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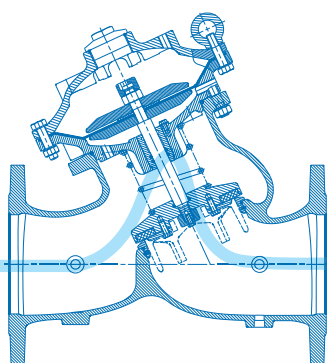
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ON THE COVER

Mpho Mookapele, acting CEO of the EWSETA, and, notably, the overall winner of the South African Institute of Chartered Accountants' Top 35-Under-35 2019 Competition, talks about the role the EWSETA plays in driving skills within two of the country's most critical sectors. **P4**

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"For us to achieve radical transformation in the sanitation sector, we need a sanitation revolution." **P36**



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ACTION NOW

As we enter a new year, we find South Africa facing a mammoth task in securing water supply.

The Eastern Cape was declared a drought disaster area in October 2019 and continues to be the province worst hit by the ongoing drought. The provincial water storage has plummeted to a low of 45.5% and the situation is dire.

Late last year, Nelson Mandela Bay Municipality reported that the combined capacity of the major supply dams for the metro sat below 34% and abstraction has been halted at the city's largest supply dam, Impofu Dam, due to low water levels.

AgriSA reports also that around 30 000 farmworkers have already lost their jobs due to the drought and concern is being raised over how the drought may affect the country's food security.

Learning from Cape Town

Residents in drought-stricken regions are being urged to reduce their consumption to 50 litres of water per day – the same target Cape Town had when facing its own 'Day Zero' crisis.

Listening to Peter Flower, director: Water and Sanitation at the City of Cape Town during the drought, speak about how his team managed the crisis, it is clear that public buy-in was absolutely crucial to meeting targets and ultimately avoiding a system shutdown (read more on page 26).

Key to this success was communication and providing citizens with technical information. Another success was the City Water Map, which graphically indicated consumption per erf and led to residents putting pressure on their peers to comply.

Cape Town's efforts are highly commendable, and it is essential that South Africa's other cities take heed

and learn from them. Unfortunately, little information appears to have been made available by Eastern Cape municipalities, who should be learning from Cape Town and adopting similar strategies.

Long-term approach

While it is essential that the sector and society pull together to get through the current drought, it is equally important that we change the whole country's approach to water. As demand continues to grow and climate variations place increasing stress on water systems, South Africa absolutely cannot follow a business-as-usual approach to water.

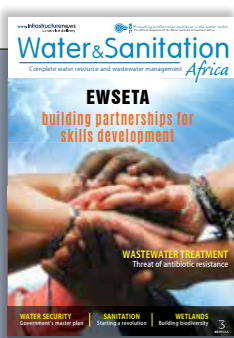
After years in the making, Minister of Human Settlements, Water and Sanitation Lindiwe Sisulu finally launched the National Water and Sanitation Master Plan late last year. This is encouraging because the plan addresses the top-priority issues confronting the water and sanitation sector, and promises to monitor performance and hold the relevant role players accountable (learn more on page 24).

Ultimately, the plan seeks to drive South Africa into a 'new normal' for water that will see water becoming more expensive, everyone using less water for the same activities, and everyone (except the indigent) paying for water and sanitation services.

For far too long has water been taken for granted. In fact, Africans use 64 l/day more than the global average. Now, as we are faced with a potential 17% water deficit by 2030, a concerted effort is needed to get the public on board to reduce consumption and understand the vital importance of conserving water. There is no time to waste – we need action and we need it now. **3S**



Danielle



COVER OPPORTUNITY

In each issue, **Water & Sanitation Africa** offers companies the opportunity to get to the front of the line by placing a company, product or service on the front cover of the magazine. Buying this position will afford the advertiser the cover story and maximum exposure. For more information, contact Hanlie Fintelman on +27 (0)11 467 6223, or email Hanlie.Fintelman@3smedia.co.za

Partnering for skills development



Mpho Mookapele, acting CEO, EWSETA

Mpho Mookapele, acting CEO of the EWSETA, and, notably, the overall winner of the South African Institute of Chartered Accountants' Top 35-Under-35 2019 Competition, met with **Water&Sanitation Africa** to talk about the role the EWSETA plays in driving skills within two of the country's most critical sectors.

Driving skills development in South Africa is the responsibility of numerous stakeholders, which includes government at national, local and provincial level; public and private training providers; employers and industry; and, very importantly, South Africa's 21 Sector Education and Training Authorities (SETAs).

The Energy and Water SETA (EWSETA) is responsible for the implementation of the National Skills Development Plan (NSDP) 2030 within the water and energy sectors.

The role of SETAs in South Africa's skills development landscape is one that many people are still unsure of. Very briefly, what does the EWSETA do?

MM Many people mistakenly believe that the EWSETA is a training provider, which is not the case. To deliver on our mandate, we are required to: register and establish learning programmes; approve Workplace Skills Plans (WSPs) and Annual Training Reports (ATRs); disburse mandatory grants to levy-paying employers and discretionary grants to employers, skills development providers, public education and training institutions, learners, NGOs, CBOs,

cooperatives and worker-initiated programmes; as well as promote learnerships, internships, apprenticeships and other training programmes.

If you were to identify the top three skills challenges facing the water sector, what would they be?

The sector is characterised by an ageing workforce – approximately 14% being older than 55 – which contributes to hard to fill vacancies. Another challenge is a severe lack of requisite technical skills both within the artisan environment and high-level professionals. Finally, the majority of graduates do not possess practical workplace experience, which is a key success factor for these young people.

How does the EWSETA respond to these challenges?

There is no easy answer to this question; however, if I were to identify two critical success factors, the first would be research into the sector with a view to determining how the EWSETA can most effectively respond to the skills shortages within the boundaries of limited financial resources. Our approach needs to be a

'smarter thinking – greater impact' one.

The second is employer participation in our projects and programmes.

What sort of employer participation does the EWSETA receive?

Not enough! We have placed focus on mobilising our employer base over the last 12 to 18 months and while we have seen some growth in employer participation, there is still extensive room for improvement.

In the next few months, the EWSETA will be hosting a series of industry collaboration sessions at various centres around the country. We are inviting the relevant provincial governments to join us at these events with a view to establishing dialogue and kick-starting cooperation that will see the EWSETA, employers and provincial government structures working together to drive skills development within the context of the Provincial Growth Development Strategy in each province.

To many, accessing SETA funding is a topic that is shrouded in mystery. How does an employer access funding?

Employers can access two types of funding. The first is mandatory grant

funding that a registered employer can access by submitting an annual WSP and ATR by 30 April each year. In fact, during the months of February and March, the EWSETA will be hosting a series of Skills Development Facilitator capacitation sessions around the country. These workshops will assist organisations with the nitty-gritty of the WSP and ATR process. The details of these workshops will be made available on our website. Employers who submit a WSP and ATR that are approved by the EWSETA will be eligible for mandatory grant funding.

Employers who qualify for mandatory grant funding are also eligible to apply for discretionary grant funding. Each year, we advertise our discretionary grant funding window in the media, on social media, on our website and through direct communication with our registered employers. This is one area where we really want our employers to step up to the plate and submit proposals for discretionary grant funding, as it is here that employers can really open up their places of work as places of training.

For more detailed information, I urge interested employers to visit our website and download the brochure entitled 'Driving Skills Development – The Role of Employers and Partnerships'. This brochure includes a detailed explanation of the WSP and ATR process.

You mentioned research earlier. What role does research play in the activities of the EWSETA?

SETAs are required to facilitate the delivery of sector-specific skills interventions that assist in achieving the goals of the NSDP 2030. It is, therefore, critical for the SETA to develop a Sector Skills Plan (SSP). The key objective of the SSP is to provide a plan of action and direction for skills development in the energy and water sectors. The EWSETA aims to support objective and informed decision-making for skills development through research. The research findings inform the sector skills strategy and guide the SETA in terms of focus of skill development

projects and grant allocations. For example, our SSP determines our top priority skills in the sector and for the water sector, wastewater and reticulation skills appear annually. But our research also indicates that skills in other emerging areas of the water sector are also important, such as water resource management, water scarcity and security, as well as the water-energy-food nexus. So when the water sector applies for discretionary grant funding, we would like to see more innovative projects other than just wastewater and reticulation.

If any employers in the water sector wish to participate in the provincial industry collaboration sessions you spoke of, who should they contact?

They can email our marketing and communications manager Elfrieda Tyrer at elfriedat@ewseta.org.za.

Any closing comments?

There is a great deal to be done and we cannot possibly do it alone. While our Strategic Plan, Annual Performance Plan and SSP are driven by the experienced, qualified and

dedicated workforce employed by the EWSETA, it is only through the active involvement and commitment of our many stakeholders in the sector that we will see a skills development shift within the water sector. **35**



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“To meet our mandate and contribute in a constructive manner to the vision of the NDP, we are reliant on partnerships with a variety of stakeholders, particularly industry. We need employers to open up their workplaces to our learners so that they are able to complete their practical training and gain valuable work experience.”

**Mpho Mookapele,
acting CEO, EWSETA**

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**3
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MEDIA**

We are at the start of a new year and the next decade. It should remind us that we only have 10 years left to achieve the 2030 Sustainable Development Goals (SDGs). In our case, we must focus on SDG 6: Clean Water and Sanitation.

New Year's Resolutions

At this time of the year, most of us will look at New Year's resolutions, and pledge our best efforts in this regard. Let us hope that the worst-case scenario will be cancelled gym memberships. As a sector, what New Year's resolutions do you think we should pledge to achieve? I think they should align to sector-driven plans already out there.

The WWF 2017 report *Scenarios for the Future of Water in South Africa* (bit.ly/3ahXRt0) and the *National Water and Sanitation Master Plan Volume 1: Call to Action* (bit.ly/2NnhJB4) should certainly guide and inspire us.

However, I think it's important that as organisations and individuals, we analyse and incorporate some of this into our personal action plans. As Benjamin Franklin famously said, "If you fail to plan, you are planning to fail."

But do these action plans consist of goals that we actually want to help achieve?

Achieving goals

Intrinsic goals are ones that reflect our inner selves and our honest aspirations. They tend to be those we actually set our minds to achieving. Studies show that people display more resilience when they are thwarted in their progress when a goal is intrinsic, in contrast to one which is extrinsic.

Extrinsic goals are those we may go after but are motivated to achieve because they are set by other people (our parents, spouses or friends), culture, or society as a whole. This suggests that we should try to use the extrinsic sector goals and convert them into intrinsic personal goals. This way we can be honest and strive to play our part.

The WISA 2020 Conference is based on the theme #AllHandsOnDeck. This is very relevant to us understanding

the role we can play, intrinsically, in achieving our sector goals. This gathering of the largest water sector minds in South Africa will attempt to drive intrinsically every member of the sector to achieve sector goals.

We hope that all our sector leaders will be there, as achieving these sector goals is dependent on every one of us playing our part. We will never all agree on the path and direction of some of these goals, but at least we must agree on the priority areas and our individual roles therein.

Meanwhile, I do hope that 2020 is an improvement on past years, that we will continue to treat each other with respect and dignity, that disagreements become improved areas of communication, and that accountability increases in all spheres of our sector. May it be a blessed year for each one of you, your families and communities. **3S**



2020

Dr Lester Goldman,
CEO, WISA

Ready for water-shedding?

We are used to electricity load shedding, but water is different because life depends on it. Unfortunately, many parts of South Africa have either been subjected to, or very close to, a water-shedding scenario in the past, without being adequately prepared.

By Achim Wurster, chair, WISA

At a global scale, climate change is making water resources less reliable. Currently, the focus is largely on limiting the human factors that have induced climate change, with very little effort on building resilience to cope with it, despite the fact that climate change is happening regardless of attempts to limit it.

The status quo

At national level, planning to ensure a reliable water resource seems good, but implementation of the required infrastructure to meet the growing future water demand is inadequate. At the same time, we are destroying some of our last remaining clean water sources with proposed developments in key water catchments and wetlands.

Our regulator is also not effective at enforcing proper treatment of waste streams that are returned to rivers.

This leaves river systems degraded, often forcing the closure of drinking water treatment that cannot cope with

the concentration and type of pollutants present.

At local government level, certain areas are experiencing rapid growth with inadequate allowance for water-related infrastructure to match. Ageing infrastructure with continuous leaks also requires excessive maintenance or replacement.

Many municipalities have only a single significant water source available to them. In times of crisis, municipal communication channels are typically not effective at reaching everyone, resulting in residents missing out on when and where tankers are available with emergency supplies. When water supply returns, the water distribution network often suffers serious leaks due to damage to the pipe network induced by water hammer or pressure fluctuation, resulting in extended water supply interruptions.

On an individual level, many residents think that because they are willing to pay for water they can use as much as they want, despite restrictions and low supply levels. By-law enforcement at municipal level to prevent this is very difficult and often non-existent as a result. In informal areas, taps are often just left to run or are vandalised, wasting large volumes of water.

Building resilience for improved water security

The reliability and security of water supply at the end-user level is decreasing. While I sincerely hope that the various tiers of government get their act together and reverse this trend, the current indications are that the end users will be left with the responsibility to ensure security of supply for themselves. So, how do you as an end user achieve this?

A number of basic principles from various engineering fields and common sense apply, whether the end user is an industrial, business or residential user:

- **Substitute:** Use a different way to achieve the same goal – e.g. dry cooling towers, waterless hand sanitiser and waterless urinals.
- **Reduce:** Use water more efficiently – e.g. low-flow but high-pressure cleaners, low-flow tap aerator nozzles and low-volume dual-flush toilets in bathrooms, drought-resistant plants.
- **Reuse:** Use water more than once – e.g. perform a water pinch analysis on your industrial site, use greywater

from bathrooms or laundry for watering gardens or toilet flushing.

- **Recycle:** With appropriate on-site treatment, all wastewater can be treated and most of it recycled. This is less likely to be a viable option at household level.
- **Multiple sources:** Locate possible alternative water sources that you could use and prepare for access to these – e.g. treated effluent from nearby sewage treatment works for industrial use or rainwater collection tanks, boreholes and swimming pools in your neighbourhood for business or residential emergency non-potable use.
- **Keep a strategic reserve:** For industry and business, this may mean investing in on-site storage tanks. At the household level, this especially applies to drinking, cooking and basic hygiene water where alternative water sources may not be safe. A few sealed water-filled drums or buckets, stored in a cool, dark place, are sufficient for short-term interruptions. During extended water interruptions, these can then be refilled from emergency drinking water sources.

If the first four principles are applied, then the demand for and cost of the last two are significantly reduced. At household level, allowing for a strategic reserve of 10 litres per person per day, together with the first three principles, will provide the basic necessities. The secret is to prepare for this now, while there is time, so that you are ready when water shedding or even just the inevitable normal water supply interruption comes.

Consider also the vulnerable members of our society – the elderly, disabled or child-headed households. They are often most susceptible to the negative effects of water supply interruptions, as they do not always have the physical strength or means to fetch water from emergency water supply points.

Be a leader and water sector ambassador, not just at work, but in community structures through which you can share your water knowledge to build water resilience. To have a resilient water-secure society requires #AllHandsOnDeck on every deck of our ship. Somebody also please wake up the captain! **35**



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A YWP-ZA conference with a twist

The Water Institute of Southern Africa's Young Water Professionals hosted their sixth conference from the 20 to 23 of October 2019 at the Durban International Convention Centre, KwaZulu-Natal. This marked the first time this conference was hosted outside the Western Cape or Gauteng. **By Mluleki Mnguni**

The excitement of the province hosting the conference for the first time was visible from the beginning, with the YWP-KZN Chapter and the WISA KZN Branch joining forces to make this event a success. The end results were worth the hard work, as the 6th WISA YWP-ZA Conference treated over 300 delegates to not only amazing technical content but also a rounded experience of the city of Durban and the culture of KwaZulu-Natal, through carefully chosen social events.

The theme for the conference was 'My Water, My Business' and aimed at encouraging active participation and making everyone aware of their role in water management, while also exposing delegates to the business side of water. The conference was intended to be more than just a 'talk show', delivering resolutions around water management issues that can be actioned between now and the next edition.

Media presence

The success of the 6th WISA YWP-ZA Conference was paved from the beginning, with the local organising committee (LOC) hosting a media launch a few months before the event. This was attended by over 40 local media houses and was achieved through partnership with the Governmental Communication and Information System (GCIS) and Umgeni Water.

The media presence helped WISA YWP take centre stage regarding water management, with the conference lead being interviewed by a few radio and television stations, and appearing in a few local newspapers. The focus on generating awareness about water issues translated across the board, with Gagasi FM (a local radio station with over 1.3 million listeners) broadcasting live from the conference's opening networking event.

A few LOC members were again interviewed live on radio, which



Mluleki Mnguni, programme lead for the 6th WISA YWP-ZA Conference

generated more traction and announced WISA's presence and involvement in water issues. Further media presence was noted during the conference, with the conference lead heard encouraging water saving and overall accountability around water management during Ukhozi FM's prime time news (a radio station with over seven million listeners).

The technical programme

Presentations on water businesses and opportunities, water and the Fourth Industrial Revolution and welcome remarks fostering water accountability and business during the opening plenary proved that the technical programme would also live up to the hype. The tone and standard were set and the delegates, including the presenters, delivered their best through participation in the multidisciplinary discussions and technical sessions that followed. The topics for the breakaway sessions were current, engaging and technical. These included:

YWP LOC during a radio interview at Gagasi FM



The 6th WISA YWP-ZA Conference in Durban was truly a water conference with a twist

- Integrated water management
- Water and the Fourth Industrial Revolution
- Innovative water and wastewater treatment
- Industrial and conventional wastewater treatment
- Emerging pollutants
- Ecological infrastructure management
- Water scarcity, a reality
- Integrated water management and governance
- Lessons learnt from Cape Town
- Sanitation solutions for a water-scarce country.

The technical competency demonstrated by presenters and the challenging questions and discussions that followed throughout these sessions made it easy to forget that it was a Young Water Professionals conference.

The difference with this particular conference was also demonstrated through a higher than normal number of workshops held. The nine workshops demonstrated how YWPs are willing to be part of the discussions aimed at improving the status of water provision and management in South Africa.

Most workshops were outcomes driven and produced documents that will be used at various levels of water management. This tied in very well with the intention of making this conference more than a talk show. Additionally, the LOC strategically placed rapporteurs and technical specialists in all the venues to capture the burning issues and to encourage effective discussions, such that the burning issues were not left hanging but unraveled and resolved by the attendees.

A few videos of the attendees' take on water issues, their role in solving them and additional assistance they require were also taken during the course of the conference. These, together with the reports by the rapporteurs, will be

further developed into a position paper to be presented by the YWP during WISA 2020.

Also, a point of difference was the independently sponsored school education session, which ran for a few hours parallel to the main programme. This was attended by a number of high school pupils and educated them on accountability around water management, water saving and conservation, and later exposed the attendees to careers that exist in the water sector through interaction with the conference exhibitors. The session was further meant to make a direct investment that will ensure a bright future for the water sector.

Technical tours and social events

The welcome function was presented as indigenous games hosted at uShaka Marine World. These were meant to give the delegates an experience of the KwaZulu-Natal culture through games that many professionals in the region grew up playing. This also facilitated an easy networking session in a rather informal set-up by the ocean.

The technical tours during the last day of the conference – which ranged from a water treatment plant that supplies more than 40% of the Durban population with potable water to a circular-economy-based wastewater treatment plant and the water tunnel in the Durban harbour – demonstrated the city's approach to water management to the attendees. It additionally presented the city as more than just South Africa's playground but a well-integrated water hub.

The conference was concluded by a South African-style braai at a local shisanyama in uMlazi township, which is the second biggest township in the country.

The 6th WISA YWP-ZA Conference in Durban was truly a water conference with a twist. The organising committee



YWPs during the social networking event at uShaka Marine World



YWPs on a technical tour at the Organica wastewater treatment plant

only hopes this is the beginning of many 'out of the box' events that remain grounded to the values of WISA and the delivering of technical content and value to the attendees.

The team would like to thank the sponsors and partners who made sure that this event would be a success. To Umgeni Water, EWSETA, Magalies Water, eThekweni Municipality, Universal Water Solutions and Mhlathuze Water, your partnerships and contributions to the future of the South African water sector are greatly appreciated. **35**



Delegates at the 6th South African Young Water Professionals Conference



Water and sanitation in Africa



EGYPT

Transforming sewerage coverage

The Integrated Rural Sanitation in Upper Egypt–Luxor (IRSUE-Luxor) project is set to boost sewerage coverage in the region from 6% to 55%, improving the quality of life of citizens most affected by poor sanitation.

By transforming sewerage coverage in Upper Egypt's rural areas, the initiative promotes efficient, equitable and sustainable development through integrated water resources management.

The network will serve approximately 22 000 households, or 161 929 inhabitants. The households in satellite villages that will not be covered by the sewer network will benefit from an improved on-site sanitation service, which involves sludge treatment in wastewater treatment plants.

IRSUE-Luxor contributes to the National Rural Sanitation Programme established by

the Ministry of Housing and Urban Communities, and aims at expanding access to sanitation services from 34% currently (nationwide) up to 60% in 2030.

The operation will support ongoing sector reforms that will scale up wastewater collecting, conveying and treating infrastructure, thus contributing to increased coverage of improved sanitation services, leading to a cleaner and healthier environment.

The project also includes a staff capacity-building component and the strengthening of a performance-based culture within the Luxor Water and Wastewater Company. **35**



NIGERIA

Water sector reforms

Nigeria has received a US\$124.2 million (R1.78 billion) loan for water sector reforms in Akure to improve access to safe drinking water and sanitation. The project is set to address bottlenecks in critical water supply services to households in the densely populated project area.

The Urban Water Sector Reform and Akure Water Supply and Sanitation Project will span five years, from 2020 to 2025, at an overall project cost of \$222.69 million (R3.19 billion). It will provide residents of Akure city access to safe drinking water and sanitation while strengthening the federal government's capacity to facilitate urban water supply and sanitation reforms.

The loan will also help to install sanitation infrastructure for schools, hospitals and markets. On completion, the project will benefit the 1.3 million residents of Akure's city and vicinities. At a federal level, the project's urban water reform component will establish a water and sanitation investment programme that would contribute to the scaling up of the National WASH Action Plan 2018-2030. **35**



MALI

Predicting water-related conflict

A new tool launched by the Water, Peace and Security (WPS) partnership claims to be able to predict water-related conflict up to 12 months in advance, enabling governments and others to intervene early to defuse conflicts.

The tool predicts that water-related conflicts are likely to flare up in Iraq, Mali and India in the coming year. It has also predicted risks in Iran, Nigeria and Pakistan.

As water availability across the globe declines and water-related conflicts escalate, WPS hopes that the new tool will save lives. Trials suggest an 86% success rate in identifying conflict situations where instances of organised violence lead to more than 10 fatalities.

Using machine learning coupled with environmental, meteorological, social and economic data to forecast exactly where organised violence is likely to occur, the WPS Global Early Warning Tool currently predicts the risk of conflict over the coming 12 months across Africa, the Middle East, and South and Southeast Asia, and soon globally.

The tool has been trialled in Mali, where water scarcity is a factor in violence and has resulted in the government and civil society groups meeting to discuss risks. In Mali, WPS expects the conflict zone to extend further south. Here, Dogon farmers and Fulani herders are embroiled in a cycle of deadly violence over increasingly scarce water and land resources, made worse by ethnic differences and the presence of outside armed groups.

In Nigeria, killings and reprisals between farmer and pastoralist groups over scarce water and land resources are reaching a crescendo. **35**



Word from around Africa – including the latest industry, project and development news.



SENEGAL **Hosting the World Water Forum**

Senegal has been selected to host the World Water Forum in Dakar in March 2021. The forum will take place in the Senegalese capital from 22 to 27 March 2021, under the theme 'Water Security for Peace and Development'.

Senegal is expecting more than 20 000 participants from more than 170 countries. "Awarding the hosting of this forum to Senegal is a testament to the urgency of the water

issue for Africa and to the country's commitment to the water agenda," said Abdoulaye Sene, executive secretary of the forum's organising committee.

Sene said the forum will be "a focused, inclusive, integrated, open-ended multistakeholder process, interacting and synergising with international events."

The 2021 event is expected to address the present and future global issues for man and nature, serving as a catalyst and accelerator of universal access to water and sanitation, as well as for the Sustainable Development Goals for Senegal, Africa and the world. **3S**

TANZANIA

Establishing a water grid

The Tanzanian government reports that it is designing a comprehensive plan to establish a national water grid system to provide water in both rural and urban areas.

Although the country's water supply exceeds its demand, the aim is to achieve equitable access for all regions, strategically benefiting regions such as Singida and Dodoma, which have limited freshwater sources.

According to the Permanent Secretary in the Ministry of Water, Professor Kitila Mkumbo, the ministry seeks to establish a water grid similar to the electricity grid.

Tanzania has been steadily increasing water production through small- and large-scale water projects. Since 2016, at least 2 642 projects have been commissioned. A total of 1 544 projects have been completed, 276 projects are in various stages of implementation, and 663 projects are in the pipeline. **3S**



ZAMBIA

Boosting sanitation in Lusaka

A project is currently improving sanitation for Lusaka's low-income suburbs under the Lusaka Sanitation Master Plan (LSP).

The LSP – funded jointly by the African Development Bank, European Investment Bank, German Development Bank and World Bank – aims to provide city-wide sanitation services by 2035 and transform the lives of more than a million Lusaka residents by 2021.

The Lusaka Water and Sewerage Company (LWSC), which is implementing the programme, says about 7 000 households in the George,

Kanyama and Chawama suburbs of the capital will benefit from improved sanitation. The objective is to increase access to sustainable sanitation services to the city's two million residents, especially low-income households, and strengthen the LWSC's capacity to manage sanitation services.

An estimated 70% of Lusaka's residents live in peri-urban areas, which are relatively high-density, unplanned neighbourhoods, largely comprising lower-income residents. About 90% of these townships rely on substandard pit latrines that pose health hazards to the communities. Others use sewers, septic tanks or open defecation.

A total of 57% of Lusaka's water supply comes from shallow wells, which are prone to contamination from pit toilets and through fissures in the underlying rocks.

The sanitation programme will improve sanitation facilities and prevent waterborne diseases. **3S**

WETLANDS and biodiversity

The Peel-Yalgorup Ramsar Site, Australia
(Credit: David Rennie)

The wide range of ecosystem services wetlands provide means that they lie at the heart of sustainable development. In 2020, World Wetlands Day focuses on 'wetlands and biodiversity' and why these matter.

Wetlands are rich with biodiversity and a habitat for a large variety of plant and animal species. However, latest estimates show a global decline of biodiversity, while wetlands disappear three times faster than forests.

Global inland and coastal wetlands cover over 12.1 million km² – an area larger than Canada. But unfortunately, natural wetlands are in long-term decline around the world.

According to Ramsar's *Global Wetland Outlook 2018*, both inland and marine/coastal wetlands declined by approximately 35%, between 1970 and 2015 – three times the rate of forest loss. Although human-made wetlands – which largely constitute rice paddies and reservoirs – almost doubled over this period, now forming 12% of wetlands, these increases have not compensated for natural wetland loss.

The biodiversity link

Wetlands are critically important for their ecosystem services, including food and water security, disaster risk reduction and carbon sequestration. Their economic and biodiversity value far outweighs many terrestrial ecosystems.

Wetlands are among the most biologically productive ecosystems, as they play a major role in the water cycle by receiving, storing and releasing water, regulating flows and supporting life.

Unfortunately, the 2018 Ramsar report shows that water quality trends are mostly negative. Water pollution has worsened in almost all rivers in Latin America, Africa and Asia since the 1990s and is expected to escalate. Severe pathogen pollution affects a third of rivers in these regions and faecal coliform bacteria have been increasing over the last two decades.

Problem areas include untreated wastewater, industrial waste, acid mine drainage, agricultural run-off, erosion and changes in sediment. The report predicts that, by 2050, a third of the global population will likely be exposed to water with excessive nitrogen and phosphorous, leading to rapid algal growth and decay that can kill fish and other species.

The report shows that wetland-dependent species are in serious decline, with a quarter threatened with extinction, particularly in the tropics. Since 1970, 81% of inland wetland species populations and 36% of coastal and marine species have declined.

Similarly, plant growth is strongly influenced by trends in water quality,

particularly nutrient loads. Nutrient enrichment can result in the invasion of aggressive species with high growth rates. Excessive nutrients from sewage, industrial waste, agriculture or aquaculture can cause eutrophication – changing biodiversity, water quality, biomass and oxygen levels. Many wetlands experience cyanobacterial blooms as a result, and hypoxia (oxygen starvation) in coastal ecosystems has increased to include over 500 coastal 'dead zones'.

WETLANDS BIODIVERSITY MATTERS FOR:

- Clean water
- Water supply
- Storm protection
- Climate
- Food supply
- Tourism
- Jobs



Valle Hermoso, Argentina
(Credit: Maria Troitino)



Mai Po Marshes and Inner Deep Bay, China
(Credit: Paul Steyn)



Mubarak Al-Kabeer Reserve, Kuwait
(Credit: Ramsar)

The climate change link

Wetlands regulate nutrient and trace metal cycles and can filter these and other pollutants. Their regulating services influence climate and hydrological regimes and reduce pollution and disaster risks. Wetlands also store the majority of global soil carbon, playing an important role in regulating the global climate.

In fact, peatlands store twice as much carbon as the world's forests, despite occupying only 3% of the land surface. However, climate change may cause wetlands to become carbon sources in the future. This is because the climate mitigation benefits of carbon storage in freshwater wetlands are partially counteracted by release of methane. Wetlands produce an estimated 100 Tg of

methane per year, accounting for 20% to 25% of total global methane emissions.

Higher temperatures under climate change are expected to increase greenhouse gas emissions from wetlands, particularly in permafrost regions where warming leads to permafrost melting.

The way forward

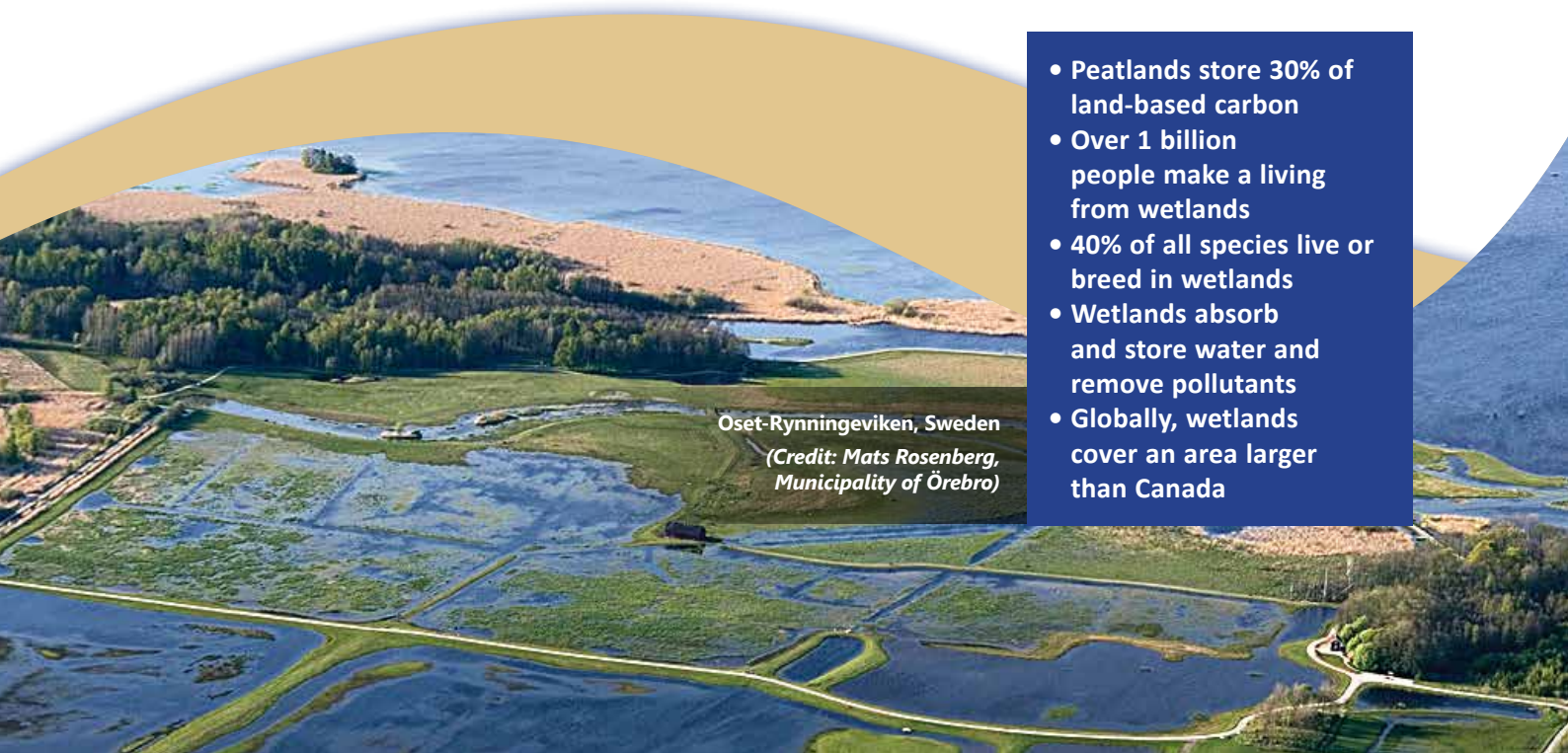
The report is clear that wetlands continue to be lost and degraded through drainage and conversion, the introduction of pollution and invasive species, extraction activities, and other actions affecting the water quantity and frequency of flooding and drying.

As wetland quality and quantity continue to decline, we see both immediate and long-term impacts

on biodiversity, and the reduction of ecosystem services.

The Ramsar Convention, which was signed 1971 to promote wetland conservation and wise use, contains guidance and mechanisms for national efforts to halt and reverse global wetland decline. Opportunities exist to include wetland benefits in the strategies of sectors such as energy, mining, urban development and tourism, promoting the recognition of the benefits presented by wetlands.

Ultimately, the *Global Wetland Outlook 2018* is clear: "Urgent action is needed at the international and national level to raise awareness of the benefits of wetlands, put in place greater safeguards for their survival and ensure their inclusion in national development plans." ³⁵



Oset-Rynningeviken, Sweden
(Credit: Mats Rosenberg, Municipality of Örebro)

- Peatlands store 30% of land-based carbon
- Over 1 billion people make a living from wetlands
- 40% of all species live or breed in wetlands
- Wetlands absorb and store water and remove pollutants
- Globally, wetlands cover an area larger than Canada

Coal mine plans to get wetland flowing again

According to Dr Simon Lorentz, principal hydrologist, SRK Consulting, the mine requested advice on remediating a wetland that had dried out – mainly due to a large trench previously excavated through the wetland.

“Once you dig a ditch in a wetland, the water drains into that space and quickly flows away. This drops the wetland’s water table and the ground dries out,” explains Lorentz.

He notes that wetlands are very sensitive to water levels, requiring that water percolates right through to the surface level. Without sufficient moisture in the peat soil of this wetland area, the ground has begun to burn frequently. While this is possibly due to the veld fires in the area, the ground may also spontaneously combust due to its high content of hydrocarbons.

Rehabilitation

Besides rehabilitation of flow pathways within the wetland, the proposed solution will include controlled and monitored discharges from the mine into the area that was previously a wetland, thereby contributing to the rehydration of the soil.

“If we can get this water to spread out again like it used to – rather than discharging down the slope through the ditch – we will bring all the benefits of the wetland back into play. This includes creating an improved habitat for greater biodiversity, and cleaner water flowing into the nearby river system,” he says.

According to Avril Owens, principal scientist, SRK Consulting, an immediate benefit for the mine is to reduce its health and safety risks arising from fires on the property.

“The significance of a project like this, however, is that we can use nature to address the issue in an entirely sustainable and non-intrusive way,” she says, highlighting that most projects involve a ‘hard engineering’ response, where structures and technology are applied in a highly structured and controlled way to serve their purpose.

“This case presents an opportunity for us to tackle the project quite differently. Here, we will essentially be allowing nature back in so that it can do its work. In many ways, it turns conventional engineering on its head.”

Overcoming challenges

There are a number of challenges to consider, including the roads that disconnect some parts of the wetland

Restoring a wetland on the property of a Free State colliery holds the promise of benefiting not just the mine but the broader environment, including biodiversity and surface water resources in the area.

from others. Culvert beds beneath ground-level roads also have the effect of lowering the water table, and thus draining the wetland. Innovative solutions will be required to address this.

Owens emphasises the importance of the country’s current environmental regulations in balancing the requirements of development and environmental sustainability. She points out that if proper studies had been conducted at the time, these roads through the wetland area would have been designed differently.

“Our plan will take into account all the activities taking place in the area, which impact both currently and historically on the functioning of the wetland. The project will engineer, in a ‘soft’ way, the necessary flow and interconnectedness that will allow the wetland to revive – while still accommodating the mining, quarrying and other activities in the area,” explains Owens.

Multidisciplinary approach

This is not to suggest that the task will be simple. There are multiple aspects to consider, requiring an integrated range of specialised expertise. The project team includes the involvement of a hydrologist for studying surface water contributions, and a vadose-zone hydrologist to focus on the soil water between the surface and the aquifer.

A soil scientist specialising in hydrogeology is also important, helping



Dr Simon Lorentz,
principal hydrologist,
SRK Consulting





Once you dig a ditch in a wetland, the water drains into that space and quickly flows away

understand how water moves from the surrounding hillslopes into the wetland. This is vital in predicting how much water will be coming into the wetland and in the development of strategies to spread it effectively. Lorentz has been engaged in vadose-zone hydrology and hydopedological studies for over 25 years. Experience in various geologies is delivering valuable results as a discipline.

Differential GPS surveying has been applied to generate a detailed topography of the wetland, resulting in accurate vertical data to augment contour maps. A civil engineer will be engaged for the most effective ways of retarding the rapid loss of water by spaced trench-filling impediments. This may involve designing suitable, environmentally friendly rock weirs or using the limited on-site material in the most conducive way. The geochemistry of the soils will also need to be analysed, to know how they will react to the mine's discharge.

The legal aspects of the project are substantial, including the necessary permissions from the Department of Water and Sanitation (DWS) and potentially the Department of Environment, Forestry and Fisheries.

"Once there is a plan regarding what construction and other changes need to be made in the wetland, this needs to be taken to the relevant departments. The rehabilitation of wetlands is an activity requiring authorisation from the DWS," says Owens.

She believes the project has the potential to demonstrate the broader

benefits of working with nature to address developmental challenges relating to water. "We can develop in a sustainable way, but we need to rethink our approach often, so that we integrate our urban and industrial structures with nature."

Lorentz takes a similar view, highlighting how functional wetlands are a valuable reflection of the health of the natural environment. "Modern society's demand for water has clearly led to many interventions in the water cycle, as we control the flow of water for our own needs. Wetlands can provide a useful indicator of where such interventions have gone too far."

South Africa certainly has much work to do in this regard. The 2011 National Biodiversity Assessment revealed that 65% of our wetland types are under threat, with 48% critically endangered, 12% endangered and 5% vulnerable. The report notes that only 11% of wetland ecosystem types are well protected, and that 71% are not protected at all.

This project may, therefore, have significance well beyond its benefits to immediate stakeholders. It is likely to be another important contribution to best practice in the field of wetland remediation. **35**



Culverts and associated drain channels under roads contribute to drawing down the water table



Avril Owens,
principal scientist,
SRK Consulting



DIGITALLY ENHANCED OPERATIONS

As water security becomes a growing concern, it is vital to improve asset management and realign water industry assets in digitally enhanced operations.

Water is increasingly being recognised as a limited, high-value resource. In fact, the UN projects that if current water usage trends continue, the world could have only 60% of the water it needs by 2030.

However, the industry is faced with numerous challenges, including ageing infrastructure, loss of skills, financial constraints, climate extremes, and more. "While the industry attacks such challenges on many fronts, including water conservation and demand management, improving asset performance is one of the most effective strategies a water and wastewater plant or network can take to reduce costs and protect quality," says Jacques Squire, segment leader: Water and Wastewater, Schneider Electric South Africa.

"Asset management has become a top concern among a growing number of water operations, with 42.7% of water industry respondents citing maintaining or expanding asset life as their most significant sustainability issue," he says.

Now, digital transformation is blending information and operational technology for asset performance improvements that

reduce costs, optimise efficiency and improve conservation in the water and wastewater operations.

Improved asset management

ARC Advisory Group reports that moving up the scale from preventive and condition-based approaches to predictive and prescriptive strategies has enabled users to cut the cost of maintenance labour and MRO (maintenance, repair and operations) materials by 50%.

"ARC analysts also estimate that, on average, industrial operations lose about 5% of their operating budgets to downtime, which can be reduced to zero through more sophisticated asset management techniques. Eliminating downtime can ripple benefits well beyond maintenance productivity, impacting service delivery, product quality, cost and many other factors," adds Squire.

New capabilities to collect, analyse and share process data digitally bring the benefits of asset performance improvement well within the reach of even the smallest operations. Results offer a 50% reduction in maintenance costs, a 30% reduction in energy costs, and 5% improved productivity.

Implementation through IIoT

According to Squire, achieving asset performance management in a cost-effective way involves augmenting traditional client/server information

architectures with technologies such as industrial internet of things (IIoT) gateways, edge analytics, and cloud computing, which are more open and amenable to digital control.

"Collecting operational data from connected assets, such as pumps, and sharing it with real-time decision support applications – in the cloud or on premises – is how digitisation improves asset performance. It involves bringing information technology and operational technology together securely in ways that were not feasible previously," says Squire.

He reports that most clients who implement asset performance improvement programs begin seeing a return on investment in as little as three months. In implementing such programs, clients are able to:

- optimise asset availability and utilisation
- manage ageing infrastructure
- reduce capex
- control opex
- manage energy costs
- reinforce physical and cyber security
- empower your workforce
- comply with environmental and safety regulations.

"As recognition of the value of asset management grows, the practice is steadily maturing, advancing from reactive run-to-failure approaches to predictive and prescriptive strategies, in which increasingly intelligent assets all but manage themselves." **3S**

Are sewage treatment plants fuelling antibiotic resistance?

Several antibiotic resistance genes and multidrug-resistant organisms have been detected in surface waters and rivers, and research suggests that sewage treatment plants may be fuelling their spread.

By Keith Cowan, Yinka Titilawo and Richard K Laubscher*

Antimicrobial agents are indispensable in reducing morbidity and mortality associated with infectious diseases. However, selective pressure exerted by excessive and indiscriminate use has led to the emergence and spread of drug resistance in many harmless commensal bacteria.

Mobile genetic elements, such as plasmids and bacteriophages (bacterial viruses), transfer these drug resistance genes between bacterial populations through a process known as horizontal gene transfer. This also allows pathogenic bacteria to evolve resistance by acquiring pre-existing antibiotic resistance genes from commensal bacteria.

In the UK alone, scientists identified 19 new mechanisms of antibiotic resistance

over the last decade. This ability of bacteria to continue to develop ways of resisting antibiotics is threatening a future in which patients could become untreatable. And, 'The Review on Antimicrobial Resistance' has estimated that, if left unchecked, the antibiotic resistance economic burden will carry a global annual cost of 10 million deaths and US\$100 trillion (R1.46 quadrillion) by 2050.

Looking at our sewage

Selection for and the spread of multidrug-resistant (MDR) organisms can be traced to complex socio-economic and behavioural antecedents, many of which impart biotic and/or chemical signatures. And, possibly the best place to locate these signatures is in the stuff we excrete. So, it is not surprising that researchers are turning their attention to sewage, in an effort to understand and gauge human behaviour, biology and health.

Perhaps the most high-profile example so far has been publication of the European multi-city study on drugs and drug abuse in the emerging science of wastewater analysis, entitled 'Perspective on drugs'. This long-term study analysed wastewater from a number of European cities and towns to gain insight into the drug-taking habits of those who live in them.

Like chemical signatures, biotic signatures in sewage can also be analysed and potentially used to assess

the overall health of populations.

A 2015 study showed that sewage accurately reflects the microbiomes of human populations. For the 71 US cities studied using high-throughput 16S rRNA gene sequence data, these researchers found that the most common oligotypes in stool samples matched the most common and abundant in sewage.

Also revealed was an apparent core set of organisms represented by just 27 human faecal oligotypes that could be clustered into either of the Bacteroidaceae, Prevotellaceae, or Lachnospiraceae/Ruminococcaceae. Based on the identity of microbes in wastewater, it was possible for the authors to distinguish cities with slimmer, healthier populations from those with more obese individuals.

What this research illustrates is the ease with which population-level traits of the human microbiome can be captured to inform policy- and decision-making. For example, analysis of the human microbiome in sewage has apparently been used to avert disaster. Authorities in Israel were able to successfully prevent a polio outbreak in 2013 by accelerating vaccination programmes after detecting the virus in wastewater before anyone developed symptoms.

Similar to the above, faecal indicators like *Escherichia coli* are among the foremost gauges of contamination and, as prescribed by the South African National Water Act (No. 36 of 1998) and the Department of Water Affairs (2013), used as the only biological parameter to



determine water quality prior to discharge of treated effluent.

Resistant bacteria in treatment plants

Currently, the special and general limit value for faecal coliforms is set at 0 and 1 000 per 100 ml respectively. More importantly, however, populations of *Escherichia coli* seem to represent a significant reservoir of genes coding for antimicrobial resistance, making this a very useful indicator species. Examples of other resistant bacteria include *Staphylococcus aureus*, which has evolved resistance to many antibiotics, most notably methicillin; *Klebsiella pneumoniae* has evolved resistance to the current generation of β -lactam antibiotics; and mutation-induced resistance in *Mycobacterium tuberculosis*, which has led to reduced sensitivity to fluoroquinolone antibiotics.

Indeed, the Centers for Disease Control and Prevention in the USA is funding research to measure the numbers of resistant bacteria and resistance genes flowing into treatment plants, and how effectively these facilities remove culprit microbes and genes.

Wastewater treatment works (WWTWs) by design act as aggregators and tend to concentrate pollutants, organics and biologicals, and represent a zone in which microbes are brought into close and sometimes direct contact with antibiotics and their metabolites. Several antibiotic resistance genes and MDR organisms have been detected in surface waters and rivers; it has been suggested that these

may have their origin in treated water released to the environment by WWTWs. Thus, it is very important to discern the contribution of WWTWs in the spread of antibiotic resistance.

Proliferation of antibiotic-resistant strains increases the likelihood of transmission to humans within the environment, either directly or indirectly. However, challenges around wastewater treatment experienced in many South African municipalities tend to mask risks. Furthermore, targeted recovery of indicator bacteria depends on, among others, geographical and temporal trends, the extent of contamination, access to such bacterial communities, and a dedicated wastewater treatment system as source.

Downstream advantages of efficient wastewater treatment are obvious, with clear benefits to the environment, community health, agriculture and tourism. Furthermore, wastewater analysis is a rapidly developing scientific discipline. Originally for monitoring the environmental impact of liquid household waste, as outlined above, it has since been used to quantify illicit drug consumption in European cities.

Similarly, the biotic component of wastewater is being sampled to explore, analyse, evaluate and predict aspects as these may relate to community behaviour and human health. Attention is now being focused by many on antibiotic drug resistance with

the potential to monitor both temporally and spatially.

To date, results from phenotypic and polymerase chain reaction (PCR) analyses reveal a worrisome increase in the prevalence of MDR isolates, with corresponding genes detected for all antimicrobial agents. This reinforces the need for reliable real-time wastewater analysis to allow for the quantification of resistant strains, estimate drug efficacy, and explore synergies between wastewater and MDR bacteria at scale.

Tests at Belmont Valley WWTW

As outlined above, WWTWs are aggregators of community chemical and biological signatures, and this provides an opportunity to screen sewage for, among other things, antibiotic-resistant bacteria and resistance genes.

Rhodes University owns and operates an integrated algal pond system that is linked to the Belmont Valley WWTW. The authors have recovered *Escherichia coli* isolates from wastewater samples and the presence of the uidA gene has been confirmed using PCR. The isolates have been classified into different phylogenetic groups using the multiple PCR assay.

Currently, the antimicrobial susceptibility test of the different *Escherichia coli* phylogroups is ongoing. Data obtained so far is being evaluated and the work will then be elaborated on to track and monitor the flow of resistance genes through

the IAPS wastewater treatment process, to address and answer the all-important question: as aggregators of community chemical and biological signatures, are sewage treatment plants fuelling the spread of antibiotic resistance?

Mining data from wastewater

Although wastewater is a very rich source of information, it is not being mined in the same way other data streams are. There are, of course, challenges to collecting data from WWTWs, not least of all a requirement for functional sewers and treatment plants, access, etc.

In contemporary South Africa, many of the >850 municipal WWTWs are in disrepair, and most are poorly operated with little routine maintenance. Monitoring chemical and biological signatures in the treated effluent prior to discharge is often not highly prioritised, while biological markers and particularly genetic markers are very likely ignored completely. There is thus an absence of basic data on process efficiency and data-driven operational management seems not to be current practice.

Some support for the prevailing circumstance lies in the regular outbreak of enteric and diarrhoeal diseases, which are all too frequent in many regions, while the contamination and pollution of adjacent environments are all too prevalent. Given the current situation,

it is probably safe to assume that if MDR is evolving in our WWTWs, the bacteria and resistance genes are proliferating unattended, being released into the environment, and in this way being transmitted.

The South African Medical Research Council (SAMRC), established in 1969, is mandated to improve the health of the country's population, through research, development and technology transfer. To this end, the SAMRC retains both intramural and extramural research units.

The extramural units are commissioned to conduct research on behalf of the SAMRC. At its Centre for the Study of Antimicrobial Resistance, a multidisciplinary team is apparently focused on addressing specific aspects of bacterial MDR pathogens, including tuberculosis. Current key focus areas include:

- understanding the pathogenesis of drug resistance by studying pharmacokinetic mismatch
- evaluating signal amplification methods as diagnostic tools to detect micro hetero-resistance (rare populations of drug-resistant bacteria) in sputum, tracheal aspirates and blood, compared to the site of disease
- conducting preliminary studies to determine the levels and efficacy of adjunct inhaled antibiotics at the disease site in tuberculosis and MDR bacterial pneumonia, and to develop and test inhaled formulations for future animal and human studies.

Conspicuous by its absence is

the critical role of municipal sewage treatment and the contribution of WWTWs to facilitating the regional spread of MDR. In short, without a measure of levels of resistant bacteria and resistance genes flowing into WWTWs – and how effectively these facilities remove antibiotic-resistant bacteria and genes – any effort to thwart the proliferation of MDR is considered lacking. ³⁵

For a full list of references, contact Keith Cowan on a.cowan@ru.ac.za.

***Keith Cowan, Yinka Titilawo and Richard K Laubscher** work for the Institute for Environmental Biotechnology, Rhodes University (EBRU), in Makhanda (Grahamstown), South Africa.



DURBAN

ready to remix its water

eThekweni Municipality and the New Energy and Industrial Technology Development Organisation (NEDO) signed a memorandum of understanding in 2016 to develop an integrated seawater desalination and water reuse system in Durban. Three years on and construction on the demonstration plant is nearing completion.

By Danielle Petterson



The RemixWater demonstration plant

Research studies by eThekweni Water and Sanitation show that inner-city water demand is expected to rise to 65 MLD (megalitres per day) by 2030, outstripping supply by 15 MLD. It is, therefore, necessary to augment supply with alternatives to surface water. One of the methods being investigated is the Hitachi seawater desalination reuse (RemixWater) project.

History

Hitachi (being the implementing agent appointed by NEDO) has been in discussions with eThekweni Municipality since 2013, after delegates from eThekweni Water and Sanitation visited Japan to view the technology. This led to an MoU being signed between the two parties to pursue the project.

The aim is for Hitachi to demonstrate that the concept would work for South Africa by building a pilot-scale plant with an outflow capacity of 6.25 MLD. The demonstration period will run for a year, during which time Hitachi must prove that the plant can consistently

produce drinking quality water in line with SANS 241.

The project is fully funded by NEDO, which plays an important role in Japan's economic and industrialisation policies through its funding of technology development activities. NEDO also acts as an innovation accelerator to realise its two basic missions of addressing energy and global environmental problems and enhancing industrial technology. eThekweni Municipality plays an oversight role on the project, with Hitachi fully responsible for the design, construction and operation of the project.

Remix technology

Hitachi's RemixWater technology utilises seawater and tertiary treated wastewater, put through a reverse osmosis (RO) process. The technology reports significant improvements

over traditional seawater desalination, including large energy savings, lower costs, and minimal environmental impact.

Conventional seawater desalination using RO membranes requires high pressure to filter dissolved materials (mainly salt) through the membranes, resulting in high electricity consumption. Energy typically accounts for almost 50% of the total operating costs, making improvements in energy conservation an important challenge.

The RemixWater technology reduces the concentration of salt by mixing the water expelled through the RO membranes during the water reuse process with seawater. This decreases RO pressure in the filtering stage, leading to a decrease in pumping pressure of around 40% compared to conventional desalination. In addition to energy savings, it reduces the salt concentration of brine discharged into the sea to



Hitachi's RemixWater technology offers lower membrane costs



approximately 3.5% – the same level as seawater.

To produce product water of 100 Mℓ using conventional seawater desalination would initially require seawater quantities in the region of 280 Mℓ; however, this system only requires 33 Mℓ of seawater if 100 Mℓ of reuse water is used. Therefore, the pumping costs as well as the membrane costs would be lower.

Building the plant

Site selection for the RemixWater plant was done by Aurecon, appointed to undertake feasibility studies for Hitachi. They looked at several sites for the project, including the Northern, KwaMashu, Tongaat and Central Wastewater Treatment Works (WWTWs).

The ideal site should have low levels of industrial effluent in the incoming sewage, be close to the ocean, and have an easy discharge point for the brine. The Central WWTW, located on the Bluff near the ocean, met all the requirements and was selected as the best location.

The Central WWTW has a design inflow of 130 MLD, with an average dry weather flow of 60.4 MLD. There is currently no South African standard for potable water reuse; however, the project team investigated some of the strictest global standards that were applied during the

design phase and a multibarrier approach will be implemented to attain the necessary tertiary wastewater treatment standards.

Membranes from various suppliers are being tested to determine which is best for the RemixWater process.

The Central WWTW's existing 3 160 m outfall pipe will be used for the RemixWater plant. The current plan is to discard all treated water from the plant for the 12-month contract duration, until it is determined that it meets the required standards. However, the municipality is investigating possible secondary uses for the treated water, such as industrial reuse.

The marine investigation, carried out by WSP, analysed various possible locations for the seawater intake. The best location was identified as the key wall at the harbour entrance, where the water was of better quality and less affected by the wave action and coastline. A pump station is being built on the key wall, taking into account Transnet's recommendations with regard to marine traffic.

Construction is currently under way, with the aim of commissioning the plant in February 2020. **35**



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Unpacking government's master plan

Late last year, Minister of Water and Sanitation Lindiwe Sisulu launched the much-anticipated National Water and Sanitation Master Plan. Water&Sanitation Africa looks at the main points contained within the plan.

According to the National Water and Sanitation Master Plan (NW&SMP), South Africa is facing a water crisis that is already having significant impacts on economic growth and people's well-being. This crisis is caused by insufficient water infrastructure maintenance and investment, recurrent droughts driven by climatic variation, inequities in access to water and sanitation, deteriorating water quality, and a lack of skilled water engineers.

The plan summarises the top-priority issues confronting the water and sanitation sector, which it seeks to address in order to avoid a predicted 17% water deficit by 2030. The plan also identifies how performance will be monitored. As a plan, rather than a strategy or policy, the prioritised actions with responsibilities are detailed against which relevant players in the sector can be held accountable by Cabinet, Parliament and the public.

Timelines

The NW&SMP is the implementation plan for the National Water and Sanitation Resources and Services and is divided into three sections:

1. Call to Action – sets out the critical priorities to be addressed by the water sector up until 2030.

2. Plan to Action – provides the basis for, and a more detailed analysis of, the key issues underpinning the Call to Action.
3. Schedule of Actions – defines all identified actions and interventions into annual measurable outcomes inclusive of roles and responsibilities, time frames and associated estimated costs.

Urgent intervention

The NW&SMP is driven by a sense of urgency and actions have been prioritised according to the level of impact that they are expected to deliver in working towards a water-secure future for all.

It is considered a 'living plan', which means that its implementation will be reviewed and reported on annually, and the plan updated utilising an adaptive management approach.

Towards a 'new normal'

Ultimately, the plan seeks to drive South Africa into a 'new normal' for water. This new reality is that water must become more expensive, everyone must use less water for the same activities, and everyone (except the indigent) must pay for water and sanitation services.

If demand continues to grow at current levels, the deficit between water supply and demand could be between 2.7 and 3.8 billion m³/a by 2030 – a gap of about

17% of available surface water and groundwater.

The NW&SMP is based on five key objectives that define this 'new normal' for water and sanitation management in South Africa, namely:

- resilient and fit-for-use water supply
- universal water and sanitation provision
- equitable sharing and allocation of water resources
- effective infrastructure management, operation and maintenance
- reduction in future water demand.

The dual focus is to reduce water demand while also increasing supply for a growing population and economy. Domestic consumption must be reduced to a target of 175 litres per person per day by 2025. On the supply side, there is a need to optimise the water mix. By 2040, treated acid mine drainage and desalinated seawater will make a significant contribution to South Africa's water mix; groundwater usage will increase and the over-reliance on surface water will reduce.

The plan clearly states that: "To achieve water security, all water users in all sectors in South Africa must use water more efficiently, and water use must be addressed in the plans of the municipal, energy, agriculture, forestry, mining and industrial sectors. South Africa has no other option, if the country is to be ready for the future and ahead of the curve." **35**

Key facts & figures from the NW&SMP

SA is facing a projected

17%
water deficit by
2030

South Africans use

64 ℓ/day
more than the
global average

Individuals must
reduce consumption

175 ℓ/day
by 2025

Over

3 million
people still do not have
access to a basic water
supply service

Municipalities lose
**±1 660
million m³**
per year through
non-revenue
water

**14.1
million**
people do not
have access to
safe sanitation

56%
of WWTWs
and
44%
of WTWs are
in a poor or
critical condition

More than
50%
of SA's wetlands
have been lost

Agriculture uses the
most water in SA
and pays the
lowest tariff

Only
5%
of agricultural water is
used by black farmers

41%
of municipal water
does not generate
revenue

35%
of municipal water
is lost through
leakages

DAY ZERO

– inside the eye of the storm

Cape Town made history when it became the first city in the world to reduce water demand by 50%, without resorting to intermittent supply, and prevented a shutdown of its water supply network.

By Danielle Petterson

Between 2015 and 2018, Cape Town experienced three years of very low rainfall – a 1 in 590-year event. This sparked fears of an impending ‘Day Zero’, when the city might become the first in the world to run out of water. Peter Flower, the city’s director of Water and Sanitation during the drought, reflects on how the city managed its water supply during what he refers to as “the perfect storm”.

Leading up to the drought

Cape Town relies primarily on rainfall, which accounts for 98% of water supply. This meant that, leading up to the drought, the city relied almost entirely on surface water from its dams.

Pre-drought, long-term average (LTA) annual run-off was around 711 million m³ per annum. However, in 2015 the city received only 54.4% of the LTA run-off. This was followed by 66.4% of the LTA in 2016 and a low 39.8% in 2017.

The city had recognised the need to diversify in the early 2000s, and alternative resources were pursued with extensive exploratory work carried out on groundwater in the Table Mountain Group Aquifer (TMGA)

and comprehensive feasibility studies done on reuse and desalination. This was done as part of the Western Cape Water Supply System Reconciliation Strategy implemented in conjunction with the National Department of Water and Sanitation (NDWS).

The strategy also included demand management and the city adopted an aggressive integrated Water Conservation and Demand Management (WC/WDM) Strategy in the early 2000s. This resulted in a significant reduction in projected water demands for the city, which pushed out the need for projects planned to bring on board additional water resources. The city managed to keep its demand curve flat for 15 years, despite a 30% population growth, only exceeding consumption of year 2000 in 2015. By this time, it had reduced non-revenue water to 20% and water losses to only 14.5%.

Flower notes that although the media pointed to poor planning being the cause of the severe restrictions that followed, this is not the case. “No system can sustain that type of drought without having to resort to extreme measures with restrictions. We in the water management sector know that restrictions are very much a part of managing any water system.”

Thankfully, 2018 saw run-off figures reach close to the LTA, which Flower says was Cape Town’s saving grace. However, to survive to that point, severe measures had to be taken.

Thriving inside the perfect storm

Despite having been through numerous droughts in the city before, Flower says this was the worst. Several factors came together to create this perfect storm, namely media, politics, revenue and trust.

1. Media

A significant amount of fake news and false information was being spread

on social media and through the formal media.

2. Politics

Politics played a big role, largely due to lateral tensions between local, provincial and national government. Tensions within the city were also problematic, largely because the mayor at the time took over management of the drought response, which Flower argues was not the most strategic approach. He believes the subsequent transfer of political leadership for the drought response to Ian Neilson – who is an engineer and was the deputy mayor then – was a major step forward.

3. Revenue

The revenue stream suffered heavily as a result of reduced water usage and tariff step adjustments not designed for the extreme level of restriction.

4. Trust

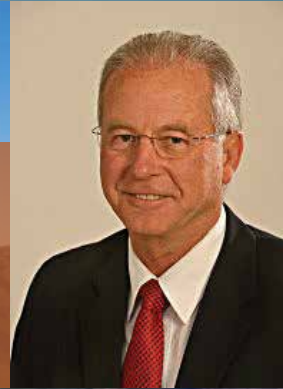
Flower says trust was eroded significantly during the drought, largely because of poor messaging from the city controlled by the mayor. People were starved of proper technical information. This was corrected following the change in leadership, but it took time to re-establish trust.

While all these factors had to be addressed, the real crunch came down to three key areas: managing dam levels, managing demand and augmenting supply.

Managing dam levels

The Western Cape Water Supply System (WCWSS) comprises six large dams, three owned and operated by the NDWS and three owned and operated by the city. The yield of these dams can be maximised by changing the loading of the subsystems and reducing spillage as much as possible during the rainy season. With the benefit of its integrated bulk water distribution system and using dam height

Peter Flower, the City of Cape Town's director of Water and Sanitation during the drought, reflects on how the city managed its water supply during what he refers to as "the perfect storm"



trajectories determined from stochastic models, the city is able to demand-load the subsystems in order to get the best yield from the system.

Managing water demand

The Western Cape Water Supply System utilisation is as follows:

- 29%: agriculture
- 7%: other urban
- 64%: City of Cape Town
 - 70%: residential
 - 13%: commerce
 - 4%: industry
 - 13%: government and other.

Because most of the demand is residential, this formed the main focus for water reduction. "By the time we got to the 2018 period, we needed to drop our outflows by a considerable amount. Over the three-year period of the drought, usage was reduced significantly to the final restrictions, which were 45% on urban and 60% on agriculture," says Flower.

It was determined that, pushing to the lowest limits, Cape Town could survive on 500 MLD. Following below average rainfall in 2015, the city and other stakeholders, dependent on the WCWSS, urged the NDWS to begin imposing restrictions. Their response was that their modelling did not indicate the need for restrictions and would take a decision after the next rain season. Cape Town took the decision to impose 20% restrictions from January 2016, and the surrounding municipalities followed suit. However, there was no restriction on the agriculture sector during the summer of 2014/15 and, in fact, agriculture water allocations were exceeded during this period. This was followed by 30% restrictions imposed by the NDWS in July 2016.

Communication formed an essential part of reducing consumption and needed to address all sectors of Cape

Town's diverse population. A variety of platforms were used, and various industry sectors were approached to become a part of the solution.

Key to success was providing citizens with technical information in publications such as the *Cape Town Water Outlook* and many other initiatives made available through various platforms and on the city website. Another success was the City Water Map, which graphically indicated consumption per erf. "This had a huge impact because people became competitive in reducing the usage and peer pressure goes a long way," says Flower.

Embracing Day Zero

The term Day Zero entered the media towards the end of 2017. This was not a term that the city chose to use, but officials decided to embrace the term and define it as the day that Cape Town would resort to extreme measures and ration supply.

Day Zero would be the day that the WCWSS dams reached 13.5%. This would require cutting supply to residential areas and reducing consumption to 350 MLD. Residents would have to collect water from central points of distribution and the city conducted a trial run to test the procedures and logistics.

If Cape Town hit Day Zero and maintained a demand of 350 MLD, the city would have three more months of water before reaching the midst of the rainy season. Towards the end of January 2018, at the current consumption rate, it was anticipated that the city would reach this day on 12 April 2018 and residents were called on to bring their consumption in line with the restrictions in order to prevent this.

Thankfully Day Zero never came. This was largely due to a good response from citizens, thus bringing the urban demand in line with the restriction level, a cap on

agricultural water use imposed by the NDWS in line with the 60% restriction level, and the transfer of water from a neighbouring dam system.

However, this required strict targets and tariffs imposed in line with restrictions. Special dispensation was attained from the Minister of Finance to implement a new set of tariffs for each restriction level above level 3, in order to maintain the revenue stream. Progressively punitive tariffs were also applied for households that didn't comply. The steep increases in price saw



households paying for the first step (0–6 kℓ):

- R4/kℓ in July 2017
- R26/kℓ in February 2018
- R29/kℓ in July 2018, with households using in excess of 30 kℓ/month paying R1 000/kℓ.

In 2017, the city took a decision to extend its debt management and water saving programme and also install flow restrictors at delinquent households using more than 20 kℓ/month. By the end of the drought, around 60 000 restrictors were installed at such properties.

Pressure reduction

Flower was adamant that Cape Town would not implement intermittent supply because of the disastrous consequences it would have on the city's infrastructure and quality of water supplied. Instead, the focus remained on pressure reduction.

Cape Town had already established numerous pressure management zones prior to the drought. The number of zones was rapidly expanded during the drought to reduce pressure across this city and

thereby reduce consumption and losses. This resulted in savings of approximately 70 Mℓ/day.

This was accompanied by a leak detection and repair programme. It was found that a large portion of water losses was not happening in the reticulation system but rather on the user's side of the water meter, and an extensive programme of plumbing repairs in indigent households was undertaken.

Cape Town is also taking a number of approaches to augment its water supply by some 300 Mℓ per annum; (see Table 1), including:

- new surface water (next scheme due being managed by the NDWS)
- improve yield of existing surface water
- better management of the WCWSS
- invasive alien plant removal
- groundwater
- water reuse
- desalination.

Looking to the future

In line with its Cape Town Water Strategy, the city has made five commitments when it comes to water:

1. We will work hard to provide safe access to water and sanitation.
2. We will promote wise use by all water users.
3. We will ensure sufficient, reliable water from diverse sources.
4. We will work with our partners to guarantee increased and shared benefits from regional water resources.
5. We will actively facilitate the transition to a water-sensitive city.

Cape Town's WC/WDM efforts during the drought were so successful that the International Water Association recognised the city's achievement of a 55% reduction in water demand between 2015 and 2017 without resorting to intermittent supply.

"The people of Cape Town really came to the party. We put the enabling environment in place, but if they hadn't responded as well as they did, we would have battled. It would have been an absolute last resort, but we might have had to go on to intermittent supply as part of the extreme restriction measures to reduce demand to 350 MLD in order to address a Day Zero scenario," says Flower. **35**

TABLE 1 The New Water Programme – 10-year view

INTERVENTIONS	FIRST WATER	EFFECTIVE YIELD		TOTAL CAPEX	UNIT CAPEX	OPERATING COST
		MLD	Million kℓ pa	R million	R m/MLD	R/kℓ
Demand management	2019	70	26	410	6	3
Alien vegetation clearing	2019	55	50			~ 1-2
Management of WCWSS	N/A	27	10			~0.2-0.5
Cape Flats Aquifer P1	2020	20	7.3	610	31	5
Table Mountain Group P1	2020	15	5.5	375	25	5
Cape Flats Aquifer P2	2021	25	9.1	450	18	5
Atlantis Aquifer	2021	10	4	290	29	5
Table Mountain Group P2	2022	15	5.5	335	23	5
Table Mountain Group P3	2022	20	7.3	326	16	2
Berg River augmentation	2023	40	15			~3-5
Water reuse P1	2024	70	26	1360	20	5
Desalination P1	2026	50	18	1 650	33-40	9
Total including WC/WDM		417	154	5 806		
Total new supply		347	128	5 396		

Tackling alien invasives

Teams tackle water-sapping alien plant species in a project to increase water flow to major supply dams

The roll-out of a new alien invasive plant clearing project in the Kouga and Kromme River systems near

Kareedouw and Joubertina is set to substantially increase the water flow to three of Port Elizabeth's supply dams while bringing much-needed job creation to the Langkloof region.

Implemented by the Gamtoos Irrigation Board on behalf of the Department of Environmental Affairs, the one-year National Resource Management project has employed 61 contractors and 800 workers to clear 950 densely populated hectares along the Diep River and its tributaries.

Increasing water supply

According to Edwill Moore, area manager, Gamtoos Irrigation Board, eradicating these alien invasive species will bring some relief to the

drought-stricken region by increasing the flow of water into the Impofu Dam as well as the Kouga and Churchill dams downstream.

"This ongoing drought has placed enormous pressure on our storage dams. Alien invasive trees – in this case, mainly black wattle – consume huge amounts of water, which would otherwise flow into these dams," said Moore.

"Clearing alien invasive plant species is one of the most cost-effective ways of increasing our water supply."

Kouga Dam, a major supply dam in the region, currently stands at 31% full, while extraction from the Impofu Dam, which is the second biggest, has been halted after its water level dropped to a critical 17.5%.

Moore said the contractors and their teams of 12 previously unemployed workers had been appointed from

The clearing of alien invasive plants in the Kromme River system is set to increase run-off to supply dams amid worsening drought in the Eastern Cape.

the local communities of Misgund, Louterwater, Krakeel, Joubertina and Kareedouw.

"Each team comprises three chainsaw operators to fell the trees along the riverbanks and three herbicide applicators to ensure that the stumps don't grow back, assisted by two general workers. There are also two health and safety reps to maintain a safe working environment and a pair of first-aiders in case of an injury on duty."

In addition to specialist training, Moore said all participants received general life skills training such as HIV/Aids counselling, substance abuse counselling and peer education. **35**

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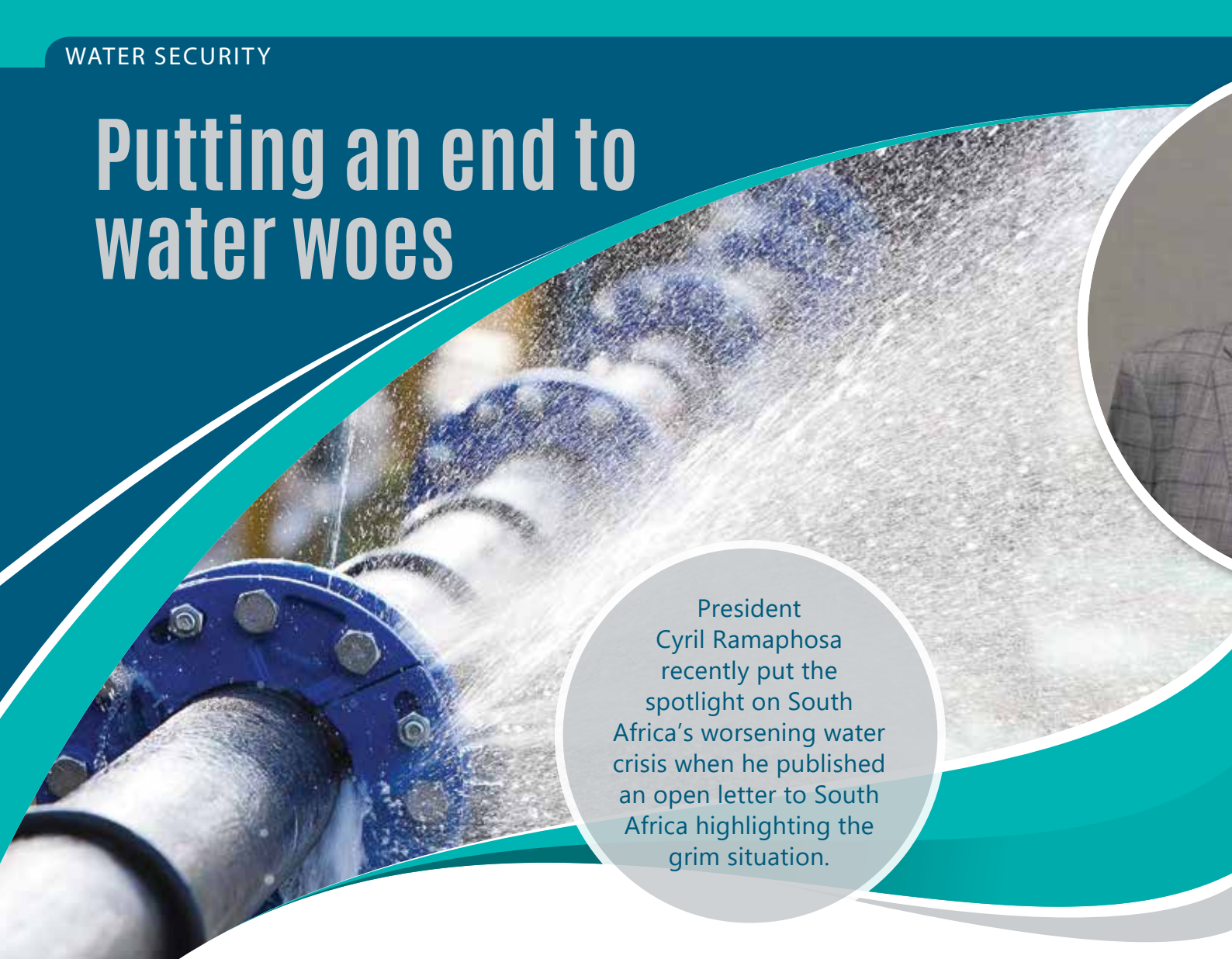


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Putting an end to water woes



President Cyril Ramaphosa recently put the spotlight on South Africa's worsening water crisis when he published an open letter to South Africa highlighting the grim situation.

In his letter, President Ramaphosa warned: "Our existing water systems are already over-exploited, as usage increases rapidly due to population growth and as more homes get connected to water. Combine this with the worsening effects of climate change and we are clearly facing a dire situation."

"Unless we take drastic measures to conserve water sources and promote efficient use, water insecurity will become the biggest developmental and economic challenge facing this country. Our current energy challenges will seem small by comparison. Unless we act now, we may not have water anywhere."

Launching the National Water and Sanitation Master Plan late last year, Minister of Human Settlements, Water and Sanitation Lindiwe Sisulu announced that South Africa intends to spend R900 billion over the next decade to improve its water supply and storage infrastructure, and tackle a growing shortage of the resource.

She also announced that a separate unit will be established to finance, manage and operate the national water infrastructure, while projects that are currently in the works will be expedited.

Commenting on these developments, the Southern African Plastic Pipe Manufacturers Association (SAPPMA) has expressed relief that the government is finally recognising the seriousness of the problem and making the necessary resources available to upgrade the country's resources, but added that the body was frustrated that the country had reached this point of desperation.

"There is no doubt that the impact of this current crisis could have, to a large degree, been reduced – if not completely avoided," says Jan Venter, CEO, SAPPMA. He conceded that while drought and climate change did aggravate the problem, a major cause is the country's failure to upgrade and maintain its water pipes and infrastructure over the last decade.

"The Water Research Council recently confirmed that the country's water resources in 2019 are not much different

from what it has been for the last 10 000 or so years. We started issuing warnings in 2009 already about a threatening water disaster unless urgent and corrective action was taken, but our calls for action fell on deaf ears," Venter says.

Plastic has a role to play

Venter explains that much of the country's water infrastructure consists of old steel and asbestos cement water pipes that were installed in the early 1960s or earlier. These pipes have a limited lifespan of no more than 50 years before they start to corrode and need replacement.

"In South Africa and the rest of the world, plastic pipes are the material of choice to replace ageing pipes and infrastructure, as they do not corrode or perish, and the joints are leakproof if installed correctly. They are available in various diameters and wall thicknesses, offer a much longer lifespan, are cheaper and more efficient to install, and offer significant savings to municipalities thanks to them offering less friction, resulting in lower pumping costs, less maintenance and fewer interruptions.



Jan Venter,
CEO, SAPPMA

“We started issuing warnings in 2009 already about a threatening water disaster unless urgent and corrective action was taken, but our calls for action fell on deaf ears.”

Jan Venter, SAPPMA

“However, we could see from our members’

dwindling sales figures, at the time, that no orders were being placed for new pipes, despite the fact that municipal budgets were allocated for upgrades and maintenance. Irregular expenditure of R13 billion wasn’t accounted for in 2016/17 in the Eastern Cape alone – making up almost half of the country’s wasteful expenditure of the same year. As a result, companies were forced to close down and a significant number of jobs were lost,” Venter says.

Combating water losses

The Water Research Council recently conducted a survey of 132 municipalities in South Africa. The results revealed that close to 40% of South Africa’s potable water is being lost because of leaks, incorrect metering and unauthorised consumption. By comparison, Australia

(also classified as a water-scarce country) loses less than 10 % per year.

“The two main causes of water loss are corrosion and the poor joining of pipes. Not only does our country suffer financial losses of more than R7.2 billion per year, but we have lost a significant supply of water that we might never be able to replace again.

“People can still live without electricity and, as South Africans, we have almost started to get used to regular power cuts. But nobody can live without water. While we cannot correct the mistakes of the past, we now have an opportunity to plan for the future and protect the valuable water sources that we have for the generations to come, through installing the correct plastic pipes that will be capable of meeting the infrastructure needs of a growing South African population,” says Venter.

He stresses that plastic pipes are not just used to supply water to towns, cities and communities, but that almost all infrastructure relies on these pipes to improve people’s lives and enable day-to-day, modern living. Electricity, gas and telecommunications supply are all possible thanks to the use and installation of

plastic pipes.

“We urge municipalities and the water engineers writing the specifications for the pipeline upgrades to specify in their planning documents that only HDPE and PVC pipes bearing the SAPPMA mark will be installed. Any other pipe will be untested, runs the risk of being inferior quality, and can put entire pipelines at risk.

“Moreover, plastic pipes that don’t clearly bear and display the SAPPMA logo are likely to contain dangerous heavy metals such as lead and cadmium, or recyclate that could leach into the pipes and will almost certainly not deliver the longevity or performance required,” Venter stresses.

SAPPMA believes the situation can be turned around through teamwork and hopes that the current crisis will act as a much-needed wake-up call to appoint competent, qualified technical personnel at national, provincial and municipal level. Decision-makers need to be encouraged to invest in the best-quality products they can afford and to commit to a disciplined maintenance regime for pipe systems. **35**



Repairing a flood-damaged spillway

Commissioned by Eastern Produce Estates SA (Epesa), the remediation of the Mambedi Lower Dam spillway represents a major feat of engineering, comprising the integration of complex structures that blend with the environment. **By Kyle Poolman and Pieter Gouws***

Located 40 km east of Louis Trichardt in Limpopo, Mambedi Lower Dam is a key water source for macadamia nut farmers, so any threat to its supply has major downstream implications. Such an event occurred when the dam suffered large-scale damage during an extreme rainfall event in February 2000. The water discharge nearly reached the regional maximum flood (RMF) peak.

The event damaged the existing concrete overflow structure and spillway channel on the right bank, leaving in its wake a nearly 80 m wide, 15 m deep donga through which water flowed freely, drastically reducing the dam's overall capacity.

Epesa appointed PG Consulting Engineers as the main consultant for the repair of the dam's spillway. This was based on a design for discharge

just higher than the RMF. The spillway design required a full spectrum of up- and downstream erosion and scour protection, as well as reinforced channel wing walls and embankment. PG Consulting approached Maccaferri Africa for assistance in designing these various water channelisation structures.

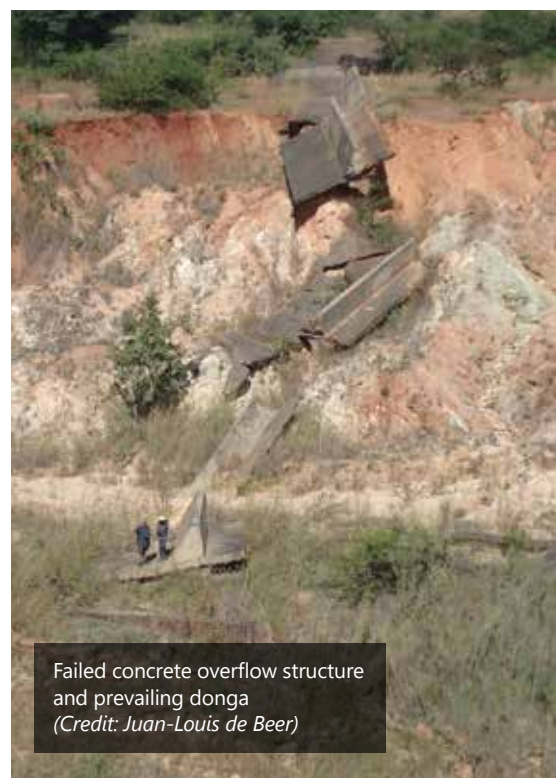
Construction started in July 2017. The overall project required the implementation of more than 12 000 m³ of gabions, Reno mattresses and Terramesh® structures, as well as 25 000 m² of varied geotextiles and 10 000 m² of geosynthetic soil reinforcement.

Gabion spillway

Conceptualising and later detail design of the new spillway required a rigorous repetition of ideas in order to produce an amicable and cost-effective solution for



The new Mambedi Lower Dam spillway
(Credit: Janes Gouws)



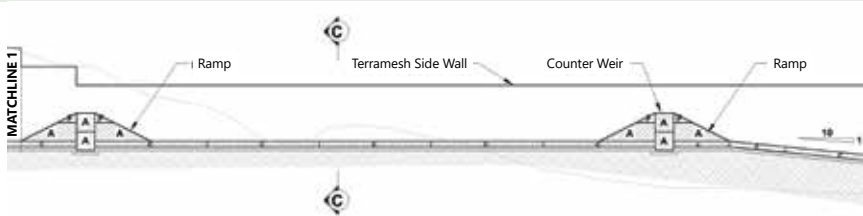
Failed concrete overflow structure and prevailing donga
(Credit: Juan-Louis de Beer)



Spillway under construction: a view from tier 7 of the stepped gabion weir
(Credit: Juan-Louis de Beer)

the client. The dam wall was designed as an embankment wall by PG Consulting. Selecting the appropriate spillway was subsequently affected by various factors, including the presence of some highly dispersive soils on-site, the height of the eroded embankment faces, and peak water velocities modelled as reaching almost 6 m/s.

The spillway was designed as a stepped gabion weir, with an approach apron created out of 0.3 m Reno mattresses underlined by a geotextile and an impervious liner to assist in preventing seepage through the dam core. The spillway embankment was created using a clay core to this effect as well.



The 1.5 m gabion counter weirs were designed with 'ramps' in order to allow any wildlife that may wander into the large basin to traverse freely

A stepped gabion weir was implemented in the down chute of the spillway and currently reaches 9 m high. This was meticulously constructed, with the eventual inclusion of a concrete capping on the steps in order to protect the underlying mesh from any possible damage due to debris crossing through the spillway during overflow.

Stepped gabion spillways have proven energy dissipation attributes due to factors such as water flow through the porous units, as well as significant aeration of water undergoing nappe or skimming flow as it flows down the steps. This, coupled with a gabion structure's ability to absorb a degree of differential settlement without compromising structural integrity, led to the decision to use an 80 m wide stepped gabion weir structure as the outlet of the spillway. A downstream stilling basin is also instituted using gabion energy dissipators and two counter weirs, as well as a mattress lining to prevent erosion of the underlying soils. The importance of implementing this 'armour layer' (in the form of Reno mattresses) in the stilling basin cannot be overstated: one of the causes of hydraulic structure failures is scour of soil at the toe, especially where flowing water meets erodible material.

The stepped weir was designed using Maccaferri's MacRA (Maccaferri River Analysis) 2 software, with the stilling basin and approach apron lining checked using Maccaferri's MacRA 1 software outside of the standard hydraulic design undertaken by PG Consulting. Once hydraulic stability was confirmed, all structures were checked for static stability using Maccaferri's MacStARS 4.0 software.

Embankment protection

With the decision being taken to implement a stepped gabion weir, attention turned to stabilisation and reinforcing of the wingwalls on the approach to the spillway, as well the embankments enclosing the stilling basin. The decision was taken to implement a reinforced soil structure (RSS) using a combination of geosynthetic soil

reinforcement of varied tensile strengths (in the form of Maccaferri's Paragrid® geogrids) as primary reinforcement, as well as Terramesh units (gabion units with double-twist steel-wire mesh tails) as secondary reinforcement.

A MacLine SDH 150 geomembrane liner was installed behind the facing to limit the amount of water ingress into the structural fill, along with longitudinal subsoil drains to enhance the structure's resistance to saturation. The Terramesh walls range from 4 m to 15 m in height and are designed in conjunction with geogrids of up to 150 kN/m tensile strength, checked using Maccaferri's MacStARS 4.0 software in conjunction with BS 8006:2012 (code of practice for strengthened/reinforced soils and other fills).

Conclusion

The remediation of Mambedi Lower Dam will ensure improved water capacity, providing water for livestock and farming activities in the greater Mambedi area. Construction also stimulated job creation, with local labour being used to place and pack thousands of cubic metres of gabions and Reno mattresses. A project of this magnitude also required quality control that is second to none, including special resources such as drone imagery and 3D CAD models in order to assist the contractor in accurately constructing this mammoth structure.

The project was completed in September 2019 and received a Commendation for Technical Excellence from the South African Institution of Civil Engineering in October 2019. ³⁵

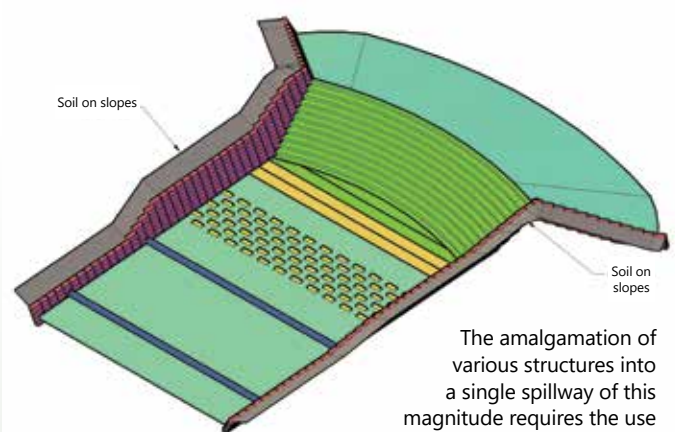
**Kyle Poolman, BEng (Civil), is an area manager at Maccaferri Africa and Pieter Gouws, Pr Eng, is the managing director of PG Consulting Engineers.*



Reno mattress approach apron enclosed by two wing walls (Credit: Juan-Louis de Beer)



Stilling basin, energy dissipators and Terramesh walls (Credit: Juan-Louis de Beer)



3D VIEW 1

The amalgamation of various structures into a single spillway of this magnitude requires the use of resources such as this 3D model created by the team at Maccaferri Africa (Credit: Barend Byliefeldt)

THE CHINESE LINK

Strategic industry partnerships depend on service and product excellence that are underscored by new alliances and class-leading innovation.

Chinese engineering, procurement and construction (EPC) companies are currently responsible for about 64% of all power projects under way in Africa and are looking to collaborate with the continent's leading equipment and service providers.

Forming part of this engagement, KSB Shanghai recently facilitated a high-level meeting between KSB's own operation in

Africa – KSB Pumps and Valves – and one of China's most prominent EPCs in Africa, PowerChina East.

The meeting was held at PowerChina's offices in Fourways, South Africa, and was chaired by Li Zhilei, business development manager at SEPCO III (a subsidiary of PowerChina). The meeting was attended by Chen Si of PowerChina East and Southern Africa; Liangxi Huang, export manager at KSB Shanghai; Helen Ding, director of business development

at KSB Shanghai; and Frikkie Botma, regional project manager at KSB Pumps and Valves.

"The opportunity to meet with Chinese EPCs and discuss the possibility of future partnerships has created the probability of future business and created the platform to build strong customer relationships," says Botma. "We also anticipate that entry barriers will be lowered, making future contact with the clients a mutually beneficial experience." 35

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Guidelines for greywater

The SABS has published a set of guidelines and requirements for greywater reuse systems.

The new SANS 1732:2019 provides for single reuse of greywater for the subsurface irrigation of gardens and the treatment of greywater for flushing toilets.

Garth Strachan, acting CEO, SABS, believes the reuse of untreated greywater will significantly reduce the demand on constrained water resources and enable South Africans to contribute towards reducing water consumption.

"In a water-scarce South Africa, SANS 1732 provides basic requirements and guidelines for ordinary households to safely reuse water," he says. Most households cannot afford to install sophisticated and expensive water treatment or collection applications, and SANS 1732 offers practical solutions to reuse water for watering gardens or flushing toilets.

SANS 1732: Greywater Reuse Systems - General Requirements was locally developed over several months through a technical committee (TC 60), made up of a group of industry experts and specialists. Various reviews of international standards, South African needs and developmental goals, a focus on the safety of people and environmental concerns were some of the criteria taken into account through the development process.

Garth Strachan, acting CEO, SABS, believes the reuse of untreated greywater will significantly reduce the demand on constrained water resources and enable South Africans to contribute towards reducing water consumption



"Reusing and repurposing greywater promotes the conservation of water, without compromising public health and the environment. While there are additional standards that guide industries and the built environment on the installation and use of greywater, SANS 1732 was developed with the focus on allowing every household to practically adopt basic greywater management," says Strachan.

The standard is available for purchase via the SABS webstore. **35**

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STARTING A SANITATION REVOLUTION

In a move to create a global sanitation revolution, South Africa is placing a focus on developing new sanitation technologies that will spur the creation of an entirely new sanitation industry.
By Danielle Petterson



Africa economic, social and environmental justice.

This leads to a sustainable development model.

"We continue to try to solve 21st century problems with 20th century technologies," says Naidoo. "In the case of sanitation, we are locked into a solution that is 2 000 years old. We have to create for ourselves the right kind of ecosystem where we are able to address all of these gaps simultaneously and concomitantly."

The Water Research Commission (WRC) has launched the South African Sanitation Technology Evaluation Programme (SASTEP) in a bid to foster a local sanitation industry that will increase access to proper sanitation, reduce pollution, improve water security, create jobs and entrepreneurial opportunities, and contribute to the country's GDP.

The programme is funded by the Department of Science and Technology (DST) and the Bill and Melinda Gates Foundation (BMGF). The latter has granted the WRC R75 million for the commercialisation and industrialisation of new sanitation technology, which will be driven by SASTEP.

Dhesigen Naidoo, CEO, WRC, believes the initiative has the potential to create significant economic growth within the developing world. He foresees the emergence of several of what he terms 'sanicorns' – or sanitation unicorns.

A unicorn refers to a start-up company that reaches a US\$1 billion (R14.31 billion) market value as determined by private or public investment.

Dr Doulaye Kone, deputy director: WASH, BMGF, believes that South Africa is a leader in the industry of 'new sanitation' and argues that innovative, first-mover companies will become sector leaders. The BMGF has been actively working to bring about new sanitation solutions, and trials of new technologies are currently being conducted in KwaZulu-Natal, under the Reinvent the Toilet campaign.

Naidoo stresses that this 'new' sanitation must offer 21st century solutions that don't only do one thing. They must offer non-sewered sanitation, use little to no water, have the opportunity for the on-site treatment of waste, and benefit that waste, thereby creating a new value chain.

He believes that new sanitation will have the opportunity to bring South

A new sanitation economy

It is estimated that 570 million people in Africa, the majority of which are in sub-Saharan Africa, are without access to improved sanitation. Globally, 2.1 billion people need access to sanitation. These numbers are substantial, considering the Toilet Board Coalition's findings that indicate that countries can gain \$70 million (R1 billion) in increased productivity per 1 million people served with safe sanitation.

An analysis conducted by the Toilet Board Coalition also found that the opportunity exists to transform the economics of sanitation from an unaffordable public cost to sustainable business opportunities via the Sanitation Economy. It found that lower capital and operating costs, together with revenues from toilet services and resource



recovery, can reduce the cost of sanitation per person per head to around \$6 (R86), compared to traditional norms of between \$100 and \$200 (R1 431 to R2 862).

By accelerating the Sanitation Economy, a robust marketplace of new opportunities can be created while meeting the requirements for SDG 6 – universal access to improved, safely managed sanitation.

However, this new Sanitation Economy must take a fresh approach to sanitation systems, looking at essential resources like water, nutrients, energy and proteins. The provision of waterborne sanitation is unsustainable and South Africa and beyond must adopt waterless, low-water or full-recycle sanitation technology where appropriate.

The Sanitation Economy links three key areas for business and social benefit:

1. The Toilet Economy

Toilet product and services innovation that provides toilets fit for purpose for all contexts and incomes. Toilet designs apply the Circular Sanitation Economy principle to minimise waste and emissions while capturing data to feed the Smart Sanitation Economy.

2. The Circular Sanitation Economy

New systems that replace traditional waste management. It connects the biocycle, using multiple forms of biological waste, recovering nutrients and water, and creating value-adding products.

3. The Smart Sanitation Economy

Digitised sanitation systems that optimise data for operating efficiencies, maintenance, consumer use and health information insights. Sanitation is included in smart cities architecture.

SASTEP will provide a common platform for all national public and private partners through which the new Sanitation Economy can be discussed.

Getting it right in South Africa

Kone believes that the adoption by the SABS of the ISO 30500 standards for non-sewered sanitation in May 2019 together with the launch of President Ramaphosa's SAFE initiative show that the South African government is taking sanitation seriously and making significant efforts to deliver sanitation solutions.

Minister of Human Settlements, Water and Sanitation Lindiwe Sisulu has put her support firmly behind the new initiative and said South Africa is ready for the uptake of new technologies. She believes SASTEP responds directly to the Industrial Policy Action Plan calling for a sanitation circular economy, the establishment of new technology and industrial platforms in South Africa.

"What is becoming clearer now is the fact that for us to achieve radical transformation in the sanitation sector, we need a sanitation revolution," she stresses.

Naidoo adds that this new sanitation platform offers the ability to create new jobs, new entrepreneurs and new economies at all levels. "Although people don't make the connection, our ability to get this new sanitation right will solve the sanitation problem, the water problem, and deal with unemployment and inequality.

And we are not only talking about the low end of the scale, but also the upper end of the scale," he emphasises.

"What we're looking at here is a global revolution. This is not just for South Africa, it is also for Africa and the whole developing world. When the world as a whole catches on to it, we will see a sanitation revolution even in the developed world." ³⁵



"For us to achieve radical transformation in the sanitation sector, we need a sanitation revolution."

Lindiwe Sisulu, Minister of Human Settlements, Water and Sanitation



"What we're looking at here is a global revolution. This is not just for South Africa, it is also for Africa and the whole developing world."

Dhesigen Naidoo, CEO, Water Research Commission

Let's talk SCHOOL TOILETS

A vast number of schools in South Africa still operate without safe and appropriate sanitation. It is important that we draw attention to this major problem, and all play our part in bringing clean and safe toilets to all learners.

By Barry Jackson

The November/December 2019 edition of **Water&Sanitation Africa** (Vol. 14 No. 6) challenged us all through the article 'Making school sanitation work'. We learnt of the many problems of managing school toilets and how some programmes are pioneering ways of addressing them. One key finding was this: "Infrastructure without a management system will fail". However, even if we devise a management system on paper, this situation is unlikely to improve much until all of us acknowledge this to be everybody's problem.

Typically, the condition of school toilets in South Africa is appalling. There are many, many toilets in schools that a lot of us would hesitate even to enter, let alone use. As a nation, we are failing our children – condemning them to use filthy dangerous toilets, to catch faecal-related diseases, to risk other health problems by deferring defecation, or to practise open defecation.

To quote the *School Sanitation Management Handbook*: "A situation where learners feel they cannot use their school toilets because they are dangerous, or degrading, undermines their physical health, psychological welfare and academic progress." That should make us all sit up.

Can we do anything?

This article is a call to action for all of us, particularly those with technical skills and/or influence (or potential influence), to talk about school toilets and to ensure that they are fit for purpose.

Most adults in South Africa have family members in school somewhere. If you have a chance, visit them and their school and do the following:

- Ask to see the toilets: Assess their physical condition and cleanliness. If feasible, ask a teacher or the school principal to show you the toilets. Ask them how the toilets are cleaned and maintained.
- Get informed: If the news is good, and the system works, please share it with the writer for wider distribution of lessons learned; if the experience is bad, share it with parents and the school governing body (SGB).
- Get involved: If there is something you can do, look into it. There is a whole range of ways in which concerned parents and community members can make a difference (see below).

Isn't this the government's responsibility?

Yes and no. The Department of Basic Education (DBE) administers a sizeable budget for the construction of school infrastructure, including toilets. Design and construction are managed by the DBE and Department of Public Works but are typically delegated to implementing agencies. So, it certainly is government's responsibility to ensure that school toilets are designed and built to be fit for purpose, but maintenance is normally delegated to schools themselves (unless they lack the ability to conduct such activities, based on their capacity to manage funds, assessed in terms of section 21 of the South

African Schools Act (No. 84 of 1996)).

Therefore, the toilets should be designed to be cost-effectively operated and maintained by each school, in the environment in which they are built. We trust that the DBE, donors, related agencies and their consultants are making sound technical decisions (in consultation with SGBs and school management) about the most appropriate types of toilets, designs of toilet blocks, location and security of toilet blocks, sources of water, plumbing design, treatment and disposal or reuse of effluent, affordable running costs, robustness of fittings, ease of operations and maintenance, and ease of cleaning.



Barry M Jackson, CEng, MA (Oxon), MICE, FWISA, former manager at the Global Sanitation Fund, WSSCC/UNOPS, Geneva – barrymjackson@hotmail.com

THE STATE OF THE NATION ADDRESS, 7 FEB 2019

Eradicating unsafe sanitation in schools

Turning to sanitation, President Ramaphosa noted that the safety of learners in schools was still high on the government's agenda. Last year, government conducted an audit of toilets in schools and found that nearly 4 000 schools still have inappropriate sanitation facilities.

"Given the scale and urgency of the problem, we launched the SAFE Initiative in August last year, through which we mobilised all available resources, including pledges

from business, strategic partners and the building industry to replace all unsafe toilets in public schools," he said.

According to Ramaphosa, since the launch of the initiative, 699 schools have received safe, appropriate sanitation facilities and government has projects in a further 1 150 schools either in planning, design or construction stages.

"We are determined to eradicate unsafe and inappropriate sanitation facilities within the next three years," the President said.

In response to President Ramaphosa's call in August 2018, when he launched the SAFE Initiative, several private sector companies have pledged to support new school sanitation facilities, through donations or direct construction. We hope that donors will insist that any facilities built with their funds will be properly operated and maintained in accordance with a suitable, fully funded sustainable maintenance plan.

The DBE recognises the need for financing operations and maintenance, and so the national budget lays down conditions that provincial educational departments (PEDs) must set aside a proportion of the Education Infrastructure Grant (EIG) for maintenance.

PEDs are required to provide SGBs with maintenance guidelines to conduct minor maintenance and should allocate no less than 20% of the EIG to address preventative and corrective maintenance at schools. It is clear that the upkeep of school toilets must be a priority for use of these funds, and SGBs (and concerned parents) should ensure that such earmarked funds are indeed used for this purpose.

In schools without section 21 responsibilities, PEDs should put in place the necessary measures to ensure that planned maintenance at these schools occurs as per the agreed-on and scheduled maintenance plan for such schools.

What can we do?

As a reader, you may have already identified tasks you could undertake. First and foremost, there is a need to hold office bearers accountable for doing what they are required to do. SGBs, together with concerned parents and community members, have the right and duty to help make the government system work, as it is designed to work for the benefit of our children.

The DBE is committed to providing safe, healthy toilets; schools are expected to keep them in good condition and PEDs are obliged to help them achieve that. What they lack is an accountability mechanism, so citizens must be prepared to identify failures in the system and report on them. If the government system appears impenetrable, find an NGO or CBO that is willing to take up the cause. If that does not work, bring in the media – but preferably in a constructive way – mobilising the community while applying pressure on those who have been unresponsive.

Second, concerned citizens can get involved by providing funds or volunteering time. There is always an immediate need to fix things on a once-off basis – such as physical repairs, painting, deep-cleaning, etc. – and perhaps the short-term provision of a cleaner and/or cleaning materials until budgets are established and stabilised. ►



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THE STATE OF THE NATION ADDRESS, 7 FEB 2019

Urgent rehabilitation to ensure safety

Children have died in unsafe unimproved pit toilets. There is an urgent need for all schools, SGBs and parent communities to check the safety of existing toilets and fill in abandoned toilets. The safety of the smallest, most vulnerable children is greatly at risk in poorly maintained toilets (especially those not designed for small children). While all toilets will need some structural assessment, one short-term measure for the youngest would be to retrofit squat pans with straight drop-holes that are too small for a child to fall through. They are also easy to keep clean. Most small children (especially in rural areas) will be familiar and comfortable with squatting, so mutterings about impaired dignity are irrelevant.

Be clear about what is needed

In his SONA this year, Ramaphosa said: "We are determined to eradicate unsafe and inappropriate sanitation facilities". Note the careful wording. He did not say "eradicate all pit latrines", as some interpret this, and then proceed to demand flush toilets.

A well-designed, well-constructed, well-managed and well-maintained pit latrine is far superior in function to a dysfunctional flush toilet. In fact, even a poorly managed and indifferently maintained pit toilet is superior to a blocked flush toilet. Unfortunately, examples of dysfunctional, dirty and unhygienic flush toilets are all too common at South African schools. The problem is not pit toilets versus flush toilets – it is safe versus unsafe toilets.

Third, help your school set up a toilet management system as proposed in the *School Sanitation Management Handbook*. Not many school educators are experienced managers, and many would likely welcome an outsider's offer to help set up the new system.

Other contributions in kind could include: technical advice on specific problems (or writing a technical report to deliver to the PED); the donation of building materials; the provision of artisan skills for simple repairs such as plumbing, carpentry or electrical; or a willingness to help with health and hygiene education. The possibilities are immense.

Let us start a movement

The readership of this magazine all has spheres of influence: at community level, within local, provincial or national government, among private companies active in the sector, and academia. Each may have a role to play.

It has been proposed that to change an institutional system, and to ensure its ongoing sustainability, requires initiatives in at least three areas:

1. Make the government system work (e.g. enforce accountability mechanisms).
2. Involve the community (e.g. volunteer assistance to kick-start improvements).
3. Promote an unstoppable momentum (e.g. always keep it on the agenda, use the media. etc.).

Expressed another way: we need to change social norms. Let us adopt a vision for the future: All schools in South Africa have clean and safe toilets that are always used by all learners. This may take 10 years because a vast number of people will need to change their mindsets, but what a difference it will make to the lives and health of our children.

So, let's talk school toilets until everyone gets the message. **35**



Recognition for sanitation units

South African technical assessment agency Agrément SA has awarded Rocla a certificate of recognition for its lightweight concrete toilet top structure.

Rocla recently had its precast concrete sanitation units certified as 'fit for purpose' by Agrément SA after they caught the attention Deputy Minister of Public Works and Infrastructure Noxolo Kiviet at a recent function in Pretoria.

Agrément SA is a fully fledged legal entity of the Department of Public Works and its certificates are comprehensive advisory documents that will assist building authorities and other relevant players to assess the in situ suitability of any innovation.

Innovative sanitation solution

"We described the unique features of our sanitation units to the deputy minister, and how the product could solve the issue of non-existent hygienic ablution facilities found at many schools, and in particular resolve the issue of pit latrine deaths endured by our young children in schools and in their homes," says Malebusa Sebatane, manager: Marketing and Communications, Rocla.

The unit was designed to provide a viable, dignified, safe and sustainable toilet to even the most remote corners of South Africa. All units are designed to be water saving and can function on the existing greywater output from a household rather than requiring fresh drinking water.

For communities and schools with pit latrines, Rocla's solutions also include an option to upgrade to a Water Research Commission-endorsed twin leach pit technology at a lower cost than a new installation.

Supporting job creation

Of particular interest to Kiviet was the unique community cast methodology with which all the new Rocla toilet structures

and substructures are manufactured. The award-winning community cast system was developed by Rocla specifically to benefit rural and township economies with a strong emphasis on local job creation and skills transfer, which aligns with the Expanded Public Works Programme. **3S**



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A circular sanitation approach



Mother Nature excels at sanitation, hygiene and sustainability. The waste of one life is the banquet of another. If we adopt a similar approach to sanitation, we can create an efficient, economical, hygienic and sustainable solution.

By Alan Hall, inventor

No one manages waste better than Mother Nature; she excels at sanitation, hygiene and sustainability. Trees and grasses exude oxygen, leaves, fruits, seeds and cereals – all of which are a banquet for billions of other life forms. Animals provide a banquet of meat, milk and leather, etc. We, as humans, have an obligation to maintain this discipline so that our waste is a banquet for billions of life forms.

Humans, for example, take up nutrition from the ground, the air and clean water. Our consumption transforms this into energy and excreta such as carbon dioxide, urine and faeces. The urine does not follow the same trajectory as the faeces.

This maintains isolation where the urine is absorbed by the ground to be an excellent fertiliser with soluble nitrogen, potassium and soluble phosphate. If it is not used as a fertiliser, it remains a harmless potential fertiliser.

Now, high-density living requires a different approach to solid waste; we need to introduce dehydration, incineration, isolation and dispersion to nature's methods for better, faster and more hygienic results.

Waterless sanitation

The LUSEC Sanitation Solution is a dignified, healthy and sustainable solution to sanitation and recycling, without water. The lack of water ensures that there is less smell, nor do the parasites and pathogens survive. Smell and disease are very easy to manage without water in the process.

Human effluent is separated in the pedestal. The urine is stored in watertight reservoirs and the solids dry in a ventilated chamber. The urine is isolated and stored in an airtight chamber to increase the pH to 9. This ensures that any pathogens are neutralised. Adding copper to the urine also kills pathogens and is one the best fertilisers in the world. The dried solids are combusted. Each person produces less than 200 grams of ash per year, which can safely be added to compost.

Imagine a world with control over pathogens, parasites, soluble/insoluble phosphate and waterless sanitation:

- Existing water storage would be sufficient.
- The cost of community health would drop by 50% and NHS could be a reality.
- The sanitation backlog could be reduced within years.
- Mining of phosphate would drop 30%.
- Plastics for food would drop by 30%.
- The distance travelled to bring food to cities would drop by 30%.
- Everyone can green up and feed up their families, especially the poor.
- The collection of household waste and industrial waste would drop by 90%.

- Social tension would be alleviated in urban and rural areas.
- Billions of hectares would be restored to health by improving soil quality.



The crossbar is of great help to children, disabled and elderly. Registered Designs, Trademarks and Copyright 2019 apply.



FIGURE 1 Examples of waterless toilets in a cubicle and in a bathroom

A circular approach

The linear economy is not just waste; it is death to the circle of life. However, it is very easy to have a circular economy if we just add treated urine to the soil and burn faecal waste to kill pathogens and parasites. Solid waste is not worth much to the soil, but urine is very valuable.

The nitrogen in urine accelerates the decomposition of lignin and fibre, and the soluble phosphate remains soluble for easy uptake by plants and microbes.

The potassium is always at hand to complete the macronutrient diet.

The LUSEC Sanitation Solution keeps urine under a layer of oil to stop odours and the loss of nitrogen. The copper added for sterilisation is also an excellent addition for fertiliser and soil health. The phosphate remains soluble.

After three years of testing the reliability and hygiene of the waterless toilets at Celimfundo School in the Khetani Township in Winterton, KwaZulu-Natal, a clear line can be drawn between waterless sanitation and flush toilets, hire toilets and composting toilets. The waterless toilets are low maintenance without a single part broken and the preference by the children is clear cut. Other types of sanitation continue to carry the risk of pathogens and parasites.

Flush toilets start a toxic journey of waste in the pedestal that accumulates other debris such as plastic, paper, plants and a host of industrial pollutants that are not sanitised and cannot be isolated. The only way the risk to health is reduced in the water is by the dilution and dumping of sludge. Modern jargon speaks of 'treated water'; however, this is still toxic.

Chemical reactions in the sludge create a product that has a pH of 10. To reduce the toxicity of the sludge, ferrous chloride and/or aluminium chloride are added to bring the pH down to 8. By this stage, the waste of thousands of people has been consolidated into a poison that includes heavy metals and phosphates that cannot be regarded as fertiliser. The phosphate has become unavailable to plants and microbes in the soil. This is a big mistake because every living cell requires phosphate.

Every farmer or horticulturalist is challenged daily to get the soil right for best plant growth. It starts with soluble phosphate. There is plenty of phosphate in the soil but it takes skill and time to make it soluble. Only when the pH of the soil is between 5.8 and 6.2 is phosphate available to the plant in large quantities.

Biodigesters seldom work because the sludge is usually out of the pH range for microbes to do their work.

The world's best fertiliser

Urine as a fertiliser has many benefits. It is free and contains nitrogen, potassium and phosphates that are soluble and available for uptake by plants. Plants grow for only a few months of the year, but urine benefits the soil throughout the year by adding nutrition to the microbes in the soil and by breaking down vegetation into excellent compost, just as nature intended, for maximum yields.

Naysayers argue that excess application of urine would be detrimental to soil because of the sodium in the urine; however, if only tiny amounts are applied to the soil on a regular basis, it gives the soil time to leach the sodium out of the top layer.

I tested toxicity by applying 20 litres of concentrated urine to one pecan nut tree. No damage has been done and the vegetative growth has been prolific. Figure 3 shows the difference between the treated and untreated trees – the treated tree grew (tree 2) new leaves while the other (tree 1) did not.

Another perspective is that farmers use superphosphate as a fertiliser. On good soils, where the pH of the soil is optimum for every 1 000 kg of applied

superphosphate, only 8 kg of this phosphate enters the plants. The rest of the phosphate is unavailable. The soil provides additional phosphate for the plant. If the soil is not right, the yields aren't good.



FIGURE 3 Pecan nut tree (2) treated with urine has more new foliage



FIGURE 4 Flowers grown with urine as the fertiliser

Where to from here?

We cannot blame municipalities for the lack of service delivery – taking back toxic water and waste of over 300 compounds is an impossible task. Dump sites and flush sanitation are short-sighted and destined to fail; however, waterless sanitation provides an efficient, economical, hygienic and sustainable solution.

Sanitation must be decentralised, and horticulture encouraged everywhere. It is best to start with the quick wins: households and communities without flush sanitation. Waterless sanitation can plug the gap.

Every adult produces enough fertiliser from urine, in a year, to produce 300 kg of tomatoes, but the soil pH has to be right. The green revolution is at our feet. **35**

For more information, contact the author at thelusec@gmail.com.

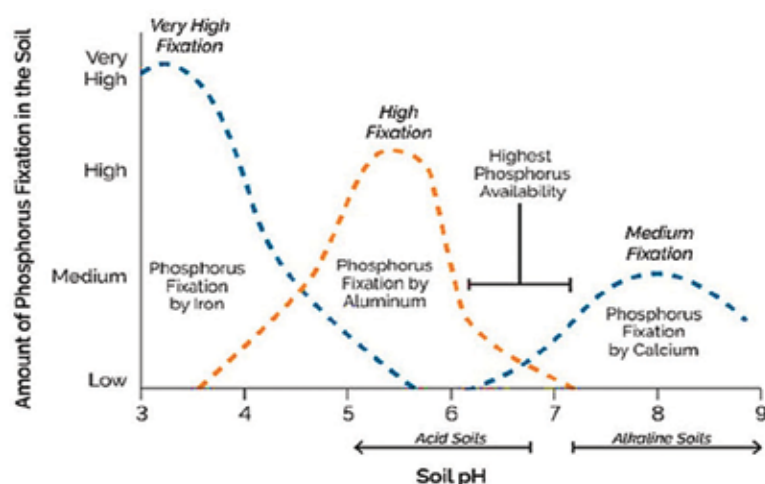


FIGURE 2 Phosphate uptake by plants and microbes

Burstlining provides soil-protecting pipe rehabilitation that obviates the need to dispose of the old pipeline and ensures the exact positioning of the new pipeline in the original pipeline route.

Burstlining success for pipe rehab

The fibre cement pipe is burst in the starting pit and a PE pipe with a larger diameter is drawn in

An old fibre cement pipeline in Bad Hall, Austria, had reached its capacity limit and was experiencing bursts. The decision was taken to replace the OD 250 mm pipe with new OD 315 mm and SDR 17 AGRU pipes with a protective layer, using burstlining.

Burstlining method

Burstlining is a trenchless pipeline rehabilitation technique that allows aged or insufficiently sized pipes to be replaced using the existing pipe route.

The first step is to inspect the existing pipeline with a camera. Fittings made of metal or cast concrete cannot be broken open and must, therefore, be removed using an open construction method.

A bursting head and expansion cone, fixed to a drawbar, are pulled through the existing pipe to break it into pieces. The expansion cone displaces the

resulting shards into the ground and makes room for a larger-diameter pipe to be pulled into place behind it. In this way, the old pipe can be destroyed, the pipe channel widened, and the new pipe inserted in a single process.

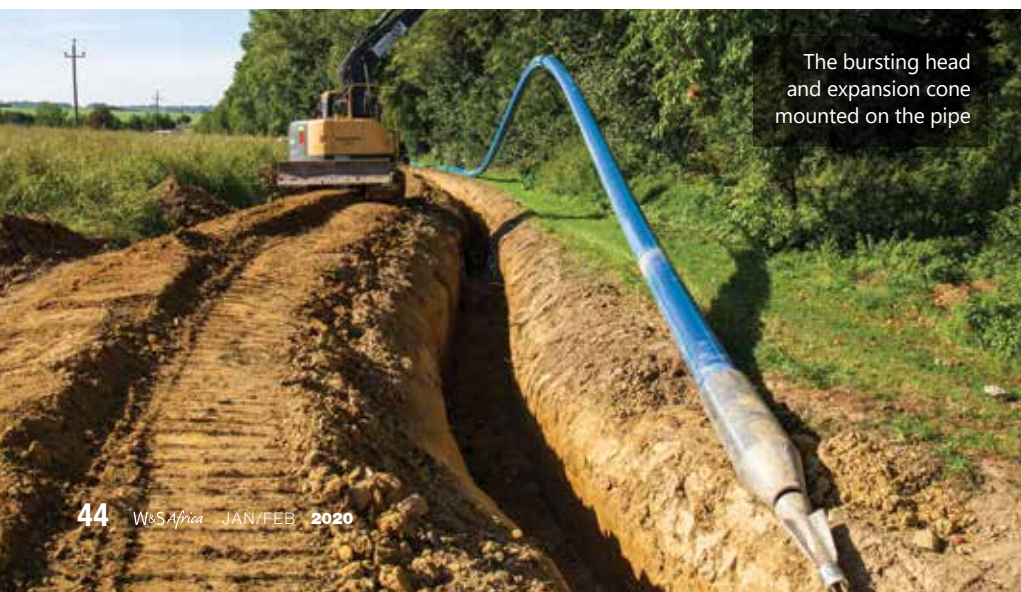
The tensile forces acting on the pipe are electronically recorded and documented throughout. After successful installation, the new piping system is disinfected and subjected to a pressure test.

Bad Hall pipe replacement

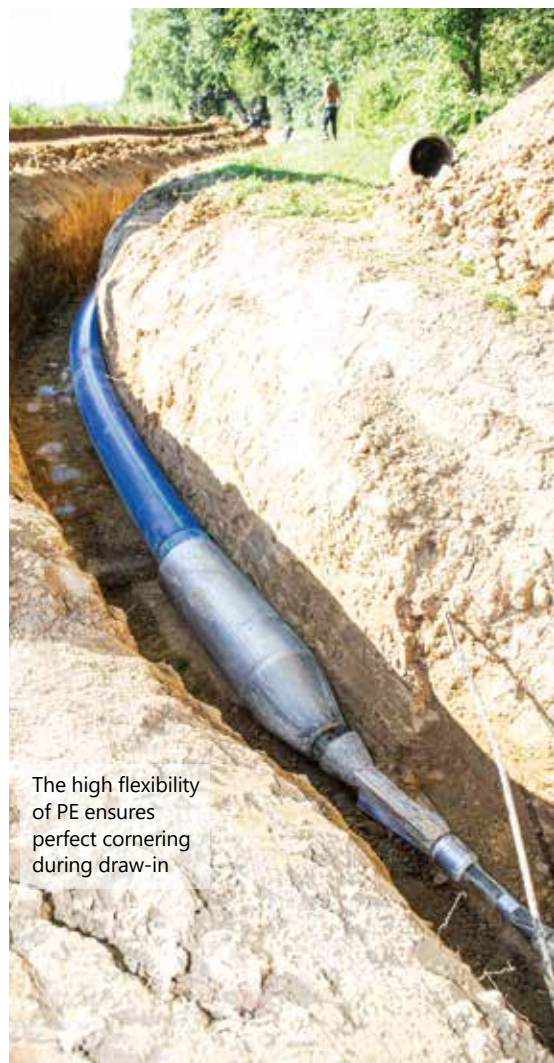
In Bad Hall, a 450 m long OD 280 mm pressure line leading to an elevated reservoir at Voglhub and a 1 800 m long OD 315 mm transport line branching off from this tank had to be installed. On its way to the elevated reservoir at Pfaffenwimm, the pipeline overcomes a height difference of 17 m and the pressure in the piping system at the lowest point rises to 5.5 bar.

Burstlining was selected as the pipe replacement method to ensure the most economical installation possible.

Since the installation costs decrease with the length of the pipe strings to be drawn in, it is important to install only the maximum possible pipe lengths. The contractor, WDS Bau, calculated the maximum draw-in lengths between the start and target pits based on the soil conditions and the resulting tensile forces of up to 250 bar pressure. The pipe strings, up to 144 m in length, were butt-welded on-site from 18 m



The bursting head and expansion cone mounted on the pipe



The high flexibility of PE ensures perfect cornering during draw-in



The CNC welding machine ensures perfect welding seams



In the target pit, the segments of the drawbar are removed from the machine and stacked

long protective layer pipes made by AGRU Kunststofftechnik.

Sureline III pipes with a protective layer offer double safety, as the stress-crack-resistant PE 100-RC core pipe is protected from the shards of the burst pipe by a scratch-resistant protective layer made of PP when the pipe is drawn in.

AGRU Kunststofftechnik provided a CNC-controlled butt-welding machine for the welding process. Thanks to the new technology, temperature, pressure and time are pre-programmed, ensuring the quality of the welds. The finished pipe strings were then drawn into the old pipe using burstlining.

According to Gerhard Dieringer, managing director, WDS Bau, the site was divided into 12 sections for burstlining. The team was able to burst and install the new pipe in one to two sections per day.

"Unfortunately, there have been a few pipe bursts in this area in recent years," says Anton Pöllabauer, managing director, Bad Hall Water Association.

"The last fibre cement pipe was installed in 1979. For more than 20 years, we have only been installing PE piping systems from AGRU. We have rehabilitated older water pipes with AGRU PE 100-RC pipes using the burstlining and ploughing method, and have had a very good experience with this. We assume that the newly installed lines will have a service life of at least 50 years." **35**



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Asbestos Identification	Identification of asbestos in bulk materials according to MDHS 77, HSE, United Kingdom and HSG 248, HSE, United Kingdom	Yes	72 hours
Asbestos Fibre Counting	Pre-packed filters including sizing and counting of asbestos fibres in accordance with HSG 248, HSE, United Kingdom	Yes	48 hours

For further technical information on our asbestos and silica capabilities, and to discuss your individual service needs please contact:

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Analysis	Sampling Media	Method Based On	Accredited	TAT	Size
Inhalable and Respirable (Gravimetric)	Polyvinyl Chloride (PVC) Filters	NIOSH 0500 & 0600	Yes	48 Hours	37mm, 5µm
Crystalline Silica	Polyvinyl Chloride (PVC) Filters	NIOSH 7602	Yes	10 working days	37mm, 5µm

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When Minergy planned its Masama Coal Project in the water-scarce region of Botswana, it was essential to build a water management strategy to ensure water conservation and efficiency.
By Stan Jewaskiewitz*

MASAMA Coal Project

Challenges of water supply and conservation

The Masama Coal Project is located near Medie Village in Kweneng District, roughly 65 km north of Gaborone, Botswana. The project is the cornerstone asset of Minergy, a Botswana-registered company listed on the main board of the BSE.

A key component in the operations of a coal mine is access to water and the use thereof in coal processing. In Botswana, it is also imperative to conserve water and recycle it wherever possible.

Water supply and conservation

At the commencement of the Masama Coal Project, Minergy appointed

consultants to undertake a hydrogeological impact study to identify potential risks caused by the proposed mining operation on surface water and groundwater, and to recommend appropriate measures to mitigate such risks.

The topography of the mine site area is generally flat, with a gentle slope to the south-east. The main drainage system is the Dikolokolane Stream, which is ephemeral by nature and drains south-eastwards into the Ngotwane River. The Dikolokolane has an upstream catchment area of 616 km² and rises from the edge of the Central Kalahari sandveld escarpment. The river bed is vegetated and the banks are not generally incised – both indicators of infrequent river flows.

The climate is semi-arid, with cold, dry winters and hot, wet summers.

The region receives most of its rain between the months of November and February. The average and maximum rainfall is 393 mm/a and 656 mm/a, respectively.

There are potentially two hydro stratigraphic aquifers present in the area. These are the sandstones of the Eccca Group and the weathered basement and Proterozoic rocks.

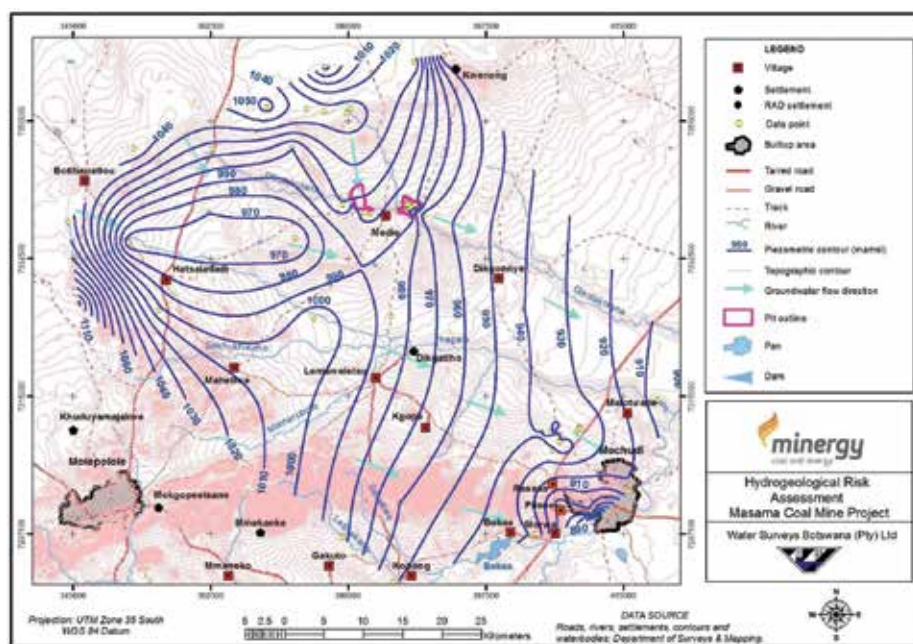
Groundwater level measurements were taken from 30 existing boreholes recorded in a hydrocensus and used to produce a piezometric contour map. The hydrocensus data provided by Minergy gives a range of groundwater levels from 64 mbgl (metres below ground level) to as little as 13.26 mbgl.

A total of 16 boreholes were sampled and analysed for major, minor ions and trace metals during the hydrocensus. Two existing boreholes located to the south-east of the project area have been selected and were equipped and connected to the mine site. Minergy is in the process of connecting a third borehole located south-west of the proposed mine infrastructure to add to the two identified boreholes.

Mine water demand and water balance

To build a water management strategy or plan for a mining operation, an understanding of where the water comes from, how it is used and where it goes is required. This is achieved by accounting for all inflows, outflows and losses across the mining operations.

A balance between inflows and outflows across the operations should be maintained to ensure that all processes



Piezometric contour map

Commissioning of the coal processing plant

are not impeded by a lack of water or the undesirable ingress of water. An accurate water balance model is required in order to manage/operate the mine's water resources. It will be easy to trace losses or over-usage, if any, and take corrective measures.

A schematic water flow diagram for the Masama Coal Project is shown in Figure 1. The sources of water at the Masama Coal Project are boreholes for potable water supply and process plant make-up water, pit inflows, stormwater (run-off) and recycled water from the process plant and sewage treatment plant. Return water from the process plant will be passed through the clarifier before being conveyed back into the plant.

Some water from the discard facilities and stockpile area will be discharged into the pollution control dam (PCD), through a drainage system that flows into the stormwater drainage channels that will be constructed around the mine facilities. Treated effluent (greywater) from the sewage treatment plant will also be recycled and used either in the proposed plant nursery or stored in the PCD for reuse in dust suppression or make-up water in the washing plant.

Water supply

Water supply will be from boreholes, stormwater, pit inflows and processing plant recycled water. Storage facilities designated for potable water and greywater have also been constructed.

Potable water: Boreholes with cumulative yield in excess of 30 m³/h are to be used by Minergy during the initial stages of the mine's operations. Potable water, some 3 m³/h, will be required for

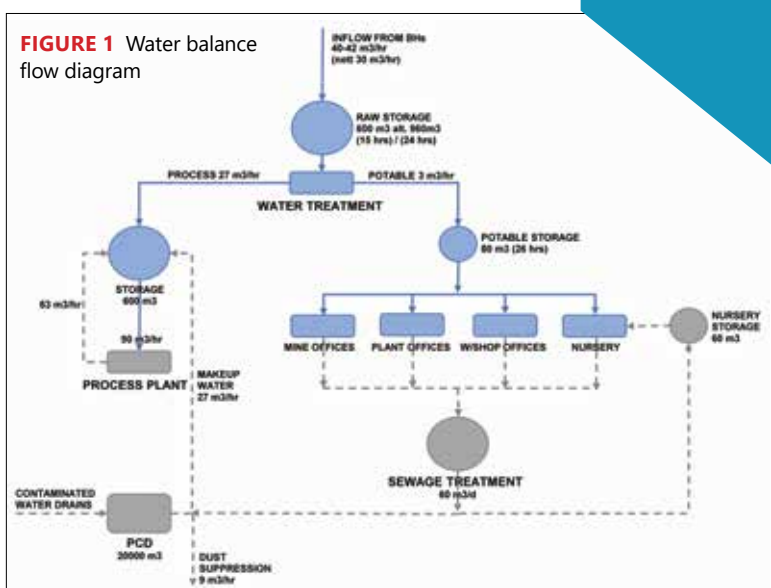
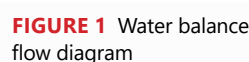
on-site use by staff for drinking and ablutions. The water quality of the three existing boreholes does not comply with the newly revised standards of 2015 (BOS 32:2015) and, as such, treatment is required before use.

Pollution control

dam (PCD):
The planned stormwater drainage system will intercept contaminated stormwater, seepage water from product stockpile and discard facilities, and direct this water into the PCD for containment and storage. The water from the PCD will be used in the plant area and for dust can also augment for the process plant. The PCD will be a of 20 000 m³ of g considered sufficient

Pit inflows: As the opencast mining advances, groundwater will flow towards the pit area with varying flow rates, depending on the heterogeneity of formations within the project area. Seepages on the pit slopes are expected as mining advances and will form part of the mine inflows. An average pit inflow rate of 0.56 m³/h was used in the water balance flow calculations.

Drainage galleries will intercept and collect water from anticipated seepages on the pit slopes and channel it to the sump where it will be pumped



out of the pit and stored together with recycled water. This water, however, will be affected by mining and, therefore, cannot be used as potable water. Water from in-pit sump will also be used to augment supply.

Recycled water: The process plant is expected to use about 90 m³/h of water once operating at the full planned production rate of 600 tph. The water will be used in a thickening stage, and then during washing coal in the plant. About 63 m³/h or 70% of these waters will be recycled back into the plant and 30% of it is expected to be lost in the process, by either remaining in the wash



Potable water treatment (RO) plant



Processing plant storage dams



Coal processing plant



Sewage treatment plant

product and through drying of the same or other losses such as evaporation. Hence make-up water of $\sim 27 \text{ m}^3/\text{h}$ is required for the process plant. Drainage channels from the plant will collect any spillage of the plant water that may occur as well as rainfall in the plant area and transfer it to PCD via the stormwater drains.

Raw water storage dam: The raw water storage dam receives water from the supply boreholes, PCD, and the pit. The raw water dam ensures constant supply of make-up water to the processing plant. The dam has a capacity of 300 m^3 allowing for make-up water to be provided to the plant for a period of up to 10 hours without replenishment. The $63 \text{ m}^3/\text{h}$ of recycled plant water remains in a closed-loop system and is fed directly back into the plant water supply system.

Water demand

The water demand includes for major activities that require water for their day-to-day operations.

Processing plant: The most significant water demand centre is the processing plant. Minergy intends to use about $90 \text{ m}^3/\text{h}$ of water in the plant when at full capacity. After the coal has passed through the process stages, the water used during thickening and washing is discharged from the classifying cyclones, while further water is removed from the discards by means of a vibrating screen. About $63 \text{ m}^3/\text{h}$ of the initial $90 \text{ m}^3/\text{h}$ will be recycled, with the rest of the water remaining in the coal product. Some of this water is then lost to evaporation as the coal dries out.

Screens will be used to size and dry the coal before being temporarily stored in stockpiles. Decant drains around the stockpiles will catch any residual seepage flows.

The process plant has an initial capacity of 400 tph, which will be expanded to 600 tph in year five. At 400 tph, the plant requires a total of $60 \text{ m}^3/\text{h}$, of which $42 \text{ m}^3/\text{h}$ will be recycled, needing $18 \text{ m}^3/\text{h}$ of make-up water; once the plant reaches its full capacity of 600 tph in year five, it will require the full amount of water – i.e. $90 \text{ m}^3/\text{h}$, of which $63 \text{ m}^3/\text{h}$ will be recycled, needing $27 \text{ m}^3/\text{h}$ of make-up water.

Drinking and change rooms: Minergy in full production will have about 200 staff members who will commute from the surrounding villages. The water demand for staff for drinking and for use in the change rooms is estimated at $3.22 \text{ m}^3/\text{h}$.

A reverse osmosis (RO) plant has been constructed to treat borehole water to supply drinking water.

Wastewater: Wastewater from on-site ablutions or change houses is expected to be around $60 \text{ m}^3/\text{day}$. A small wastewater treatment plant tank has been built, with final effluent being discharged to the PCD for use in the plant and for dust suppression.

Dust suppression: Haul roads that will be used for accessing the pit and around mine infrastructure will be watered occasionally to suppress dust on them. A road leading from the mining area to the rail siding coal storage facility will also be watered for dust suppression. A total of $9 \text{ m}^3/\text{h}$ will be required for dust suppression. The PCD, pit dewatering, stormwater and mine boreholes will be the sources of water for dust suppression and most water will be drawn from the PCD. Should it be found that there is insufficient water available for dust suppression at times (e.g. during winter or once the plant reaches full capacity), it is recommended that a new borehole targeting the lower Eccasandstone aquifer be drilled near the mine infrastructure site.

Conclusion

Botswana depends heavily on groundwater resources and it is imperative that the present, generally good quality be maintained for future generations. In mining operations, the pollution risks include wastewater and sewage, coal storage, discards storage, acid mine drainage, heavy fuel and oil storage, and chemical and explosives storage.

The Masama Coal Project, therefore, needs to implement stringent measures to manage and control any potential pollution threats in order to preserve the quality of groundwater and conserve the available water through recycling water wherever possible. ³⁵

**Stan Jewaskiewitz is the technical director of Envitech Consulting.*

The degree of automation in the wastewater industry is steadily increasing and many facilities now operate completely autonomously. For that reason, the associated measurement technology must be reliable and maintenance-free.

VEGA has recently extended the proven VEGAPULS family with a new instrument series for continuous level measurement in the wastewater industry. These compact radar sensors measure at a frequency of 80 GHz and deliver accurate readings over many years, regardless of the ambient conditions.

The new radar series is available in two versions: as a compact model with cable connection housings and as a standard model with fixed cable connection (IP68).



This makes the new VEGAPULS ideal for, among other things, flow measurement in main sewers leading to sewage treatment plants, determination of the degree of contamination in mechanical screening or level measurement in rainwater overflow basins. Thanks to the high precision of the radar sensors, the impounded and discharged water quantities can be measured with just one sensor.

Up until now, such measurements were mostly carried out with ultrasonic measurement technology, which was often

influenced by environmental factors such as solar radiation, condensation, temperature fluctuations or build-up.

Drinking water solution

The compact sensor can also be used in a wide range of drinking water applications, from water catchment to water treatment and distribution. For example, the sensor is used to measure ahead of coarse and fine screens regardless of ambient conditions.

The new instrument series is also ideal for deployment in precipitant and chemical treatment stations. It is capable of measuring a wide variety of media and gases reliably – even through the tops of plastic vessels if necessary.

The new VEGAPULS sensors also deliver a convincing performance in elevated storage tanks for water distribution: their compact design and the fact that they are not even influenced by condensation make them perfect for this task. **35**

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The Process Controller Division of WISA recently celebrated excellence in process control at the Western Cape Process Controller Awards.

CELEBRATING process controllers

The WISA Process Controller Division recently hosted the 10th annual Western Cape leg of the Process Controller Open Day Workshop. Process controllers from all over the province gathered in Cape Town to network and expand their skills through a number of interactive group discussions.

The event also served as a platform for the Western Cape Process Controller Awards. This annual event, hosted by the Department of Water and Sanitation (Bellville), and supported by

the Process Controller Division of WISA, acknowledges unsung heroes for the hard work they do to ensure treatment processes function optimally.

Award winners

The Department of Water and Sanitation, as the adjudicator of the awards, invited municipalities from across the Western Cape to submit nominations for water and wastewater treatment works and their process controllers that excel at prescribed criteria in various categories. The 2019 winners are:

CATEGORY	WINNER
Best process controller at a water treatment works with a design capacity of less than 10 Mℓ/day	Shaun Gallant, Theewaterskloof Municipality, Grabouw WTW
Best process controller at a water treatment works with a design capacity of more than 10 Mℓ/day	Isaac Henecke, Overstrand Municipality, Preekstoei WTW
Best process controller at a wastewater treatment works with a design capacity of less than 10 Mℓ/day	Ashlene Lewis, City of Cape Town, Westfleur WWTW
Best process controller at a wastewater treatment works with a design capacity of more than 10 Mℓ/day	Ngelekanyo Munyadizwa, City of Cape Town, Bellville WWTW
Best water treatment works: capacity greater than 10 Mℓ/day	Wemmershoek Water Scheme, City of Cape Town
Best water treatment works: capacity less than 10 Mℓ/day	Friemersheim WTW, Mossel Bay Municipality
Best wastewater treatment works: capacity less than 5 Mℓ/day	Klapmuts WWTW, Stellenbosch Municipality
Best wastewater treatment works: capacity 5 to 10 Mℓ/day	Wesfleur WWTW, City of Cape Town
Best wastewater treatment works: capacity greater than 10 Mℓ/day	Stellenbosch WWTW, Stellenbosch Municipality
Best pond system	Herold's Bay WWTW, George Municipality
Best internal laboratory	Breede Valley Laboratory, Breede Valley Municipality
Best on-site laboratory	Wellington, Drakenstein Municipality



Every year a special award is also presented to a woman who – through consistent ethical conduct, leadership, knowledge, experience, skills and ability to share it with passion, commitment and dedication – acts as a true ambassador for woman process controllers.

This award, aptly referred to as the Marlene van der Merwe-Botha Woman in Water Care Leadership Award, was presented to Saskia Langner, manager: Water & Wastewater Treatment, Breede Valley Municipality.

Says Dewald van Staden, lead: Western Cape Process Controller Division, "Although these awards are currently focused on process controllers in the Western Cape, the Process Controller Division of WISA wishes to acknowledge the outstanding work that process controllers all over South Africa are doing to provide safe drinking water and protect our valuable water resources. After all, water is life." **35**

In just a few months, WISA will hold its 2020 Biennial Conference and Exhibition under the theme of #AllHandsOnDeck.

WISA 2020 technical tours

The WISA Biennial Conference and Exhibition is the region's biggest water conference, bringing together water sector professionals and other stakeholders from across the country and beyond. This year's conference is expected to be bigger and better than ever before.

"I invite you to attend the 2020 WISA Biennial Conference and Exhibition, and immerse yourself in the discussions, interact with fellow delegates and speakers at our social functions, and expand your horizons during the technical tours and workshops," says Lester Goldman, CEO, WISA.

"Help us action the change that South Africa needs to ensure that the country has access to clean, safe water that is preserved and protected by all of society."

Technical tours

The 2020 conference will feature several informative technical tours, including:

1. Hartbeespoort Dam

Visit Hartbeespoort Dam for a presentation and tour of strategic interventions to rehabilitate the dam. The tour includes viewing of driving floats to neutralise eutrophication, an earthworm farm, and a hyacinth composting facility.

2. Laboratory tours

Visit laboratories to view best practice principles for water and wastewater

analysis, toxicity testing, and specialised applications for research testing.

3. Anglo American eMalahleni Reclamation Plant

This tour will explore the production of potable water from mine water, addressing engineering and environmental aspects regarding mine water decant pollution and how to address water resource scarcity. The tour further highlights the significance of the food-energy-water nexus through the exploration of the Kusile Power Station and the role of water in safeguarding sustainable energy supply.

4. Biogas-to-energy

This visit will share lessons in planning and executing a combined heat and power (CHP) project. The tour aims to raise awareness on the practices of cogeneration or CHP generation, and elevate interest in anaerobic digestion and cogeneration.

5. Vaal Dam and Boschkop Pump Station

View and explore the complexities of the Integrated Vaal River System management as an example of integrated water resource management. This tour will provide delegates with the opportunity to experience the operationalisation of water resources on the largest scale in South Africa.

6. Eastern Basin Acid Mine Drainage Treatment Plant

Tour one of the largest high-density sludge plants in the world with a

capacity of 110 MLD and explore the technology and challenges of treating acid mine drainage.

7. Kruger National Park

Tour the world-renowned national park from the perspective of its integrated water and sanitation and integrated river management.

Water and society

The technical tours support the conference's mandate to consider the broader impacts of water on society and the environment.

"Our past conferences have provided a platform to discuss problems and solutions facing the water and related sectors. Now is the time to create mechanisms and an enabling environment to set us on a path of implementation and impact.

"Water is everyone's business, and everyone should be involved in ensuring we have water security. This is now more important than ever, as we need to navigate issues of climate change, weather variability, demand growth, infrastructure needs and so forth," concludes Shafick Adams, chair of the conference organising committee. ³⁵

IMPORTANT DATES

- Deadline for presenter registration – 29 February 2020
- Early bird deadline for registration – 29 February 2020
- Provisional programme published – 15 March 2020
- Launch of mobile app – 15 March 2020
- Conference starts – 31 May 2020





Muzi Siyaya, new CEO of Semane

Semane welcomes new CEO

Engineering solutions provider Semane, which was spun off by Anglo American in 1998, has appointed Muzi Siyaya as its new CEO.

Muzi Siyaya holds an MBA from Wits University and joins Semane after spending six years at GIBB Engineering as group executive responsible for business development and strategy. Siyaya has more than 20 years' experience, having previously held senior management and executive roles at MTN, Cell C and Dimension Data subsidiary Plessey.

"The board believes Muzi's multifaceted experience will direct Semane into a new trajectory. He has broad business skills and experience in managing growth in a rapidly evolving business landscape," says executive chairman Joel Mokgohlwa.

Siyaya is taking over from founding CEO Joe Araujo, who is retiring from the company after 21 years at the helm and will continue in a consulting capacity. On behalf of the company and its stakeholders, Mokgohlwa

extends the board's profound gratitude and appreciation to Araujo for his impeccable service and leadership, which have seen Semane grow to its current market position as a respected engineering solutions consultancy, delivering sought-after expertise and experience.

Semane boasts clients such as Anglo American, Foskor, Exxaro, Rio Tinto, Seriti, BHP and Gold Fields, among others.

"I was attracted to Semane because it is a well-managed business that has stability, an enviable track record, a good culture and a great team. The framework for good governance that was laid by Anglo American 21 years ago is evident in the business today," says Siyaya.

"Semane is a company poised for its next growth trajectory. From that standpoint, I feel I can make a difference. I look forward to getting to know the people at Semane, our clients and partners." **35**

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