text{PO}_4 \cdot 6\text{H}_2\text{O}$) from the urine solution during a chemical reaction, and nearly all the phosphorus can be precipitated from stored urine. The concentrated liquid is produced via nitrification of the urine in a moving bed biofilm reactor (MBBR) followed by vacuum distillation.





Assessing the use of waste products in agricultural trials

Various waste products from on-site sanitation systems and decentralised wastewater treatment systems can be used beneficially in agriculture as sources of water and nutrients. Studies have been conducted which investigate the effectiveness of using these products in agriculture. The products that have been tested are: effluent from DEWATS, struvite, concentrated nitrified urine and pellets from the LaDePa (Latrine Dehydration and Pasterurisation) which processes sludge from VIP toilets. Trials are being conducted on a laboratory scale using plants in pots, and in field trials.

The field trials compare two water sources (DEWATS effluent, and tap water with fertilizer) using drip irrigation. For each water source, four different crop species have been selected on the basis of microbial risk and importance to local diets.

These are Swiss chard, dry bean, maize and taro (amadumbe). Pot trials have been expanded to include the use of LaDePa pellets, struvite and nitrified urine concentrate on soy bean, indigenous vegetables, maize and perennial rye grass.

Aspects that are investigated include plant growth variables such as plant height, number of leaves per plant, chlorophyll content and biomass. Plant tissue analysis is also done to determine the content of important mineral elements such as nitrogen, phosphorus, potassium and selected micronutrients. The risk of pathogen contamination to workers and potential consumers is also assessed.

The knowledge gained from these studies will be important in estimating the volume of DEWATS effluent that may be needed to irrigate a specified area of land for different crop species. The outcome of this investigation will assist the municipality in the roll out of further DEWATS and possibly linking these to community gardens.





Laboratory

Laboratory facilities are available on-site. The laboratory is used for sample preparation and analysis.

The following equipment is available permanently:

- Oven
- Furnace
- Vacuum pump
- pH/Electrical Conductivity Meter
- Test tube heater
- Spectrophotometer
- Balances

On an ad-hoc basis, the following equipment can be found:

- Digester for COD analysis
- Respirometer
- Centrifuge



Facilities

In addition to the DEWATS and the agricultural trials, the research site also houses other facilities including:

- Offices
- Laboratory
- Testing of dry and low flush toilets
- Weather station
- Containerised DEWATS
- Growing tunnels



Toilet design

The research site provides the ideal setting for the testing of different toilet designs. Urine diversion toilets and low flush toilets are demonstrated at the site and are used by researchers and visitors at the facility.

Urine Diversion Toilet

In 2002, the eThekweni Municipality introduced urine diversion toilets to the under-served communities inside the city's recently extended metropolitan boundaries. The urine diversion toilet is a dry, double chamber toilet. Faeces and urine are separated at source by way of a specially designed pedestal. The separation of the excreta at the source makes it easier to process the different streams as they are relatively pure. Without the presence of urine in the chamber, the solids can dry faster and are easier to handle. The urine is directed to a

soak-away. Installation of urine diversion toilets was part of the municipality's overall strategy to provide sanitation for all citizens. These toilets were chosen because providing a pipe network and a treatment system would have been prohibitively expensive and impractical due to the hilly landscape. To date, about 85 000 urine diversion toilets have been installed in eThekweni.



Low Flush Toilet

The low flush toilet bridges the gap between ventilated improved pit (VIP) latrines and flushing toilets. These toilets are popular in Asian countries. In South Africa, these toilets have been tested in areas around Pietermaritzburg since 2010 and have resulted in high user satisfaction, no blockages and low maintenance. The low flush toilet uses 1-2 L of water per flush and grey water can also be used for flushing. The toilet is connected to two leach pits, once the one pit is full, the users can switch to the alternate pit. The pipe from the pedestal

has a water seal which prevents odours from the pit. The drain has a small diameter and therefore prevents large objects from being flushed down the toilet; this extends the lifetime of the pits. The low flush system is seen as the middle ground between dry sanitation and full water borne systems.





Contacts

eThekwini Water and Sanitation

Teddy Gounden: Teddy.Gounden@durban.gov.za

Lungi Zuma: Lungi.Zuma@durban.gov.za

Pollution Research Group, University of KwaZulu-Natal

Chris Buckley: buckley@ukzn.ac.za

Susan Mercer: mercer@ukzn.ac.za



September 2015

Second edition

prg.ukzn.ac.za