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THE NEW SANCOLD

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ON THE COVER

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Civil Engineering

June 2009

Vol 17 No 5

Published by SAICE/sAisi

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Annual Subscription Rate

SA R560,00 (VAT included), International US$120,00

Advertising

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Design and Reproduction

Marketing Support Services, Menlo Park, Pretoria

Printing

Ultra Litho, Johannesburg

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ISSN 1021-2000

Civil Engineering | June 2009
WHETHER THE CHALLENGE is finding and implementing complex and unique engineering solutions, successfully completing a wide range of construction projects quickly and expertly, working tirelessly with local communities close to where the contracts are taking place or fastidiously instituting practices for the protection of the environment, Sanyati Construction, a JSE-listed construction company, has developed a reputation with colleagues and clients alike for doing things with a hefty dose of excellence.

Many recent contracts have demonstrated Sanyati’s ability to work under extreme time pressure and to take on a wide variety of work in remote areas. One such example is a project at a leading mine in the Northern Cape. The mine is located in the Kalahari sands and ‘remote’ is more than an apt description of this location.

Sanyati’s full scope of works here includes bulk earthworks and terracing for a railway siding, a haul road, access roads and terraces, terracing for a coal fines stockpile (~6 mm), an Eskom yard and stockyards, and the construction of the bulk water connection, conveyor culvert and load-out silo.

The project started in November 2008 with the construction of the initial 4.2 km of the eventual 7.2 km haul road. After the clear and grub stage, 400 mm of topsoil was removed to a width of 23 m and spoiled. Thereafter a layer of Kalahari sand, 500 mm deep and 19 m wide, was also removed and spoiled. A three-sided impact roller was used to compact the bottom of the cut.

The material used for the construction of the haul road is known as “banded ironstone formation” (BIF), which is blasted in the mine. The layer works consist of a layer of BIF 1 m thick and a wearing course, 300 mm deep and 16 m wide, of crushed BIF (G5) mixed with clay.

In December 2008, the construction of the railway siding was awarded to Sanyati Central. This crucial piece of infrastructure consists of a 5 km railway loop, which links up with the existing railway that carries manganese to the
Sanyati Central Operations Director Louw De Bruin says that this seven-month project includes railway track construction, 3 kV dc electrification and overhead track equipment, signalling and radio communications, a load-out facility, rail turnouts and fixings. At present it is on schedule to be completed on time.

“An interesting feature of the railway contract was the stipulation that all filling be done with a G7 material, but because the BIF from the mine is suitable for this purpose, the specification was changed accordingly,” says De Bruin. The properties of the material make it difficult to process however. This is because BIF consists of large stones with very sharp edges which cut the tyres of the articulated dump truck (ADT) and roller while they are driving and working on the BIF.

For the railway project alone, more than 100 000 m³ of rock fill (blasted BIF) was required. The fill consisted of 500 mm layers of BIF (up to 3 m in places), followed by the layer works consisting of G5 and G2 (crushed BIF).

The construction of the load-out station/silo was done by Sanyati’s Concrete Division, Conform, which has developed an enviable reputation for its specialist skills in concrete work.

The silo, which has an internal diameter of 14 m and will stand 37 m high, will ultimately use 975 m³ of concrete and 145 t of reinforcing steel. Its foundation consists of a ring beam resting on 72 continuous-flight auger-grouted piles, while the thickness of the silo wall changes from 800 mm at the bottom to 300 mm at a height of 17,398 m.

There are also four 2 x 1,2 m columns reaching a height of 17,398 m, which accommodate a suspended slab 1,75 m thick.

André Coetzer, Sanyati Concrete manager, says they are sliding continuously on two 12-hour shifts with approximately 35 personnel on each shift.

“We slide both the columns and the bottom-wall section for 10 days until we reach the elevation height coinciding with the change in wall thickness. At this point we take five days to alter the inside shutter to accommodate the change of wall thickness and to ‘cut off’ the column.
The remaining section of the slide takes a further five days to complete,” says Coetzter.

Meanwhile, Sanyati Piling and Geotechnical have been contracted to install the piles for a number of different structures on the mine project, including those for the load-out silo, the railway culvert, the load-out bin and trestles.

Piling’s Anton Stoll says that the main challenges from a geotechnical point of view have been the sandy soils and the socket into the bedrock, which consists of calcrites in this area. “This meant, inter alia, that a powerful Bauer piling rig was required to install the 162 piles into bedrock at varying depths in order to support the loads for which they were designed,” said Stoll.

He adds that from the outset logistics was the key factor in this successful and fast-track programme. “The excellent working relationship between the various Sanyati companies and divisions made the logistics, planning and execution easier.”

This mine project is one of the most successful and dynamic operations of its kind in the world. Sanyati Construction has amply demonstrated its multi-disciplinary and organising capabilities and its ability to function as a unified construction entity.

INFO

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Crushing BIF 20 hours per day to meet the deadline
Strategic planning for water resources in South Africa

This article explains the thinking and planning of the Department of Water and Environmental Affairs (DWA) (formerly the Department of Water Affairs and Forestry), and how it seeks to meet its responsibility to reconcile growing water needs from a limited supply, now and in the future.

Historically the focus has been on major dams, irrigation schemes and inter-basin transfer schemes – all to meet agricultural, urban and industrial demands. The resource situation is very different now, with almost all readily available water already being put to use. Water resource planning can no longer simply propose the development of new schemes to supply demand, but must work towards the careful management and optimisation of existing uses.

The Department is required to ensure that water can be supplied to all major development centres, while also serving industrial and agricultural requirements on a regional and national scale. Planning must account for ecological imperatives, international obligations and human needs at a local level.

There is a growing emphasis on ways in which water can make a difference to people’s lives at all levels of economic growth and development.

Recognising that water does not drive development, but is the resource that underpins most, if not all, of it, it is the Department’s duty to be in a position to respond to the expected growth, and to ensure, where economically viable, that water is available when and where it is required.

The planning for water resources must be done far in advance of the actual need. While planning for the next 25 years is taking place, thinking has also to be extended beyond this to a time when there may no longer be ‘available water’ as we have come to know it. A long-term view is thus also required.

Strategic water resource planning in the Department of Water and Environmental Affairs

The Directorate of National Water Resource Planning, within the Chief Directorate: Integrated Water Resource Planning, is responsible for planning on a strategic level to ensure sufficient water resources for the country. Its work is aimed at providing raw water up to the point where this water is abstracted for purification and distribution to users.

The planning approach is to seek to reconcile the current and potentially available water resources with the growing requirements. Water quality, and the delivery of water fit for use, is a very critical consideration in determining availability. All responsible water management authorities need to understand the constraints that would be imposed by a lack of water so that they too can work towards a convergence of need and supply in their own planning and development initiatives.

An important cue for the Department has been the National Spatial Development Perspective, published by the Office of the State President in 2006, which has identified 26 core growth areas in which most of the country’s wealth is generated. It stands to reason that water resources need to be planned into the growth scenarios.

Planning has followed a logical sequence in seeking to contextualise the
water resource situation and to provide strategies and tools that can serve all levels of decisions. The sequence has been as follows:

- Compilation of the National Water Resource Strategy
- Development of the Department’s Internal Strategic Perspectives, addressing each of the 19 Water Management Areas
- Intensive reconciliation studies for the major metropolitan areas
- Studies focused on all other towns and villages across the country, with the intention of having a holistic water resource picture and plan for the country. These aspects are discussed below.

**THE NATIONAL WATER RESOURCE STRATEGY (NWRS) (2004)**

The first edition of the NWRS provides a clear indication of the overall state of the country’s water resources as of 2000, with projections up to 2025. Many catchments are shown to be under stress, with water requirements and existing allocations to users exceeding the available supply. By 2025 the situation is expected to worsen considerably.

The NWRS argued, nevertheless, that “In general, sufficient water can be made available at all significant urban and industrial growth points in the country for water not to be a limiting factor to economic development.” To achieve this, a number of reconciliation interventions were listed:

- Demand management
- Water resource management
- Managing groundwater resources
- Reuse of water
- Control of invasive alien vegetation
- Reallocation of water
- Development of surface water resources
- Inter-catchment transfers

This clearly indicated that the time has come to consider many interventions other than just adding more dams.

**THE DWA’S INTERNAL STRATEGIC PERSPECTIVES (ISPs – 2005)**

In the Department’s ISPs the water resource situation was reviewed for each of the 19 Water Management Areas, thus at a finer level of detail than in the NWRS. The ISPs pointed to the need for water reconciliation strategies to be conducted for all of the country’s major metropolitan areas, these being the recognised engines of growth of the economy. These strategies were addressed as the next core planning activity.

**RECONCILIATION STRATEGIES FOR LARGE METROPOLITAN AREAS**

The objectives of these reconciliation studies are to:

- Develop future water requirement scenarios
- Investigate all possible water resources and other interventions
- Investigate all possible methods for reconciling the requirements for water with the available resources
- Provide recommendations for the development and implementation of the interventions and actions required
- Propose a system for continuous updating into the future

The major reconciliation studies addressed thus far are listed below. The Western Cape Reconciliation Study was described in the June 2007 issue of Civil Engineering (pp 16 – 19). The Vaal River, Crocodile (West) and KwaZulu-Natal Coastal Metropolitan Areas Reconciliation Studies are covered in detail elsewhere in this issue.

- Completed studies are:
  - Western Cape Water Supply System
  - Amatole Bulk Water Supply System
  - Vaal River System

- Studies in progress are:
  - Crocodile (West) catchment, including the Waterberg coalfields
  - KwaZulu-Natal Coastal Metropolitan Areas
  - Algoa Water Supply Area
  - Mangaung Municipality (Bloemfontein area)

A study for the uMhlathuze Local Municipality, including Richards Bay, will start towards the end of 2009. Municipalities, provinces and other water management institutions are generally providing excellent cooperation and are assisting in dealing with the uncertainties in the planning process and the formulation of the planning scenarios.

The most important conclusions arising from these studies are:

- Water-use efficiency measures (Water Conservation and Water Demand Management) must be implemented as a matter of urgency. For many of the systems investigated no other measure can be implemented in time to prevent shortages over the medium term. If water is not used more efficiently, shortages will develop and water restrictions will become inevitable. There is still enough time to implement structured programmes to achieve greater efficiency, provided these are well managed and given political support.

- The reuse of water has been identified as a major potential source of water for coastal cities. In some inland areas this has now also become a necessity. Return flows from Gauteng have been identified as the best resource for developments on the Waterberg coalfield near Lephalale in Limpopo Province.

- Groundwater resources are of particular importance, not only for smaller towns, but also for larger cities such as Cape Town.

- Further development of surface water resources also has to occur. For each area the strategies and their implementation will have to be adjusted as the future unfolds. The strategies will be taken forward by Strategy Steering Committees which will include important stakeholders in each area. These committees are being set up to monitor actual water use and the implementation of interventions, to assess the results from further planning studies and to make recommendations on the approaches taken. This will happen annually and a 25-year time horizon will be maintained.

**RECONCILIATION STRATEGIES FOR ALL OTHER TOWNS**

A major planning thrust, which was started in June 2008, is to extend the planning process discussed above to cover all other towns in the country as well. This study intends to deliver a thorough situational analysis for all towns, particularly those where water resources are scarce. Typically, multi-faceted strategies will be required in the search for solutions. Infrastructure, management and capacity problems will also be highlighted.

**WATER SUPPLY TO THE ENERGY SECTOR**

The Department works very closely with the large water users in the energy sector to ensure that existing and planned power plants and other energy industries, as well as possible future power plants, are taken into account in its water resource planning.

The planned power stations and coal-to-liquid plant in the Lephalale area...
will be supplied primarily from return flows from Gauteng in both the Crocodile (West) and Vaal catchments. A feasibility study is currently being done on the pipelines, pumping stations and reservoirs that will be required for these transfers.

**WATER SUPPLY TO THE AGRICULTURAL SECTOR**

Even though South Africa has moved on to a diversified and modern economy, irrigation still uses some 60% of the country’s available water resources. Agriculture’s (irrigated and dryland) direct contribution to the GDP is relatively small at 3%, although its indirect contribution, in forward and backward linkages, is indisputably much higher. Given the very high consumption demand of irrigation, it becomes a particularly important strategy to increase agricultural water-use efficiency.

New ‘greenfields’ irrigation projects will of necessity be very limited. The expected trend is that the application of the water resources will move up the value ladder, i.e. either that crops of higher value will be produced, or that water will migrate from the irrigation sector to other sectors of higher value. The Department will continue to support viable irrigation projects but will also facilitate agreed improvements in the application of the water resource asset base.

**CLIMATE CHANGE**

The planning of water resources requires the consideration of many uncertainties, including the extent and nature of future requirements, and the inaccuracy of our knowledge of both rainfall and runoff. Climate change adds to the uncertainty, with trends becoming the most important feature to be distilled from historical records.

Climate change is an accepted reality, although in South Africa the actual impacts are not yet obvious. The Department considers the long-term predictions in its planning and makes allowances for these. At present climate change can be viewed as an added uncertainty, with impacts that can be mitigated. The relatively gradual nature of climate change allows time for well-considered adaptation measures. What is important is that the monitoring of rainfall and runoff must be continued rigorously, and the hydrological monitoring network must be improved to ensure that the actual effects of climate change are measured accurately and brought into the analysis of resources as quickly as possible.

**CONCLUSIONS**

*Are we keeping up?*

Water resource planning is structured but flexible, with the Department being guided by national policies, plans and programmes. Flexible reconciliation strategies have been developed and will ensure water for the large metropolitan areas if implemented in time. The Strategy Steering Committees will keep the strategies relevant and will monitor changes and the implementation of interventions to maintain a 25-year planning horizon.

*There are challenges left*

Deterioration in water quality is a huge threat and will have to receive much focused attention. Every sector and every individual needs to recognise the water resource limitations. Bringing all South Africans up to an acceptable standard of water-related service and

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We can no longer afford to stay in the world of one dam, one valve, one pump, one pipe and one operator, but have to work towards the complex optimisation of various distributed sources and savings. This may be less grand, but it is no less complex than the giant construction schemes of the past.
delivery remains a tough challenge in this context. Recognising the limits of what is possible in water-scarce areas, becoming more efficient, using less water, and in some cases moving water from traditional uses such as agriculture into urban and industrial development, are all challenges we shall have to face. The reuse of water is both a technical and a social challenge. The National Water Act demands that the environmental standards of rivers be upheld for our own preservation. Technical and management skills in the water sector are needed in both local and national government. Above all else, neither the Department nor the country can afford to slip on the long time horizons, and must retain the skills and capacity that will allow the identification and implementation of necessary measures in good time.

Gazing into the crystal ball
We do not know just where the planet is headed, whether ‘minor’ economic corrections will yet become major planetary adjustments. The conservative view of growth suggests that where people live will be increasingly dominated by the availability of water and the cost of that water. The reuse of all water will be the norm. Desalination technologies will provide enough water to the coastal cities, but desalinated sea water is unlikely to be affordable inland. Industries will lead the way by relocating where there are cheaper water sources and people will follow. Water may become too valuable to continue using it in the irrigation schemes we have nurtured in the past. It may be economical to shift such agriculture north beyond our borders. If it is to grow as a populous industrial nation, South Africa may have to rely on importing ‘virtual water’ from the rest of Africa through the food produced there.

Where does this leave the civil engineer?
The biggest challenge to the civil engineer is to adapt, and this is not happening fast enough. Far too many schemes are being planned at local level, perhaps with the best of intentions, in the paradigms of the past: capture and store surface water; pipe it; pump it; move it; and use it. We can no longer afford to stay in the world of one dam, one valve, one pump, one pipe and one operator, but have to work towards the complex optimisation of various distributed sources and savings. This may be less grand, but it is no less complex than the giant construction schemes of the past. Indeed, systems are likely to be far more complex and far more demanding of detail and innovation. Engineers urgently need to move into the new realms of water conservation and demand management, resource protection and the reuse of polluted and contaminated water in all its bewildering variety. They need to design and develop multiple conjunctive sources, to improve desalination technology and to see that we are effective in bringing water to our country. The excitement lies in stripping off the shuttering and getting immersed in solutions for the future.
Vaal River System:
Large Bulk Water Supply Reconciliation Strategy

THE PURPOSE OF THE Large Bulk Water Supply Reconciliation Strategy Study for the Vaal River System Study is to develop a strategy for meeting the growing water requirements of the industrial and urban sectors that are served by the Integrated Vaal River System (IVRS).

The key objectives are:
- Update the current and future water requirements
- Assess the water resources
- Formulate reconciliation interventions
- Consult stakeholders during the development of the strategies

STUDY PROCEDURE AND METHODOLOGY
The overarching study approach was to develop reconciliation strategies in two stages. The first stage involved developing and assessing scenarios of possible future reconciliation options. These scenarios were presented to the management and stakeholders of the Department of Water and Environmental Affairs (DWEA, formerly DWAF, the Department of Water Affairs and Forestry) for comments. Further necessary investigations were identified during the development of the Second Stage Reconciliation Strategy and the results are reported on in this article.

An essential part of the strategy development process was the integration of information from various processes in order to arrive at a strategy that will account for all the major aspects that influence the bulk water supply situation in the Vaal River System.

Information was sourced from the following studies:
- Vaal River Reconciliation Strategy Study

Map of the Integrated Vaal River System
Integrated Water Quality Management Plan Study for the Vaal River System
Potential Savings through Water Conservation/Water Demand Management (WC/WDM) in the Upper and Middle Vaal Water Management Areas
Crocodile (West) River Reconciliation Strategy Study

An integrated stakeholder-engagement process was followed for the three Vaal River studies, which ensured the coordination of interdependent activities.

WATER REQUIREMENTS AND RETURN FLOW SCENARIOS

The system provides water to one of the most populated and important areas in the country as reflected by the magnitude of the developments located in the Upper and Middle Vaal, the Olifants and the upper portion of the Crocodile West/Marico Water Management areas. These developments include many of the country’s power stations, gold mines, platinum mines, petro-chemical plants, sprawling urban development, and various other strategic industries. The water requirements in the area are therefore very important to sustain the economy of the country and the well-being of its people.

Urban water requirement scenarios were developed for the Rand Water supply area by applying the Water Requirement and Return Flow Model for the planning period up to 2030. Three population scenarios were developed as main drivers of the model.

The Water Requirement and Return Flow Model was configured for 47 sewage drainage areas (SDAs) and calibrated for the census year 2001. The calibration involved changing model parameters to match both the water use and the return flows observed for each SDA.

Water requirement scenarios for Sedibeng Water and MidVaal Water Company were obtained from the respective organisations. For all the other urban areas the water requirement projections were determined using the growth rates from the National Water Resource Strategy (NWRWS).

There are three main industries receiving water in bulk from the Vaal River System: the electrical power utility Eskom, the petrochemical (coal-to-liquid fuel) industry Sasol and Mittal Steel, all of which provided water requirement scenarios based on their respective future outlooks.

The Department did a thorough investigation of irrigation upstream of the Vaal Dam and found that as much as 174 million m³/annum of the year 2005 irrigation water use could be unlawful. This is an unacceptable situation that puts the other users from the Vaal River System under a very high risk of shortages and water restrictions. The Department has already started with actions to remove the unlawful irrigation.

In addition to the above, the water balances for the Crocodile (West) System and the Lephale Area indicated that additional raw water transfers will be necessary from the Vaal. The necessity for this transfer results from the proposed developments on the Lephale coal-fields, which include new power stations planned by Eskom and a possible new coal-to-liquid plant planned by Sasol.

WATER CONSERVATION AND WATER DEMAND MANAGEMENT SCENARIOS

The focus of the WC/WDM assessment was on the nine largest urban water users, which in total used 1 186 million m³/annum of water in 2004. A standard water balance was compiled for each municipality; these were built up from assessments of water supply zones in their respective supply areas to represent the actual conditions in each zone. From this water balance the potential savings were determined, with the focus on the components billed but not paid for consumption and potential savings on physical leakage.

Based on detailed assessments of the specific situation in each municipal area, the potential savings, coupled with a range of WC/WDM measures, were determined and costed.

WATER RESOURCES

The core of the Integrated Vaal River System consists of the Upper, Middle and Lower Vaal River Water Management areas. However, due to the numerous inter-basin transfers, reconciliation planning has to include the linked systems. Significant water transfers occur to water users in the Crocodile (West) River catchments through the Rand Water system.

In addition, a scheme is proposed to transfer water from the Crocodile (West) River Management area to the Lephale area (Mokolo River System) in order to address the increasing water needs resulting from significant future developments planned in the area. Figure 1 shows a geographical map of the water resources of the Integrated Vaal River System and the respective inter-basin transfers.

BULK AUGMENTATION OPTIONS

The Vaal Augmentation Planning Study (VAPS), completed in 1996, concluded that either a further phase of the Lesotho Highlands Water Project (LHW) or further water resource developments in the Thukela River System could be considered as alternatives for augmenting the water resources of the Vaal River System. Further parallel feasibility and comparison studies were carried out for these two options.

PERSPECTIVE ON WATER QUALITY MANAGEMENT

A water quality situation assessment of the Vaal River System was carried out as part of the Integrated Water Quality Management Plan (IWQMP). It was found that salinity (represented by total dissolved solids), eutrophication and microbiological water quality were the major water quality issues that need to be addressed by the strategy.

The salinity in the Grootdraai Dam and Vaal Dam catchments is currently adequate and meets the water user requirements. However, the water quality in both these dams is influenced by the water quality of the transfers from the Lesotho, Thukela, Zaaihoek and Usutu transfer schemes. Currently, this transfer water is of good quality and assists in maintaining the present water quality in these dams, but the water quality in Grootdraai Dam is under threat from mining, in particular from decants from closed mines in the catchment. The salinity deteriorates significantly downstream of the Vaal Barrage due to urbanisation, return flows from wastewater treatment works, and industrial and mine dewatering discharges. The current status does not meet the Resource Water Quality Objectives (RWQOs) set for this reach of the river.

The water quality assessment showed that the Vaal Dam, the Vaal Barrage and the Bloemhof Dam are eutrophic to hypertrophic. The average phosphorus concentrations exceed the proposed RWQOs significantly. The eutrophic conditions in the middle reaches of the Vaal River have affected...
the performance of the water treatment plants of Midvaal and Sedibeng Water. Additional treatment processes to deal with the colour and odour have had to be installed. The major source of the nutrients is the effluent from wastewater treatment works (WWTWs) and the maintenance of the sewerage systems. A number of WWTWs are not performing according to specifications.

The findings from the IWQMP were used to formulate a number of management measures to improve the water quality in the system.

The proposed immediate to short-term management strategy is:
- Continue with dilution of the Vaal Barrage water with releases from the Vaal Dam and levy waste-discharge charges to offset the economic disbenefit of the downstream users.
- Select target schemes for treating saline effluent.
- Incorporate additional dilution releases to manage the algal blooms in the middle reaches of the Vaal River.
- Audit WWTWs and develop perspectives on hotspots requiring urgent action.
- Effect the control of pollution sources through licensing and integrated water and waste management plans.

The medium to long-term management strategy is:
- Implement schemes for treating saline effluent.
- Implement the system of charging for waste discharge.
- Implement WWTP retrofit and upgrading projects in the ‘hot spot’ areas.

**WATER BALANCE AND RECONCILIATION**

Given the water requirements and return flows and the potential saving scenarios, the need for intervention was determined by assessing the water balance situation over the planning period. This was undertaken by firstly defining the planning scenarios and, secondly, carrying out scheduling analysis to determine the dates when further intervention may be required.

The water balance situation in the Vaal River System is presented in Figure 2 for the high water requirement scenario without the implementation of further WC/WDM measures. The unlawful irrigation water use was removed, as shown by the reduction in the system demand between 2008 and 2011. This scenario results in significant shortages (deficits) in supply until 2021 when the Polihali Dam (Lesotho Highlands Water Project Phase 2) will be able to deliver its full yield. Jana Dam in the Thukela River has to be implemented shortly thereafter to commence delivery in 2025.

The effect of implementing measures to reduce water loss through WC/WDM activities is illustrated in Figure 3. This shows significant reduction in the shortages up to 2021 and that only the Polihali Dam and the much smaller Mielietuin Dam in the Bushmans River (a tributary of the Thukela River) are needed to achieve a water balance up to 2030.

The remaining shortages indicated for 2015 to 2020 could be alleviated by desalination of mine water effluent for reuse.

**RECONCILIATION STRATEGY**

Ensuring that sufficient water is available to meet the future water requirements in the supply area of the Vaal River System requires a six-pillar strategy consisting of the following main components:

1. Enforcement of compliance with water use arrangements to eradicate unlawful water use
2. Water conservation and demand management measures to reduce losses and improve efficiency
3. Utilisation of treated effluent and other discharges, especially those from the mines
4. Implementation of the infrastructure augmentation option
5. Management of the water quality in the system
6. Constitution of a Strategy Steering Committee

The reasons behind these and other recommendations for water resource management are given below:

![Reconciliation scenario excluding further WC/WDM](image1)

![Reconciliation scenario with WC/WDM loss management measures](image2)
Eradication of the unlawful water use is essential in order to rectify the current deficit in the Vaal River System. The Department has already started a process in which legal and compliance enforcement measures are being investigated for an enforcement campaign.

The continuation of further WC/ WDMs is essential to maintain a positive water balance in the Vaal River System over the next ten years. Savings of about 15% are required.

The results from detailed simulation analysis indicated that the reuse of mine water effluent, in combination with other interventions, could have a significant benefit by postponing the need for further augmentation after the implementation of Phase II of the Lesotho Highlands Water Project. A feasibility study will be carried out to evaluate all the options to find an optimum solution.

Cabinet has given its approval that the Department should proceed with negotiations with the Government of Lesotho for the implementation of Phase 2 of the Lesotho Highlands Water Project. This scheme consists of the construction of the Polihali Dam and a conveyance tunnel to transfer water under gravity to the Katse Dam, from where it will be delivered to South Africa via the existing delivery tunnel.

The Strategy Steering Committee (SSC) will oversee the implementation and continuous revision of the Reconciliation Strategy.

CONCLUSIONS
The recommended strategy provides the focus for water management in the Integrated Vaal River System. Successful implementation of the strategy will require the commitment of and substantial resources from the Department of Water and Environment Affairs (DWEA, formerly DWAF) and other institutions.

The interdependency of the Vaal River and Crocodile (West) River systems will require coordinated and synchronised planning in future to ensure coherent management of the water resources.

Cooperation among water service providers, municipalities, industries and the DWEA in the implementation of the strategy will be essential to foster the principles of integrated water resource management and to achieve the objectives of the strategy.

PROJECT TEAM
The study was undertaken for the Directorate of National Water Resource Planning by DMM Development Consultants, Golder Associates Africa, SRK, WRP Consulting Engineers and Zitholele Consulting, supported by various subconsultants, collaborating institutions and DWEA directorates.

Project status Completed in March 2009.
INTRODUCTION
The Crocodile (West) River catchment area is one of the most developed river catchments in the country. It is characterised by the sprawling urban and industrial areas of northern Johannesburg and Pretoria, extensive irrigation downstream of the Hartbeespoort Dam and large mining developments north of the Magaliesberg. As a result, the Crocodile River is one of the rivers in the country that has been most influenced by human activities, and one for which more specific management strategies are of paramount importance.

The purpose of this study was to formulate a detailed strategy to ensure the sufficient and reliable supply of water of appropriate quality to all existing, as well as future users. This should be achieved within the framework of the best utilisation of water resources, at the lowest cost and in an environmentally sustainable manner.

The strategy caters for both existing and future needs, and is sufficiently comprehensive and flexible to enable a quick response to changing circumstances. It takes cognisance of possible future scenarios and impacts, and identifies preferred options and interventions that could be implemented as being most appropriate to the situation. Although a chronology of events and time scales is considered, the strategy should not be viewed as a rigid single plan with fixed sequencing and time scales. The development of the strategy was facilitated in an open process and one
of the mechanisms employed will be a steering committee which is representative of sectors important to the study.

THE STUDY AREA

The study area covers the whole of the Crocodile (West) River catchment as shown in Figure 1. The Mokolo River catchment, where water supplies to the large mining, power generation and petrochemical developments in the Lephalale area need to be augmented from or via the Crocodile River catchment, is also included.

Currently, roughly 70% of the GDP for Gauteng Province is generated in the Crocodile River catchment. Also about 80% of the GDP for the North West Province, mostly from platinum mining, and in the order of 20% compared with Limpopo Province, is generated in this catchment. In total, about 25% of the national GDP is generated in the Crocodile River catchment.

The water resources that occur naturally in the Crocodile River catchment have already been fully developed and most of the tributaries, as well as the main stem of the river, are highly regulated. Because of the extensive developments and level of human activity in the catchment, water use in the catchment far exceeds the water available from the local sources – already more than fourfold. Most of the water used in the catchment is supplied from the Vaal River System via Rand Water, mainly to serve the metropolitan areas and some mining developments. This in turn results in large quantities of effluent from the urban and industrial users, most of which is discharged into the river system after treatment for reuse downstream. In many of the streams and impoundments, water quality is severely compromised by the proportionately large return flows.

These influencing factors are inextricably linked together through various complex inter-relationships and are not to be viewed in isolation.

WATER REQUIREMENTS AND RETURN FLOW SCENARIOS

Estimates were made of the current and future requirements for water for the following sectors:

- Urban, which consists of (i) domestic or household use of water and (ii) commercial, industrial and public use of water
- Rural water requirements, which include domestic use and stock watering
- Irrigation requirements for commercial agriculture
- Mining water requirements
- Power generation in the Crocodile catchment
- Transfers of water to neighbouring areas; this relates mainly to the Lephalale area, for which different development scenarios were also considered, mostly for the energy sector

Urban water requirement scenarios were developed by applying the Water Requirement and Return Flow Model for the planning period up to 2030. One of the driver variables in the model is population. Three population scenarios were developed, with the information from Statistics SA (2007) forming the base scenario, and two further alternative scenarios (high and low).

The 2005 urban population in the Crocodile River catchment of about 4.5 million people is expected to grow to
between 5.3 and 7.1 million by 2030. The 2005 rural population of just more than 1.0 million people is expected to grow to between 1.1 and 1.2 million by 2030. As a consequence, the 2005 urban water requirements are expected to grow from the current 570 million m³/a to between 640 and 850 million m³/a in 2030. The rural requirements are expected to grow from 15 million m³/a to between 40 and 44 million m³/a during the same period.

The existing irrigation requirements are about 450 million m³/a and are expected to remain at that level. Mining water requirements are expected to increase from about 90 million m³/a to between 140 and 150 million m³/a in 2030. The existing water requirements for power generation at the three power stations are 34 million m³/a, and stock watering requirements have been estimated at 22 million m³/a. No change in these requirements is expected.

In total, the water requirements of all the users within the Crocodile River catchment are expected to grow from about 1 100 million m³/a in 2005 to between 1 300 and 1 500 million m³/a in 2030.

Future transfers of water to the Lephalale area will significantly influence the water balances in the subareas of the Crocodile River catchment. The extensive developments associated with the Waterberg coalfields in the Lephalale area were planned for. Construction of the Medupi Power Station started in 2007 and additional water will be required by the time the third unit of the plant is commissioned. Three more Eskom power stations are likely to be built and proposals for the establishment of power stations by independent power producers are under consideration. Sasol is investigating the feasibility of a coal-to-liquid fuel plant in the area. All these and consequential secondary and tertiary developments are expected to increase the water requirements substantially in the Lephalale area from about 20 million m³/a to over 185 million m³/annum by 2030.

WATER CONSERVATION AND WATER DEMAND MANAGEMENT SCENARIOS

Specific consideration was given to Water Conservation and Demand Management (WCDM) and the influences of different levels of WCDM were investigated. The focus was on the urban water users, which already represented over 50% of the water use in the catchment in 2005.

Based on the detailed assessments made of numerous supply zones in each municipal area, the potential savings, coupled with a range of water conservation/water demand management (WC/WDM) measures were determined. With the knowledge that these measures will require substantial financial and human resources to implement, a schedule (projection) of future savings was made, resulting in the development of four scenarios.

WATER RESOURCES

The following main components were considered with regard to the availability of water:

- Local resources, which comprise (i) surface water, (ii) groundwater and (iii) increases in runoff from paved urban areas
- Return flows from urban areas and from irrigation
- Transfers of water from the Vaal River System

Due to the high degree of development and regulation of the water resources in the catchment, and to the large quantities of return flows to many tributaries and eventually to the main stem of the river, the natural flow regime of streams in the catchment has been greatly altered. This will limit the extent to which natural variability can be reinstated through the implementation of the reserve.

BULK AUGMENTATION OPTIONS

It was assumed that Rand Water’s current water users will continue to be supplied by them. Local water sources (including return flows) will be used to meet the growing water requirements in those areas not supplied by Rand Water. With these assumptions, the water transfers from the Vaal River System to the Crocodile River catchment are expected to increase from 550 million m³/a in 2005 to as much as 800 million m³/a in 2030. Proper synchronisation between the reconciliation strategies for the Crocodile (West) and Vaal River Systems was therefore done.
**PERSPECTIVE ON WATER QUALITY**

Although the reconciliation strategy is focused mostly on water quantity (with water quality being dealt with in detail in other studies), some key perspectives on water quality are given below:

- The water quality in streams and impoundments downstream of the major urban areas is poor as a result of the return flows and urban wash-off. This has serious environmental impacts and can also limit the potential for reuse. The poor quality of water in the Hartbeespoort Dam is a major concern.

- Irrigation return flows and runoff from highly fertilised rain-fed cultivation areas also impact on downstream water quality.

- As a result of these impacts, the Hartbeespoort and Roodeplaat Dams are highly eutrophic.

**WATER BALANCES**

The main growth in the available water resources is expected from the growth in water requirements, which in turn will generate effluent. Given the underlying purpose of the strategy, namely to reconcile the requirements for water with the availability thereof, there are different scenarios of growth in demand, each of which will again have an impact on the availability of effluent. Different WC/DM measures will also have different impacts on the quantity of effluent. Various combinations of WC/DM measures and growth scenarios were tested, and one of these scenarios is shown in Figure 3. The scenarios are the same as those for the Vaal River System Reconciliation Strategy. The top black line indicates the total water availability and the bottom red line indicates the total water requirements of the Crocodile River catchment. The difference between the two lines represents the surplus volumes of water available for transfer to the Lephalale area.

On the Lephalale side various scenarios were also considered. The high scenario is currently being used in the planning for the transfer pipeline, taking into account five Eskom power stations, a coal-to-liquid fuel plant, the water requirements of the coal mines and consequential secondary and tertiary developments in the Lephalale area. The water balance for this scenario is shown in Figure 4.

The blue line indicates the available yield from the Mokolo Dam. The black line represents the combined Mokolo Dam yield plus the surplus in the Crocodile River catchment for the scenario of high population growth with medium-efficiency water demand management in the Crocodile River catchment. The red line represents the expected future water requirements in the Lephalale area. For this specific scenario the Mokolo Dam should be able to meet the growing water requirements in the Lephalale area until about 2011, after which the supply will have to be supplemented from the Crocodile River (where the blue and red lines cross). After 2013 (where the red and black lines cross) the Crocodile River resources will have to be supplemented by a transfer from the Vaal River System.

**RECONCILIATION STRATEGY**

The strategy is not intended to be a single master plan with fixed sequencing and
time scales, but should cater for a spectrum of plausible future scenarios, and also be both flexible and robust under changing conditions.

The strategy can be broadly classified under the following three key geographic areas:

(i) Gauteng North, which is mainly the part of the catchment south of the Magaliesberg: Water for urban and industrial use in the Gauteng North area will continue to be supplied by Rand Water.

(ii) The Crocodile River catchment north of the Magaliesberg: Growth in water requirements in this area will be met from the growing effluent return flows from the urban and industrial users south of the Magaliesberg.

(iii) The Lephalale area: Surplus effluent from the Crocodile River catchment will be supplied to the Lephalale area. Future projected deficits will be made up with transfers from the Vaal River. It has already been decided that effluent from Johannesburg Water Treatment Works situated south of Soweto could be used for this. This part of the strategy is also covered in the Vaal Reconciliation Strategy.

IMPLEMENTATION OF THE STRATEGY

For this strategy to be implemented and to serve its purpose properly in the future, the water balance situation needs to be monitored continuously and the strategy must be regularly updated and maintained in general. This will ensure that intervention planning can be adjusted to take account of any changes that may have an impact on the projected water balance.

A Strategy Steering Committee will be constituted, with members from the Department of Water and Environmental Affairs (DWEA, formerly DWAF) and other key stakeholders. It will be a voluntary body operating at a strategic level and ensuring that the technical aspects of the strategy are transparent, open and consultative, and that cooperative governance is embraced.

STATUS OF THE STRATEGY

The information and perspectives given above were taken from Version 1 of the Reconciliation Strategy for the Crocodile (West) Water Supply System, and are therefore subject to review and refinement. Some of the information is still being verified and a final version of the strategy is planned for the end of 2009.

PROJECT TEAM

The study was undertaken on behalf of the client, Directorate: National Water Resource Planning of the Department of Water and Environmental Affairs (formerly the DWAF), by BKS and by Arcus Gibb, supported by various subconsultants, collaborating institutions and DWEA directorates.
Strategies to ensure sufficient water availability for the KwaZulu-Natal Coastal Metropolitan Area

The water requirements of the KwaZulu-Natal (KZN) metropolitan areas have been growing rapidly as a result of the expanding economy, urbanisation, several large new infrastructure projects and a general improvement in the existing water supply services. These trends are expected to continue in future and to deal with this situation the Department of Water and Environmental Affairs (DW and EA, formerly DWAF), in collaboration with all major water services organisations, has developed strategies on how to meet future water needs up to 2030. The proposed strategies were developed through the Water Reconciliation Strategy Study for the KwaZulu-Natal Coastal Metropolitan Areas, which is in the process of being completed.

The aim of the Reconciliation Strategy Study is to identify, evaluate and prioritise interventions to reconcile the water requirements with the available water resources up to 2030. All key stakeholders were included in the development of the Reconciliation Strategy and the recommendations were derived through a transparent and open process, resulting in collective endorsement. The strategy must be sufficiently flexible to accommodate future changes in actual water use since it is impossible to predict the future demands with certainty, due to the numerous factors that can influence such demands. It is also important to identify the actions and responsibilities required to implement the strategy.

The study area extends from Pietermaritzburg to Durban (west to east) and from KwaDukuza (Stanger) in the north, to Amanzimtoti in the south. It includes the eThekwini Metropolitan area and the Msunduzi and iLembe Municipalities – as reflected in Figure 1. This is one of the most densely populated areas in South Africa with approximately 5.2 million people and is the third-largest contributor to the national economy.

WATER REQUIREMENTS AND RETURN FLOW SCENARIOS

The urban sector is the largest water user in the study area and has experienced continuous growth in water use over a period of many years, which can be attributed to the favourable socio-economic conditions in the region. The economic prospects, coupled with the rising living standards of the population, as well as other factors such as HIV/AIDS, will have a significant influence on the future water requirements.

Sophisticated models were used to assist in developing water requirement and return flow scenarios for each sewer drainage area (SDA) – delineated to represent the area contributing to...
each waste water treatment works. Population, service level and land-use information were the main factors used in the models to estimate the future water use. In total, 53 areas were configured.

The population scenarios were developed by Prof Jeff McCarthy of the University of KwaZulu-Natal and additional information from the housing implementation programmes of the eThekwini and Msunduzi municipal areas was used to refine the estimates.

The water requirement scenarios for the North Coast areas were based on various planning studies carried out by Umgeni Water, the DWEA and the iLembe District Municipality.

Various scenarios of future requirements were developed and the ‘high’ scenario was used in the planning to ensure that measures are in place to deal with that. The other scenarios were used mainly to check the impact on timing of the measures, as well as to ensure that the recommendations remain stable.

WATER CONSERVATION AND WATER DEMAND MANAGEMENT SCENARIOS

A key element of the Reconciliation Strategy was the assessment of the potential savings that could be achieved through the implementation of various Water Conservation and Water Demand Management (WC/WDM) measures. The eThekwini Municipality has a WC/WDM programme in place covering a wide range of measures for reducing losses and improving the efficiency of water use. Following detailed consultation with eThekwini it was estimated that there is scope for further WC/WDM initiatives in eThekwini and that further savings of between 9 and 23% are achievable. In the case of the Msunduzi Municipality it was estimated that savings of between 15 and 31% are achievable through further WC/WDM activities.

The harvesting of rain water, through the use of roof tanks, was identified as a measure that should be promoted and encouraged throughout the area. This will limit users’ dependence on the formal water supply and also stimulate a culture of efficient water use.

Scenarios of future savings were developed, along with a programme of measures that could be implemented. This information was integrated into the various water requirement and return flow scenarios.

WATER RESOURCES

The water resources supplying the KZN Metropolitan Area can be divided into the Mooi-Mgeni and the North Coast systems.

The Mooi-Mgeni River System includes the Mooi-Mgeni Transfer Scheme which pumps water from the Mearns Weir on the Mooi River into a stream flowing into the Midmar Dam. The Albert Falls and Inanda Dams in the Mgeni River provide additional storage. The bulk water distribution and treatment facilities are managed by Umgeni Water. The conveyance pipe network is illustrated in Figure 1.

The North Coast System consists of the Mdloti River, regulated by the Hazelmere Dam in the south, and the largely unregulated Mvoti River from where river-runoff abstraction takes place, and extends to the Thukela River in the north.

BULK AUGMENTATION OPTIONS

Various possible future surface water resources with their associated conveyance systems were identified and considered as schemes to meet the growing water requirements. They were:

- Spring Grove Dam in the Mooi River
- Smithfield Dam in the Mkomazi River
- Raising of the Hazelmere Dam to augment the supply in the North Coast Area
- Abstraction of water from the Lower Thukela River to supply the Far North Coast Area
- A dam on the Mvoti River

REUSE OF WATER FROM WASTE WATER TREATMENT WORKS

Significant volumes of treated waste water are processed by eThekwini and preliminary evaluations of the volumes from the different treatment works indicated that approximately 60 million m³/annum would be suitable for further treatment to meet urban water-use requirements.

The time taken to implement a reuse scheme is significantly shorter than that for a large dam development, which makes it an attractive option. eThekwini has initiated a dedicated
feasibility study to investigate this option in more detail. Umgeni Water is also investigating the feasibility of reusing water from the Darvill treatment works.

**DESALINATION OF SEA WATER**

A study to investigate the feasibility of desalination of sea water as an option to provide additional domestic water is being undertaken by Umgeni Water. Preliminary indications suggest that desalination of sea water is still more expensive than other options, although it is recognised that at some point in the not-too-distant future this form of water treatment will become economical.

**YIELD ASSESSMENTS**

Information on the availability of water from the existing water resources and potential bulk schemes was obtained from previous hydrological and system analysis studies. Only in cases where assumptions have changed were the yield analyses revised using the Water Resources Yield Model.

**WATER BALANCE AND RECONCILIATION**

The water balance situation for the Mooi-Mgeni River System is presented in Figure 2. The upper water-requirement projection represents the ‘high’ scenario which excludes further WC/WDMs and the lower projection indicates the ‘high’ water-demand scenario based on the case where water-loss management initiatives have been implemented. If one compares the water requirements with the existing long-term system yield it can be seen that there is currently a significant shortfall.

The only suitable option for reducing the shortfall in the short term is to implement WC/WDMs. However, even with the WC/WDM savings, the system will remain in a negative balance situation until the Spring Grove Dam can deliver
Further augmentation will be required in 2017, which is two years before the earliest possible commissioning date for the Smithfield Dam (Mkomazi-Mgeni Transfer Scheme). The shortfall from 2017 to 2020 can be met by reusing treated waste water as indicated. However, it would also be possible to exploit the reuse option to the full. This would delay the need for the Mkomazi River development to beyond the current planning horizon of 2030. This is shown in Figure 3.

Figure 4 presents the projected water balance for the combined Mdlozi (Hazelmere Dam) and Mvoti River Systems and indicates that shortfalls will be experienced even with the raising of the Hazelmere Dam until a reuse option can be implemented in 2014. The earliest date by which the Mvoti development (a large dam) could deliver water is 2018, as indicated.

The reduction in yield in 2019 indicated in Figure 4 represents the implementation of the Ecological Water Requirements (EWR), involving river releases from the Hazelmere Dam. This will be possible only when the development on the Mvoti River has been commissioned, in order to limit the risk of supply failures over the short term.

An alternative augmentation scheme to the reuse option involves utilising the surplus yield in the Lower Thukela River, which could deliver water by 2014. This Lower Thukela option does not require a regulating storage structure and hence a significantly shorter implementation period is needed compared with the Mvoti River development option. However, it will limit the availability of additional water supply to other areas in the Thukela River.

**MANAGING THE INITIAL SHORTAGES**

Both Figures 2 and 3 show shortages from now until other measures can be implemented. The line on each graph showing the water available from the current schemes is based on the so-called 1:100 year yield, which is an appropriate assurance level used in the planning for metropolitan areas. This effectively means that shortages will be experienced by the users only if a very severe drought occurs during this period. It is thus entirely possible that this period may pass without any problems. However, if a serious drought occurs, it will mean that water restrictions will have to be implemented rigorously to ensure that basic human needs and the requirement for the industries that drive the economy of this area are met.

**PERSPECTIVE ON WATER QUALITY MANAGEMENT**

The following water quality management issues will have to be considered when evaluating the indirect and direct reuse options proposed in the Reconciliation Strategy:

- The waste water treatment plants (WWTPs) identified for reuse must be functioning correctly and producing water of a quality that is consistent with the installed technology. The industrial component of the effluent should also be limited to 10%.
- The water from the WWTPs that is prepared for indirect reuse will require an additional process to remove nutrients and microbiological pollution. This will protect the water stored in the receiving dams from becoming eutrophic.
- The water from the WWTPs may contain harmful levels of endocrine disruptors, pathogens and toxic substances. A number of barriers must be added to the process to produce water suitable for reuse as potable water.
- The public’s perception of reused water and possible resistance to consuming it will have to be managed very carefully. The issues listed above will be addressed in more detail in the reuse feasibility study begun by eThekwini.

**STAKEHOLDER INVOLVEMENT**

From the outset of the study, partnerships were formed with key stakeholders representing the various sectors of society and, in particular, close cooperation was achieved between eThekwini Metropolitan Municipality, Umgeni Water and the DWEA.

Stakeholder involvement was facilitated by various public meetings at which representatives were selected to serve on the Study Steering Committee. The management of technical matters was undertaken by a Study Technical Committee.

**RECONCILIATION STRATEGY**

From the findings of the water reconciliation scenarios, specific strategies were identified that are required for the sustainable management of the water resources in the study area. These strategies are outlined below.

A study to investigate the feasibility of desalination of sea water as an option to provide additional domestic water is being undertaken by Umgeni Water. Preliminary indications suggest that desalination of sea water is still more expensive than other options, although it is recognised that at some point in the not-too-distant future this form of water treatment will become economical.
Priority infrastructure projects

- Implement the Mooi-Mgeni Transfer Scheme consisting of the Spring Grove Dam in the Mooi River catchment and a conveyance system to deliver water by 2012. The Department has recently directed the Trans-Caledon Tunnel Authority (TCTA) to implement the scheme.
- Raise the Hazelmere Dam to provide additional yield and extend the water-treatment capacity and related infrastructure.
- Proceed with the planning and implementation of the proposed bi-directional North Coast Augmentation Pipeline to convey water from the Hazelmere Dam to KwaDukuza and adjacent areas.

Priority feasibility and supporting studies

- Proceed with the feasibility study of the Mkomazi River Transfer Scheme; the first phase will consist of the proposed Smithfield Dam with gravity conveyance infrastructure for transferring water into Umgeni Water’s bulk supply system.
- Commission a feasibility study of the Thukela and Mvoti Systems to support the far northern areas (KwaDukuza and surrounding developments) and to augment the water resources of users currently supplied from the Hazelmere Dam.
- Undertake a feasibility study to investigate the options for reusing treated waste water, for direct and indirect use. Due to the urgency of the supply situation, eThekwini appointed consultants for this task in February 2009.

Water-use efficiency

- Intensify the WC/WDM programmes in the eThekwini Municipality; the study confirmed the potential for further water savings and recommends the continuation and extension of measures to reduce losses and improve water-use efficiency.
- Plan and implement WC/WDMs in the Msunduzi Municipality supply area. The potential for savings in water use is high.
- Encourage and support rain water harvesting in the study area as it is a further method of extending the water resources.

Other initiatives

- Construct a flow gauge on the Mvoti River in order to improve confidence in the hydrological modelling and yield estimates of the system.

Institutional arrangements

- Constitute the System Operation Management Forum and promote active involvement in the operational management of the Mgeni and Mdloti River Systems among the relevant institutions. Consideration should be given to the early implementation of drought restrictions to ensure that water is available for essential use.
- Convert the Study Steering Committee into a Strategy Steering Committee, which will be responsible for the review, maintenance and updating of the strategy.

CONCLUSIONS

Clear strategies have been recommended to ensure enough water for this very important area. Successful implementation of these measures will now have to receive the highest priority.

Coordination among all the institutions involved in the water supply cycle was essential to share relevant information and apply valuable knowledge to formulate and endorse the Reconciliation Strategy.

The integration of information from relevant past studies and other development planning initiatives prevented duplication of efforts and ensured that the strategy is in line with other processes.

Stakeholders have embraced the urgent need to improve the water supply situation in the KZN Metropolitan Area and extraordinary, ‘business unusual’, steps are being taken to implement the components of the strategy.

Study status

The study is scheduled for completion by the end of 2009 and all the reports will be available on the Department’s website at http://www.dwaf.gov.za/  

PROJECT TEAM

The study was undertaken on behalf of the client, Directorate: National Water Resource Planning of the Department of Water and Environmental Affairs (formerly the DWAF) by DMM Development Consultants, Golder Associates Africa, Kwezi V3 Engineers, WRP Consulting Engineers and Zitholele Consulting, supported by various subconsultants, collaborating institutions and DWEA directorates.
An overview of the engineering components
Lesotho Highlands Water Project:

BACKGROUND
The Lesotho Highlands Water Project (LHWP) Treaty, signed in October 1986, envisaged the development of the project in a number of phases to transfer up to a maximum of 70 m³/s of water from the highlands of Lesotho to the Vaal River System in South Africa, and committed both parties to implement Phase I. Phase I has been implemented and commissioned.

Before agreement could be reached on the development of further phases, certain key issues needed to be resolved between the parties and the main features of the further phases (after Phase I) had to be defined. The parties agreed to undertake jointly a two-stage feasibility study in order to acquire and collate the information necessary to make a decision on the further phases.

In Stage 1 of the feasibility study, all previous studies were reviewed and a reconnaissance study of possible layouts to meet the specified schedule of water deliveries to South Africa (the “Delivery Schedule”) was carried out. Some 21 layouts of possible new dams and tunnels, with various phasings, were identified, designed and costed. Pump stations, hydropower plants and infrastructure were designed and costed, with running costs. Costing, economics, social and biophysical impact assessments, together with public participation and layout assessments, completed the Stage 1 investigations. A multi-criteria technical, environmental, social, cost and economic assessment of

Phase I layout and proposed Phase II
An overview of the engineering components of the proposed Phase II of the Lesotho Highlands Water Project: based on the feasibility study the layouts resulted in a recommendation of the layout for all future phases of the project to meet the Delivery Schedule. Thereafter the configuration of Phase II of the recommended layout was agreed.

The accepted Phase II consists of the Polihali Dam, which is a concrete-faced rockfill dam, 163.5 m high, on the Senqu River downstream of Mokhotlong, at a full supply level (FSL) of 2 075 m above sea level (masl), transferring water through a 38 km long gravity tunnel to the Katse Reservoir. The Phase II layout is shown in Figure 1.

The Stage 2 feasibility-level study consisted of dam and tunnel design, the assessment of hydropower-generation potential, and feasibility-level designs and costing for access roads, power supply, telecommunications and construction camp facilities. These designs were supported by surveys and mapping, geotechnical investigations, reservoir simulation modelling, water quality assessments, public participation, and social and environmental studies. Legal, institutional, procurement financing and implementation studies completed the Stage 2 study.

**WATER RESOURCES**

The Stage 2 study included an extensive catchment-specific hydrological modelling exercise for the catchment of the proposed Polihali Dam in order to improve the confidence in the Stage I inflow sequence to the dam and gave a natural mean annual inflow of 697 million m³/a. However, the stream flow gauging in the vicinity of the Polihali Dam site is being improved.

In the yield determination the long-term average instream flow requirement was modelled at 130 million m³/a, about 18.7% of the long-term average natural mean annual inflow of 697 million m³/a.

From the stochastic yield analysis, the reservoir and system yields, for 98% assurance of supply to the Vaal River System (base case results), were:

- The incremental yield of Phase II of the LHWP will be 465 million m³/a or 14.75 m³/s.
- The total system yield for the LHWP (Phases I and II) will then be 1 271 million m³/a or 40.30 m³/s.

The addition of Polihali Dam to the Orange River System will give an overall increase in yield of the Orange River System of 182 million m³/a.

The agreed Delivery Schedule and proposed water transfers, based on the envisaged implementation programme, are summarised in Table 1.

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<th>Proposed annual water transfer m³ x 10⁶</th>
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<th>Cumulative shortfall assuming that proposed Polihali transfers are made m³ x 10⁶</th>
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THE PROPOSED POLIHALI DAM

The location of Polihali Dam and Reservoir are shown in Figure 2. The key statistics of the Polihali Dam are given in Table 2. It is a concrete-faced rockfill dam with a concrete-lined side-channel spillway and a concrete-faced rockfill saddle dam 49.5 m high.

During construction, the works will be protected by upstream and downstream embankment cofferdams with diversion tunnels 7 and 9 m in diameter through the left flank. Material for the rockfill and concrete aggregate will be obtained from three quarries, primarily located below the full supply level (FSL).

WATERWAYS

After considering three alternative alignments for the gravity tunnel to transfer water from the proposed Polihali Reservoir to the existing Katse Reservoir, the southern alignment, via Matsoku to Katse, as shown in Figure 4, was selected.

The proposed tunnel is 38.2 km long and 5.2 m in diameter, sized to convey a maximum flow of about 35 m$^3$/s. The intake, with an invert level of 2,000 masl, is located approximately 5 km upstream of the Polihali Dam wall.

Details of the recommended southern alignment tunnel option are given below and shown on Figure 4. Altogether 29 km of the tunnel will be constructed using two tunnel-boring machines, and the 9 km from Matsoku to Katse will be done in three drill-and-blast drives.

Water from Phase II will flow under gravity into the Katse Reservoir, from where

<table>
<thead>
<tr>
<th>Table 2: Key statistics: Polihali Dam</th>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dam type</td>
<td>Concrete-faced rockfill dam</td>
<td></td>
</tr>
<tr>
<td>Full supply level</td>
<td>2,075.0 masl</td>
<td></td>
</tr>
<tr>
<td>Gross reservoir storage</td>
<td>2,085.5 m$^3$</td>
<td></td>
</tr>
<tr>
<td>Reservoir surface area at FSL</td>
<td>50.4 km$^2$</td>
<td></td>
</tr>
<tr>
<td>Top of rockfill</td>
<td>2,081.5 masl</td>
<td></td>
</tr>
<tr>
<td>Riverbed level</td>
<td>1,919 masl</td>
<td></td>
</tr>
<tr>
<td>Live storage</td>
<td>1,892 million m$^3$</td>
<td></td>
</tr>
<tr>
<td>Upstream slope</td>
<td>1V: 1.4 H</td>
<td></td>
</tr>
<tr>
<td>Downstream slope</td>
<td>1V: 1.25 H, with 4.5 m access road berms at various levels</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Main embankment</th>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embankment height</td>
<td>163.5 m to top of rockfill</td>
<td></td>
</tr>
<tr>
<td>Crest width</td>
<td>10 m</td>
<td></td>
</tr>
<tr>
<td>Crest length</td>
<td>915 m</td>
<td></td>
</tr>
<tr>
<td>Embankment volume</td>
<td>12,311,210 m$^3$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Saddle embankment</th>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embankment height</td>
<td>49.5 m</td>
<td></td>
</tr>
<tr>
<td>Embankment volume</td>
<td>664,380 m$^3$</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spillway</th>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>PMF outflow</td>
<td>4,024 m$^3$/s</td>
<td></td>
</tr>
<tr>
<td>Outlet works</td>
<td>Free-standing tower, 70 m high and 8.0 m in diameter, with intakes at five levels</td>
<td></td>
</tr>
</tbody>
</table>
it will flow through the existing transfer tunnel to the Muela power station, into the Muela Reservoir and through the delivery tunnel to the Ash River outfall. The Ash River already has extensive energy-dissipation and erosion-control measures and it is not anticipated that significant further work, other than some limited additional protection, will be required.

The existing delivery tunnel has sufficient capacity to transfer the water required, until at least 2048. The Muela Dam will not require any modification, but raising the dam and upgrading the delivery tunnel are future options that will increase the hydraulic capacity of the delivery tunnel if required.

HYDROPOWER

The Phase II development will have the following implications for hydropower:

- Transferring Polihali flows to Katse will reduce the status of the existing Muela hydropower station from being a load-following power station to being a base load plant, generating about 80 MW for 100% of the time. Further potential exists to expand the hydropower generated over and above the 72 MW currently being generated.

- Harnessing the instream flow requirement (IFR) releases from the dams, assumed to equal about 19% of the mean annual runoff, will produce about 4 MW at the toe of the dam and seems to be a cost-effective course of action.
Two alternative main access routes were investigated:

- The Butha Butter-Oxbow-Mokhotlong route, with a length of about 80 km, would involve upgrading the width and grades of the existing surfaced road from St Peters via Moteng Pass and Oxbow. From the junction with the surfaced road, the existing gravel road would be upgraded to a surfaced road and extended to the construction sites at Polihali.

- The alternative route from Ha Seshote to Polihali Dam, approximately 60 km long, would, for most of its length, require new construction, crossing three major rivers and several minor streams. It is mainly above the snow line and its design would have to cater for freeze-thaw conditions.

Either of the two routes could be implemented since the capital costs are relatively similar and the final selection of the road access route should be done on the basis of other factors such as the impact on the environment and the local community.

Table 3 Summary of costs M refers to Maloti (Lesotho currency) with 1 M = 1 Rand

<table>
<thead>
<tr>
<th>Cost centre</th>
<th>Activity</th>
<th>Total project cost (incl VAT) M x 1 000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polihali Dam</td>
<td>Construction contract</td>
<td>2 301 604</td>
</tr>
<tr>
<td></td>
<td>Environmental management</td>
<td>70 680</td>
</tr>
<tr>
<td>Polihali/Katse Tunnel</td>
<td>Construction contract</td>
<td>1 948 786</td>
</tr>
<tr>
<td></td>
<td>Environmental management</td>
<td>42 180</td>
</tr>
<tr>
<td>Access roads and bridges</td>
<td>Construction contract</td>
<td>414 203</td>
</tr>
<tr>
<td></td>
<td>Environmental management</td>
<td>3 420</td>
</tr>
<tr>
<td>Feeder roads, road bridges and footbridges</td>
<td>Construction contract</td>
<td>289 726</td>
</tr>
<tr>
<td></td>
<td>Environmental management</td>
<td>2 280</td>
</tr>
<tr>
<td>Power supply and telecoms</td>
<td>Construction contract</td>
<td>200 463</td>
</tr>
<tr>
<td></td>
<td>Environmental management</td>
<td>5 700</td>
</tr>
<tr>
<td>Camps</td>
<td>Construction contract</td>
<td>206 167</td>
</tr>
<tr>
<td></td>
<td>Environmental management</td>
<td>5 700</td>
</tr>
<tr>
<td>Total construction costs</td>
<td></td>
<td>5 360 949</td>
</tr>
<tr>
<td>Total environmental management costs</td>
<td></td>
<td>129 960</td>
</tr>
<tr>
<td>Engineering</td>
<td>Polihali Dam</td>
<td>420 692</td>
</tr>
<tr>
<td></td>
<td>Polihali/Katse Tunnel</td>
<td>463 928</td>
</tr>
<tr>
<td></td>
<td>Access roads</td>
<td>35 462</td>
</tr>
<tr>
<td></td>
<td>Feeder roads and bridges</td>
<td>94 549</td>
</tr>
<tr>
<td></td>
<td>Power supply</td>
<td>15 389</td>
</tr>
<tr>
<td></td>
<td>Camps</td>
<td>20 073</td>
</tr>
<tr>
<td>Total engineering costs</td>
<td></td>
<td>1 050 093</td>
</tr>
<tr>
<td>Administration</td>
<td>Total cost of implementing agent</td>
<td>324 292</td>
</tr>
<tr>
<td>Environmental costs</td>
<td>Biophysical monitoring</td>
<td>11 400</td>
</tr>
<tr>
<td></td>
<td>Short term IFR baseline study</td>
<td>11 400</td>
</tr>
<tr>
<td></td>
<td>Environmental mitigation</td>
<td>296 400</td>
</tr>
<tr>
<td></td>
<td>Environmental management (included above)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ESIA for advanced infrastructure</td>
<td>5 472</td>
</tr>
<tr>
<td></td>
<td>ESIA for dams and tunnels</td>
<td>5 700</td>
</tr>
<tr>
<td>Long term</td>
<td>Environmental monitoring</td>
<td>22 800</td>
</tr>
<tr>
<td>Total environmental costs</td>
<td></td>
<td>353 172</td>
</tr>
<tr>
<td>Social costs</td>
<td>SIA implementation and monitoring</td>
<td>1 254</td>
</tr>
<tr>
<td></td>
<td>Short term Resettlement and compensation</td>
<td>67 335</td>
</tr>
<tr>
<td></td>
<td>Social mitigation: livelihoods and income restoration</td>
<td>97 802</td>
</tr>
<tr>
<td></td>
<td>Long term Resettlement and compensation</td>
<td>184 560</td>
</tr>
<tr>
<td>Total social costs</td>
<td></td>
<td>350 951</td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td></td>
<td>7 569 417</td>
</tr>
</tbody>
</table>

Transferring Polihali flows to Katse will reduce the status of the existing Muela hydropower station from being a load-following power station to being a base load plant, generating about 80 MW for 100% of the time. Further potential exists to expand the hydropower generated over and above the 72 MW currently being generated.
in conjunction with the selection of the route for the powerline to Polihali.

The reservoir will impede the community’s access across the river and inundate some local roads which will have to be relocated above full supply level. Two vehicle bridges, 85 and 135 m high, two footbridges up to 110 m high, as well as additional all-weather access roads have been proposed to provide access across and around the reservoir.

Power supply for construction needs to be provided at the Polihali Dam site, the tunnel intake, the tunnel construction adits and the tunnel outlet works. Communication during construction and operation is vital and provision has been made for appropriate telecommunications infrastructure for the construction camp, the routing of fibre optic cables to all camps, and a tower at Polihali for a wireless code-division multiple-access (CDMA) network.

COSTING
The approach to costing differed for the various components of Phase II. The most detailed estimates were undertaken for the dam and the tunnel. Construction costs were estimated using resource-base costing methods in the same way as a contractor would price a tender. The cost of infrastructure works was estimated using current industry unit rates, adjusted for Lesotho conditions and applied to the relevant items in a Bill of Quantities.

Engineering, administration, and operating and maintenance costs were built up from first principles by estimating person hours and disbursements, and then applying appropriate staff rates and direct costs.

Resettlement and compensation costs were arrived at using assumptions regarding the number of people and the assets that would be affected, then applying current costs or current Lesotho Highlands Development Authority rates, adjusted where applicable. The cost of the environmental management activities, including livelihood and income restoration, and social and biophysical surveys, were assessed from first principles and compared with experience from other projects.

Physical operating and maintenance costs were estimated at M 20 million per annum for the life of the project.

The capital expenditure cash flow is presented in Figure 5.

IMPLEMENTATION PROGRAMME
The implementation programme is based on the Memorandum of Understanding between South Africa and Lesotho, which is being concluded in 2009 and which will allow for the studies to be reviewed and approved, as well as for the parties to agree on the principles for implementation.

The programme indicates that it will take about 10 years from when the parties sign the Memorandum of Understanding, allowing project implementation to
commence, until the first delivery of water from the Polihali Dam can be made. The various agreements, studies, resettlement and compensation, design and tendering processes will take approximately four years. The construction activities, some of which will run concurrently with the later design activities, will begin with the infrastructure contracts and take a total of seven years. Two-and-a-half years have been allowed for the dam to fill to minimum operating level and four months for commissioning the works.

According to the accepted Delivery Schedule, the Vaal River System will require limited further augmentation from 2013. As described above the first delivery from Polihali cannot be expected before 2019, so there will be a shortfall for six years. However, this shortfall can be made up by implementing water demand management measures and by reusing mining effluent and wastewater. Continued implementation of the latter course of action could mean that the next augmentation of the Vaal River System, after LHWP Phase II, may only be required in about 2050.

Allowance of 30 months has been made for impoundment to reach the minimum operating level, at which time commissioning can commence. The construction of the tunnel should not affect or be affected by impounding.

CONCLUSION
The feasibility study has defined the main features of Phase II and further phases, thus providing the information required to enable the Lesotho and South African governments to resolve key issues and decide to proceed with Phase II of the project.

ACKNOWLEDGEMENTS
The feasibility study was carried out for the Lesotho Highlands Water Commission by the C4 SEED Joint Venture which consisted of SEED (Senqu Engineering, Environment and Development Consultants) and Consult 4 (Goba (Pty) Ltd, Ninham Shand (Pty) Ltd, SRK (Pty) Ltd and Vela VKE (Pty) Ltd), consulting groups.
Integrated water management of the Vaal River catchment

Overview of postgraduate research at the Tshwane University of Technology

INTRODUCTION
The protection of South Africa’s limited water resources is mandatory for ensuring the future sustainability of its people and economy. With a growing population and a thriving economy, abuse of the environment, especially rivers, is a convenient side-effect. As a consequence, the continued decrease in available water quantity in rivers and their declining water quality are the two major issues currently facing South Africa. These issues are a threat to the very growth that we are striving towards. Furthermore, change in the global climate is manifesting itself as an additional source of pressure on water resources, with stronger negative consequences being foreseen in southern Africa. Therefore, an urgent compromise has to be agreed on between socio-economic development and the environment in order to adapt to these dynamics before it is too late. To achieve this goal, continued research into developing appropriate solutions to the above issues must have the highest priority.

The Department of Civil Engineering of the Tshwane University of Technology (TUT) is currently working towards this goal under its postgraduate research agenda. The focus of research is on the Vaal River catchment which is made up of the Upper Vaal, the Middle Vaal, part of the Lower Vaal and the Lower Orange water management areas (WMAs). This catchment is one of the proverbial life-lines of the country’s economy, contributing over 25% of the country’s GDP and having a population of more than 12 million directly depending on it for water.

THE VAAL RIVER CATCHMENT
The Vaal River is known as one of the most ‘hardworking’ rivers in South Africa and flows across the Upper, Middle and part of the Lower Vaal WMAs. The upper Vaal is the pivotal WMA out of the three because of its extensive level of urbanisation and industrialisation. Therefore, its water resources have been highly developed and utilised. According to the National Water Resource Strategy (NWRS) of 2004, an upward trend in population and economic growth is foreseen in this WMA; hence future requirements of water will have to be met from additional inter-basin transfers from adjacent WMAs. The Middle and Lower Vaal regions are not highly urbanised, but have a higher presence of mines. The population of the latter two WMAs is not
expected to grow drastically. However, the surface water and to a certain extent the ground water resources have already been exploited to the maximum, thus requiring inter-basin transfers to augment the locally available yield.

The water quality in the Vaal River has also been drastically affected due to extensive industrialisation, and especially by the mining sector. As a result, the river environment has been compromised, and salinity and eutrophication are now widespread plagues in the dams and parts of the river. This has a significant impact on water-treatment economics in the region because of the unfair distribution of treatment costs upstream and downstream for the same resource.

With a cautious outlook towards the future possibility of reduction in water availability and worsened water quality, the following postgraduate research is currently ongoing at the TUT.

**CURRENT POSTGRADUATE PROJECTS**

Hydrological and water-quality modelling of the Upper Vaal Water Management Area using a stochastic mechanistic approach

The current trend in hydrological and water quality modelling in South Africa is to utilise the conventional deterministic and complex conceptual-type models. These models suffer from a number of disadvantages that hinder their effective and extensive application in the catchments. The key objective of this study then was to develop alternative, simple stochastic, mechanistic and parsimonious rainfall-flow (R-F) and flow-concentration (F-C) models using the readily available hydro-meteorological and water quality data. The station that was modelled was located on the Vaal River at Goedgeluk.

To model the R-F dynamics, stream flow, evaporation and rainfall data were used to develop a daily time-step model. Stream flow and sulphate concentration data were used to develop a monthly F-C model. In achieving the study objective, an inductive empirical transfer function (TF) approach, known as Data-Based Mechanistic (DBM) modelling, was used. In model identification and estimation, the most parsimonious model structure and associated parameter estimates are inferred statistically from the available time-series data with a minimum of *a priori* assumptions about the form of the model. The TF model identification and optimisation were implemented with the CAPTAIN Toolbox in MATLAB. The R-F model predicted stream flow at the chosen station fairly well, with coefficient of determination R of 56.3% over the entire data period.

An overall conclusion drawn from this study is that the application of the DBM modelling approach in this area has yielded simple, parsimonious and mechanistic models. These models reasonably represent the catchment’s hydrological response and the transport of contaminated flows with minimal data requirements. Therefore, the way forward is to initiate a paradigm shift in hydrological modelling to explore DBM techniques as an alternative to solving current modelling discrepancies in design and requirements for raw data.
Application of the Water Evaluation and Planning Model (WEAP) to assess the impacts of climate change on future water availability in the Vaal River catchment.

This study proposes to investigate the possible impacts of climate change on the Vaal River’s ability to meet future water demand using the WEAP model. This model is an integrated water resource management tool because it encapsulates the hydrological, water allocation, water quality and economic calculation components on a single platform, thus giving it an overall management capability.

Present and future water demands in this catchment were determined in a previous study finalised in 2006 for the Department of Water and Environmental Affairs (DWEA, formerly DWAF). These data will form the basis for the water allocation component of the model. Climate change projections based on regional climate models (RCMs) will then be used to assess the ability of the river in meeting the projected water demands. The study horizon is 2030.

The envisaged output of this study is the development of a decision-support tool to carry out ‘what if’ analyses of future impact scenarios and possibly assist in formulating the adaptation and mitigation measures necessary for the Vaal River’s continued sustainability.

The user-pays principle in abating a water quality crisis

The user-pays principle encourages costing of raw water as a capital resource. The DWEA sells raw water to water boards, generally at a fixed cost determined annually. This cost, however, does not take into account the quality of water that the water boards receive. Water boards are then expected to treat this water to certain specified standards for distribution to local authorities, which then supply the consumers. The end users are then charged based on the volume they consume, presumably at a rate that would recover the operation and maintenance costs of the suppliers and which is agreed on in advance. The result of this could be one of two things, namely that the consumers in different parts of the country pay different rates or that the water boards may be operating at a loss.

Therefore, based on recent and ongoing research in the Vaal River catchment, this study examines the effect of this pricing strategy on the final cost of treatment and ultimately the cost to consumers. A model will be developed which will assist in determining ways in which raw water can be priced to ensure pro rata distribution of the burden of treatment costs to the consumers, based on the quality of the raw water. The focus area for this research is the Vaal River and selected tributaries between the Vaal Dam outlet and the Bloemhof Dam inlet (see Figure 1).

Passive pre-treatment of mine water using roughing filters

Roughing filters can be considered as possible passive pretreatment units for mine water since they efficiently separate fine solid particles over prolonged periods without the addition of chemicals. In this study, horizontal roughing filters (HRFs) have been selected because of their better performance compared with vertical
roughing filters (VRFs). HRFs are also simple to design and have minimal operation and maintenance requirements.

For the purpose of this study, a pilot plant will be constructed at Delcoal mine in Mpumalanga. The design and sizing of the pilot plant will be guided by Wegelin’s design criteria. Two different filter media will be tested individually, such as coconut fibre and broken burnt clay, against a control medium of gravel. The choice of the control medium is based on the fact that the design criteria were developed using gravel and also because of the popularity of broken burnt clay as a filter medium.

The prototype unit will have three equal compartments with medium sizes decreasing in the direction of flow. The performance of the units will be determined by monitoring the pH and removal efficiency of the iron and manganese content of the influent under the prevailing field and varying climatic conditions.

The output of this study will be determination of the viability of the HRF as a low cost pretreatment option for mine water. This would have significant economic implications for the mines, as well as a much-desired positive impact on the discharge environment.

**Development of design criteria for the construction of sand dams**

Abstraction of water from sand reservoir deposits is a well-known alternative source of underground water in arid and semi-arid regions with seasonal river flows. Internally, due to the uneven surface of sand particles, voids are created which can store water. Several models developed in the past to simulate sediment transport and depositions in alluvial flow have focused mainly on the prevention of sediments in downstream water resources and have not been optimised for the possible yield of water extractable from the sand deposits behind the barrier wall given various field conditions. This study will therefore establish the relationship between different hydraulic and sediment parameters, such as flow rate, slope, channel characteristics and roughness, with the quality of deposited sediment.

A model will eventually be developed for optimising these parameters and for determining the range of barrier heights required to derive maximum water storage in the sand dam.

The results of this study will contribute to the development of affordable alternative water sources that are ideal for the rural dry areas where surface and ground water potential is low.

**CONCLUSION**

This article has presented an overview of the research currently in progress at the TUT. It is our sincere hope that the findings from these studies can be used in the ongoing battle to safeguard our water resources for a sustainable future. In conclusion, the words of former American President Lyndon B Johnson come to mind. He said that a "nation that fails to plan intelligently for the development and protection of its precious waters will be condemned to wither because of its shortsightedness. The hard lessons of history are clear, written on the deserted sands and ruins of once-proud civilisations."
Current service delivery challenges for municipalities with regard to water management

Governing today is far from simple. The pressures caused by ongoing budget constraints, exacerbated by the subprime mortgage crisis and the resulting rise in foreclosures, plus a contracting credit market are compounded by major challenges which include insufficient capacity within local government resulting in poor operation and maintenance of infrastructure. This manifests within municipalities as ineffective utilisation of municipal resources, non-compliance with environmental legislation, little or no service delivery, and potential hazardous environmental and human health impacts. The management of water, one vital aspect of the environment, is consequently being neglected in most regions of South Africa. There is an urgent need today to protect our scarce water resources and, at the same time, properly manage storm water and waste water for the benefit of the environment and the protection of communities.

BACKGROUND

The White Paper on Local Government (1998) introduced the concept of "developmental local government”, which is defined as “local government committed to working with citizens and groups within the community to find sustainable ways to meet their social, economic and material needs and to improve the quality of their lives”. The policy document makes it quite clear that local government is not responsible for creating jobs. Instead, it is responsible for ensuring that the overall economic and social conditions of the locality are conducive to the creation of employment opportunities. Therefore, local government is charged with creating an enabling environment.

Officials often do not realise the impact that arbitrary decision-making has at grass roots level. Decisions to cut operational and maintenance budgets for storm water management, water supply and waste water treatment works may lead to more frequent breakdowns, resulting in untreated effluent and waste in the water resources. A water-borne health impact on the poorer communities has the potential to continue the poverty spiral since the young cannot attend school to obtain a qualification and parents have to spend time to accompany the young to clinics. Frequent absenteeism reduces productivity and the knock-on effects on the economy have been well noted.

A disastrous example of poor water management led to the outbreak of cholera in Zimbabwe, with its overflow into Limpopo Province, and later in Delmas, Mpumalanga. These were examples of little or no management of sanitation, little or no management of storm water flow and of the disposal of grey water, where there is an inadequate or no system for the reticulation of waste water.
Communities receiving poor services are also reluctant to pay for the services and this in effect has a negative impact on the income of local government, which increases the notion to cut budgets and, more often than not, water services. Communities also often turn to vandalising government property in an attempt to voice their dissatisfaction with poor or non-existent municipal services. This, in turn, makes employees despondent with low motivation.

**PRINCIPLES FOR WATER MANAGEMENT**

In the face of tough times, governments ought to focus on core competencies and their mission should be to make the most of limited financial resources to cope with critical responsibilities. The talent and expertise of government staff gained from years of experience should not be lost, but leveraged to deliver — or even enhance — the core services on which citizens rely. As more and more governments have discovered, having the right partners from the private sector not only ensures that services are delivered, but also helps to provide much-needed budget relief through innovation and experience during a funding slowdown.

Guiding principles when making decisions on water management are:
- A partnership approach with the private sector which promotes the search for common objectives and defines the roles, responsibilities and accountabilities of each agency and individual that participates in the process of decision-making.
- A balanced approach by which close attention is given to decisions designed to achieve a sustainable blend of economic development and the protection of resource integrity, while meeting social norms and expectations.

A realisation in local government of the importance of water management, often not considered a priority even when funding is available

The management of water resources should therefore be done in partnership between the government departments and, among others, industry, engineers, hydrologists and environmentalists, taking cognisance of the long-term goal of sustainability. The private sector can offer a host of professional skills and innovative ideas to help extend limited budget allocations.

It is also essential that government agencies at national and provincial level should provide strong leadership, with an emphasis on water management, which will help to coordinate the development and implementation of integrated environmental management policies and strategies.

**DEVELOPMENT OF A GENERIC ENVIRONMENTAL MANAGEMENT PLAN**

The Pretoria office of SRK is currently busy with a project that has been initiated by the City of Tshwane. A Generic Environmental Management Plan (GEMP) is being compiled with the aim of streamlining the process of obtaining environmental authorisation for “emergency storm water and flood management activities” within the local authority area. In broad principles, this involves the following:

- Initiate and arrange an authority liaison committee.
- Possibly establish a subcommittee of the existing Gauteng Department of Agriculture, Conservation and Environment (GDACE)/Local Authority Forum.
- Urgently define storm water remediation, maintenance activities and categories.
- Prepare a work procedure/method statement for each category of activity in a draft memorandum of understanding between the local authority and GDACE.
The objective of the project is to find a simplified solution to gaining the required approval, in terms of the National Environmental Management Act, faster. The provisions of the Act stipulate cumbersome procedures that take time for approval, even for local government.

A formal procedure for gaining quick approval from GDACE, while complying with the requirements of the Act which aims to protect all aspects of the environment, is envisaged to enable the City of Tshwane to complete urgent civil projects, whether these are new or remedial. The Act provides heavy penalties for non-compliance.

CONCLUSION
Although public service spending is continuing in the short to medium term, capital projects within the local government sector may eventually also either be postponed or their implementation periods may be extended. Pressure on existing infrastructure will increase, resulting, in the case of waste water treatment works, in discharges of waste to the rivers exceeding the discharge limits. The planning processes for replacing or increasing the capacity of existing infrastructure within the local government sector, at least, must and should continue. This would include all feasibility studies and obtaining all environmental authorisations.

For various reasons the operation of treatment works has over the past decades been declining. Now is perhaps the time for local government to reconsider these processes. There is a dire need in urban areas for local governments to upgrade waste water treatment services, and in some instances to replace facilities. Many private companies can either take over the operation and management functions on a contractual basis, or assist in supporting the local government operational staff through training.

Industry also has a responsible role to play in the protection of the resource, and therefore also in integrated environmental management. Industry should manage its own systems in an integrated approach. Traditionally, industry has concentrated efforts on developing technology, not taking cognisance of the impact that these developments may have on the wider environment, but focusing on financial viability. Only now is industry becoming aware of the need for resource conservation, cleaner production and cleaner technologies.

Increased public awareness worldwide has resulted in the formulation of various international treaties aimed at protecting water resources and the wider environment. Chemical processes, products and wastes have long been a cause for concern regarding their adverse interactions with the natural environment.

Local governments must become and remain responsive to changing times and changing constraints. Revenues need to be maximised, fixed and variable operating expenses minimised, and service delivery offerings enhanced. Now, more than ever, government agencies need to streamline their processes and activities for industry and developers to obtain the necessary environmental approvals so as to not hamper development during the current economic turmoil.

Although industry and job creation are important, cognisance has to be taken of the fact that South Africa faces major challenges with regard to its water supply. Like Eskom, which has little capacity in store, South Africa has a limited water capacity. Unfortunately, resources are being pushed to the limit and in some areas pollution of water resources is of major concern. Pollution can affect the ecology and human health.
Mathematics vs pattern recognition in water resource studies

Pattern recognition is hard-wired into our brains. Unfortunately, it seems that most civil engineers have forgotten how to apply it to solve complex problems. This article gives some examples of where pattern recognition led to the solution of problems, and the examples date back to biblical times.

My first experience in pattern recognition goes back to my first year at high school. We had to write an essay on the Renaissance. I visited the library and started my essay with a quote: “The Renaissance was a time when the people opened their eyes and saw.” I was congratulated in front of the class. I still have strong memories of the occasion and the message. We have to open our eyes and see things before even attempting to describe them mathematically.

The next experience occurred when I was on leave in Rome. I was a non-smoker so I collected my weekly cigarette rations. I bought a 10 cm Nestler slide rule for a few packets of cigarettes. It was my constant companion for many years. Together with graph paper and a ruler, I could solve all the engineering problems that came my way.

After some 20 years in the field, I was promoted to the post of Chief of the Division of Hydrology in the then Department of Water Affairs. My hydrological knowledge was minimal so I was sent on a study tour of the UK and USA. I was also ex officio a member of the IAHS (International Association of Hydrological Sciences). In that capacity I attended an international conference at Reading in the UK. Late one afternoon I was enthralled by a vigorous blackboard debate. The opponents were Vujica Yevjevich, a stochastic hydrologist of the Colorado State University in the USA, and James Wallace, an IBM engineer.

1 Elements of pattern recognition (vide Alexander)
2 The Noah Effect
3 The Joseph Effect
mathematician. The subject was the mathematical description of annual river flow sequences. It was all beyond me. The only words that I recognised were ‘white noise’ and ‘red noise’. It was only years later that I realised that they were debating the nature of the random, and therefore unpredictable, component of annual river flow sequences.

In the years that followed I became increasingly involved in this problem. There were major difficulties in the determination of the flood magnitude/frequency relationships (called the Noah Effect) and the relationships required for water resource studies (called the Joseph Effect).

**THE NOAH EFFECT**

Figure 2 illustrates the Noah Effect. There are a number of high outliers that have observed return periods in the range from 50 to 100 years but calculated return periods between 200 and 2,000 years. These are serious discrepancies. They cannot be resolved mathematically. (Try drawing a curve that fits the outliers.)

**THE JOSEPH EFFECT**

The Joseph Effect is a little more difficult to explain as it involves the additional dimension of time. The key diagram is the cumulative departure from the record mean. This is the basis for storage/yield calculations.

Now comes my problem. Thirty years ago and on many occasions since then I demonstrated the presence of the alternating patterns in annual river flow and their linkages with sunspot activity. Why am I having difficulty in persuading others that these relationships exist? Their argument is that these properties cannot be detected mathematically, therefore they cannot be meaningful.

Where should we place our trust – in mathematics or pattern recognition? My response is to point out that a one-year-old child can recognise its feeding bottle without difficulty. None of us can describe it mathematically in such a way that it will be immediately recognised as such by an Internet colleague. In this situation I had to develop a more convincing counterargument.

Remembering my first experience, I decided to challenge my undergraduate students. I introduced them to the Joseph Effect that was clearly present in the cumulative departure plots of the annual flows in the Vaal River. I asked them to resolve the problem. I gave them a hint. The foundation of stochastic hydrology was the assumption of random variations about a constant mean. I asked them to consider an alternative explanation.

One of the students produced the diagram in Figure 3. He was able to remove the alternating pattern in the cumulative departure plot by assuming a variable mean. He then proceeded to demonstrate it graphically. It now became very clear that the Joseph Effect was the consequence of regular, alternating changes in the mean value. The residual values in the cumulative departure plot (the bottom panel of the figure) were truly random, i.e. white noise.

We could now replicate this property mathematically by abandoning the Gaussian models in which the random component was independent of the mean. We substituted a Generalised Extreme Value model where the periodicity and randomness were applied directly to the mean itself. It was now possible to replicate any anomalies and trends in the data series mathematically and recover the properties from the synthetic data sequences.

**THE HURST PHENOMENON**

Continuing with the Joseph Effect, it must be obvious that a long record is likely to contain a more severe drought sequence than a short record. It is also obvious that the greater the variability of the flow in the river, the greater the storage capacity required to meet the specified demand.

In 1950 the civil engineer R E Hurst examined the 1,080-year-long record of the maximum water levels in the Nile River. Not only did he find multiyear anomalies in the data, but he also found the same anomalies in other geophysical data, including deposits in lakes, tree rings, temperatures, rainfall, sunspots and wheat prices. Surely it must be very obvious that all these processes must be related to a single cause.

The only conceivable cause is variations in received solar energy, but this was not investigated any further at that time.

Stochastic hydrologists then abandoned their search for the causes of these well-known and well-documented anomalies, the Noah and Joseph Effects and the Hurst Phenomenon. This is what Vit Klemes, a distinguished stochastic hydrologist, wrote in his paper *The Hurst Phenomenon – A Puzzle?*

“We are then, in one of those situations, so salutary to theoreticians, in which empirical discoveries stubbornly refuse to accord with theory. We are forced to the conclusion that either the theorists’ interpretation of their own work is inadequate or their theories are falsely based; possibly, both conclusions apply.”

The mathematically inclined stochastic hydrologists then departed from the scene. By the end of the 1980s, we were ahead of the pack but we still had much to learn.

**PERIODIC FLOW SEQUENCES**

They say that fortune favours the brave. I innocently compiled Table 1 by showing the Vaal Dam inflow in columns of 20 values for the sake of convenience. Once I had done this, even to the untrained eye there was a very clear pattern in the data showing approximately 20-year sequences (actually 20.8 years...
as I later calculated). There is another fundamentally important characteristic. This is the abrupt transitions from low flow to high flow sequences. I was later to discover that these sequences were synchronous with the double sunspot cycle, and that the abrupt changes coincided with the sunspot minima.

Note the clearly evident, abrupt changes from drought sequences to high runoff sequences at the ends of the cycles, shown by the thick horizontal lines. A number of years went by. As the hydrological records increased in length, another pattern became evident. All the records were chopped up into 21-year sequences, beginning with the clearly evident, abrupt changes from drought to high inflow sequences. They were then plotted together as multiples of the individual record mean values. The product is shown in Figure 4. We are now in period year 13, with period year 14 starting in October this year.

### PERIODIC OSCILLATIONS

One of my colleagues, Alwyn van der Merwe, produced Figure 4. Yet another oscillating pattern is emerging. Another colleague, David Bredenkamp, equates it to a siphon effect where a constant flow into a tank of water can result in alternating outflows.

### CHALLENGE

I started this article by describing the challenge that our history teacher gave us a long time ago. Many years later I challenged my students to quantify the Joseph Effect. I now challenge readers of this article to describe the annual river flow sequences shown in Figure 4 mathematically or numerically. It has to be such that it can be used for the determination of likely future inflows in our major rivers for the next ten years, starting in October 2009. I will add a trick question. How will climate change affect your answer? I would be very interested in hearing from you.

---

**Table 1 Non-random grouping of annual flow sequences in the Vaal River (MAR = 1 942 10^6 m^3)**

<table>
<thead>
<tr>
<th>Year</th>
<th>Inflow</th>
<th>Year</th>
<th>Inflow</th>
<th>Year</th>
<th>Inflow</th>
<th>Year</th>
<th>Inflow</th>
</tr>
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<tbody>
<tr>
<td>23/24</td>
<td>765</td>
<td>43/44</td>
<td>6 863</td>
<td>63/64</td>
<td>1 136</td>
<td>83/84</td>
<td>1 535</td>
</tr>
<tr>
<td>24/25</td>
<td>4 777</td>
<td>44/45</td>
<td>1 696</td>
<td>64/65</td>
<td>2 890</td>
<td>84/85</td>
<td>581</td>
</tr>
<tr>
<td>25/26</td>
<td>808</td>
<td>45/46</td>
<td>1 277</td>
<td>65/66</td>
<td>520</td>
<td>85/86</td>
<td>708</td>
</tr>
<tr>
<td>26/27</td>
<td>1 283</td>
<td>46/47</td>
<td>1 117</td>
<td>66/67</td>
<td>3 392</td>
<td>86/87</td>
<td>896</td>
</tr>
<tr>
<td>27/28</td>
<td>862</td>
<td>47/48</td>
<td>1 100</td>
<td>67/68</td>
<td>597</td>
<td>87/88</td>
<td>4 040</td>
</tr>
<tr>
<td>28/29</td>
<td>1 612</td>
<td>48/49</td>
<td>641</td>
<td>68/69</td>
<td>686</td>
<td>88/89</td>
<td>3 209</td>
</tr>
<tr>
<td>29/30</td>
<td>2 754</td>
<td>49/50</td>
<td>1 938</td>
<td>69/70</td>
<td>1 172</td>
<td>89/90</td>
<td>1 254</td>
</tr>
<tr>
<td>30/31</td>
<td>778</td>
<td>50/51</td>
<td>638</td>
<td>70/71</td>
<td>1 008</td>
<td>90/91</td>
<td>1 138</td>
</tr>
<tr>
<td>31/32</td>
<td>698</td>
<td>51/52</td>
<td>1 167</td>
<td>71/72</td>
<td>1 977</td>
<td>91/92</td>
<td>256</td>
</tr>
<tr>
<td>32/33</td>
<td>469</td>
<td>52/53</td>
<td>1 951</td>
<td>72/73</td>
<td>440</td>
<td>92/93</td>
<td>501</td>
</tr>
<tr>
<td>33/34</td>
<td>3 301</td>
<td>53/54</td>
<td>881</td>
<td>73/74</td>
<td>2 176</td>
<td>93/94</td>
<td>1 780</td>
</tr>
<tr>
<td>34/35</td>
<td>2 549</td>
<td>54/55</td>
<td>3 510</td>
<td>74/75</td>
<td>5 727</td>
<td>94/95</td>
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<td>55/56</td>
<td>1 545</td>
<td>75/76</td>
<td>4 803</td>
<td>95/96</td>
<td>9 009</td>
</tr>
<tr>
<td>36/37</td>
<td>4 361</td>
<td>56/57</td>
<td>5 379</td>
<td>76/77</td>
<td>2 395</td>
<td>96/97</td>
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<td>77/78</td>
<td>2 366</td>
<td>97/98</td>
<td>501</td>
</tr>
<tr>
<td>38/39</td>
<td>3 928</td>
<td>58/59</td>
<td>1 344</td>
<td>78/79</td>
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<tr>
<td>39/40</td>
<td>2 178</td>
<td>59/60</td>
<td>1 449</td>
<td>79/80</td>
<td>1 231</td>
<td>&gt;2000</td>
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</tr>
<tr>
<td>40/41</td>
<td>2 534</td>
<td>60/61</td>
<td>2 039</td>
<td>80/81</td>
<td>1 205</td>
<td>1 500 – 2 000</td>
<td></td>
</tr>
<tr>
<td>41/42</td>
<td>1 039</td>
<td>61/62</td>
<td>961</td>
<td>81/82</td>
<td>364</td>
<td>1 000 – 1 500</td>
<td></td>
</tr>
<tr>
<td>42/43</td>
<td>3 597</td>
<td>62/63</td>
<td>1 315</td>
<td>82/83</td>
<td>227</td>
<td>&lt;1 000</td>
<td></td>
</tr>
</tbody>
</table>

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**Key**

- Periodic dam inflows (prepared by Alwyn van der Merwe)
The new SANCOLD

THE SOUTH AFRICAN National Committee on Large Dams (SANCOLD) changed its governance structure in September 2008 to be more democratic and representative of the broader dam industry. SANCOLD activities cover both 'large' and 'small' dams, as well as tailings dams. SANCOLD membership will provide organisations and individuals with various opportunities for interaction with other people involved in water resources management. Dams play a very important role in the development and management of South Africa’s water resources, and future dam construction is planned as part of the general infrastructure development in South Africa.

The revised mission of SANCOLD is to:

- Advance the knowledge and skills relating to the science and art of planning, design, construction, management, operation, maintenance, rehabilitation and decommissioning of dams among its members in a safe, financially sound, and ecologically and socially sustainable manner
- Establish a democratically elected national committee in South Africa to represent South Africa on the International Commission on Large Dams (ICOLD)
- Provide forums for local interaction between interested participants in the dam industry
- Engage with other African countries in support of initiatives such as the New Partnership for Africa’s Development (NEPAD), as well as those of ICOLD

The new constitution of SANCOLD is available on the SANCOLD website. The website contains a lot of information about SANCOLD and ICOLD, as well as information relating to dams. An example of this type of information is given in the accompanying article in this edition on the SA Register of Large Dams. SANCOLD also issues an electronic newsletter (SANCOLD News) to members at least once a month, which contains useful information for those involved in the dam industry. These newsletters are also placed on the website.

The benefits of SANCOLD membership are extensive and include:

- Environmentalists, earth scientists, social scientists and engineers, as well as institutions, dam owners or operators, water users, corporate organisations and interested individuals will all have an opportunity to interact and contribute to the aims, objectives and benefits of SANCOLD. Potentially, all members can participate in the Management Committee and Executive Committee by democratic election.
- Since South Africa’s dam owners are faced with a situation where existing dams will require ongoing skilled operation and maintenance, SANCOLD will provide the link to the required expertise.
- Through SANCOLD South Africa’s dam developers and designers have future opportunities locally and in the rest of Africa where their expertise is recognised and highly valued. SANCOLD will provide access to current international and local expertise, and provide platforms for training in the required skills.
Since 1 January 2006, ECSA has required all registered engineers to undertake continuing professional development. SANCOLD will promote events of local interest and provide access to international conferences and seminars.

Dam safety is an increasingly important aspect requiring attention from dam designers, owners and operators. SANCOLD will provide local training platforms and access to latest international trends and methods for handling dam safety issues.

Discounts are provided to members for courses, conferences, publications and advertisements on the SANCOLD website.

Support will be provided for commercial opportunities regarding calls for consultancy proposals and tenders.

SANCOLD has a postgraduate bursary for studies in subjects related to the dam industry.

You and/or your organisation can participate and have a meaningful say in the affairs of SANCOLD. Two membership categories are now available, namely:

Corporate membership (2009 membership fee R2 500)
Individual membership (2009 membership fee R250).

The form for membership application is available on the SANCOLD website.

SANCOLD will be holding its biannual conference from 4 to 6 November 2009 in the Drakensberg. The topic for the conference is Sustainable Development of Dams in Southern Africa. SANCOLD invites all members from Africa and the wider family of ICOLD to participate in the conference which will include technical presentations, a technical visit, an exhibition, a preconference tour and a full accompanying person’s programme in and around the scenic Drakensberg. The preconference tour will be to the existing 1 000 MW Drakensberg Pumped Storage Project and the technical visit to the 1 332 MW Ingula Pumped Storage Project currently under construction. The first Annual General Meeting of the new SANCOLD will be held during the conference to elect people to vacant positions on the Management Committee. Only paid-up members of SANCOLD will be allowed to vote for a new Management Committee at the SANCOLD AGM. The detailed conference arrangements are available on the SANCOLD website.

A SANCOLD activity that will be of special interest to the dam industry is the updating of the SANCOLD guidelines on different aspects of dams. The first guideline to be updated is that related to freeboard for dams. The updated guideline should be available at the coming SANCOLD conference in November 2009.

SANCOLD currently has an Interim Management Committee as part of the transitional governance arrangements in terms of its constitution.

Day-to-day SANCOLD activities are governed by an Executive Committee of the four office bearers featured alongside.

SAICE is a Corporate Member of SANCOLD and has one of the four reserved positions on the SANCOLD Management Committee. The other eight positions on the Management Committee are filled by a democratic election procedure. The SAICE representative is Tente Tente from the SAICE Water Division (centre, front row in the group photograph) and his alternate is Dr Schalk Jacobz from the SAICE Geotechnical Division.

For further details of the new SANCOLD and the forthcoming conference and Annual General Meeting, please visit the SANCOLD website (www.sancold.org.za). The SANCOLD Secretary can be contacted by e-mail at the following address: secretary@sancold.org.za

SANCOLD Executive Committee

1 SANCOLD Interim Management Committee (13 March 2009)
2 Rob Williamson Chairperson
3 Peter Pyke Vice-Chairperson
4 Paul Roberts Secretary
5 Reason Mwaka Treasurer
South African Register of Large Dams
SANCOLD is pleased to announce that the South African Register of Large Dams can now be downloaded from the SANCOLD website (www.sancold.org.za). The Register is given in the form of an Excel spreadsheet. This provides the facility of being able to sort the information easily and to draw interesting conclusions. This Register is part of the larger ICOLD Register of World Dams which contains information on about 50 000 large dams.

The South African Register of January 2009 contains information pertaining to 1 082 large dams. To qualify for inclusion in the Register, a dam must meet the following criteria:

- The dam must have a height of not less than 15 m calculated from the lowest point of the foundation.
- Dams between 5 and 15 m impounding more than 3 million m$^3$ are included, but limited statistical information is provided.

DAM SAFETY: SMALL AND LARGE DAMS

South Africa has a greater number of dams classified as "small" than those classified as "large". These dams are owned mostly by the agricultural sector, primarily for irrigation and stock watering. Some local authorities also own such dams for water supply to towns.

All dams in South Africa with a safety...
risk, with a height (measured from the downstream toe) of 5 m and greater and a storage capacity of more than 50 000 m³, are subject to the Dam Safety Regulations in terms of the National Water Act (No 36 of 1998).

Owners of such dams are required to register the dams with the Department of Water and Environmental Affairs (DWEA, formerly DWAF). The dams are then classified into different categories depending on their hazard potential rating which considers the potential loss of life and potential economic loss that may result from dam failure. Three dam safety classifications are defined, with Category I dams being small dams with a low hazard potential rating. At the other end of the scale Category III dams have the highest potential hazard rating and require the most attention from a dam safety perspective. Category II dams are of an intermediate nature and also require the involvement of dam professionals.

The current (August 2008) information on the number of South African dams and their classifications is given below and has been kindly supplied by the Dam Safety Office (DSO) of the DWEA.

The total number of registered dams is 4 457, of which 4 173 (94%) have been classified into the different dam safety categories. Information on this Register of Dams can be downloaded from the DSO page of the DWEA website (www.dwaf.gov.za/DSO/publications.asp). Note that some of the information in the DSO Register differs from that in the SANCOLD Register; this is because of differences in the definition of terms. The height given for the dams is also different for the same reason. The registration of dams started in 1986 and after a five-year build-up period, the rate of annual registrations has remained essentially steady. Currently 49 mine and industrial residue deposits (tailings dams) are registered and included in the list.

The distribution of registered dams according to size class and reservoir capacity is given in Tables 1 and 2. Almost 75% of the dams are small (lower than 12 m) and 85% have
a storage capacity of less than 1 million m³.

The distribution of existing dams classified according to hazard potential rating and category is given in Tables 3 and 4.

**INTERESTING FACTS ABOUT SOUTH AFRICAN LARGE DAMS**

Interesting information abstracted from the South African Register of Large Dams is as follows:

- The oldest dam is the Upper Mpate built near Dundee in 1880. It is an earthfill embankment with a height of 18 m and a crest length of 293 m.
- The total storage capacity of the 1,082 dams is 31,619 million m³, which is about 65% of the mean annual runoff of South Africa of 49,000 million m³.
- The development of major dams over time is shown in Figures 8 and 9. The graphs illustrate that there was a lull in dam development during World War II, but development accelerated in the period from 1970 to 1980 with the construction of the Orange River Project and the Thukela-Vaal Project.

---

**Table 5 Percentage distribution of large dams**

<table>
<thead>
<tr>
<th>Dam type</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthfill</td>
<td>74%</td>
</tr>
<tr>
<td>Rockfill</td>
<td>2%</td>
</tr>
<tr>
<td>Concrete gravity</td>
<td>12%</td>
</tr>
<tr>
<td>Concrete arch/buttress</td>
<td>10%</td>
</tr>
</tbody>
</table>

**Table 6 Distribution of the heights of large dams in South Africa**

<table>
<thead>
<tr>
<th>Height range [m]</th>
<th>No of dams</th>
<th>% of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;30</td>
<td>950</td>
<td>85%</td>
</tr>
<tr>
<td>31-50</td>
<td>27</td>
<td>11%</td>
</tr>
<tr>
<td>51-70</td>
<td>28</td>
<td>2%</td>
</tr>
<tr>
<td>71-90</td>
<td>8</td>
<td>1%</td>
</tr>
<tr>
<td>&gt;90</td>
<td>2</td>
<td>0.2%</td>
</tr>
</tbody>
</table>

**Table 7 Details of the ‘Big Five Dams’ in South Africa**

<table>
<thead>
<tr>
<th>Dam (alphabetical order)</th>
<th>Height [m]</th>
<th>Volume [million m³]</th>
<th>Storage capacity [million m³]</th>
<th>Water surface area [km²]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gariep</td>
<td>88</td>
<td>1.4</td>
<td>5,343</td>
<td>352</td>
</tr>
<tr>
<td>Pongolapoort</td>
<td>89</td>
<td>0.6</td>
<td>2,267</td>
<td>132</td>
</tr>
<tr>
<td>Sterkfontein</td>
<td>93</td>
<td>19.8</td>
<td>2,617</td>
<td>67</td>
</tr>
<tr>
<td>Vaal</td>
<td>63</td>
<td>1.4</td>
<td>2,610</td>
<td>323</td>
</tr>
<tr>
<td>Vanderkloof</td>
<td>108</td>
<td>1.3</td>
<td>3,187</td>
<td>133</td>
</tr>
</tbody>
</table>
There has been a progressive decline in dam development since 1980. Although the rate of development has reduced, dams will still be required to provide water for various purposes to meet future rising demands.

- The percentage distribution of large dam types in South Africa is shown in Table 5. Some dams consist of a combination of dam types such as a concrete gravity spillway plus earth flanks. Changing technology and the dam site characteristics (geology, floods and topography) influence the selection of dam type. Most dams in South Africa are constructed from earthfill.

- The distribution of the heights of large dams in South Africa is shown in Table 6. Most large dams in South Africa are lower than 30 m in height.

- The highest dam in South Africa is the Vanderkloof Dam on the Orange River with a height of 108 m.

- The ‘Big Five Dams’ in South Africa are given in Table 7. The storage capacity of the Sterkfontein Dam in the Upper Vaal River catchment is virtually the same as that of the Vaal Dam, although its water surface area is only 20% of that of the Vaal Dam. The evaporation losses from the Sterkfontein Dam are accordingly far lower than those from the Vaal Dam. Water is therefore kept in reserve in the more efficient Sterkfontein Dam and released only once the Vaal Dam is at its minimum operating level, thus saving appreciable evaporative losses.

- The dam with the largest storage capacity is the Gariep Dam on the Orange River with a capacity of 5,343 million m$^3$.

- The dam with the longest crest is the Bloemhof Dam on the Vaal River with a length of 4,270 m.

- The shortest dam is the Hells Gate Dam near Uitenhage built in 1910 with a crest length of only 4 m. This concrete dam with a height of 26 m is built in a narrow gorge.
The largest floods are expected in the Vaal River and provision has been made in the Vaal Dam for a spillway capacity of 25 000 m$^3$/s.

The two major dams on the Orange River each have a spillway capacity of 20 400 m$^3$/s.

The dam with the largest water surface area is the Gariep Dam at 352 km$^2$ (352 million m$^2$).

The Woodhead Dam on Table Mountain constructed in 1897 (50 m height) was awarded International Landmark status in 2008 by the American Society of Civil Engineers (ASCE) (see the October 2008 issue of Civil Engineering).
PORT ELIZABETH, LIKE SO MANY South African towns, suffered severe water shortages as it developed during the 19th century. It was the duty of John Gamble, the Colonial Hydraulic Engineer (Past Master 18), to sort out such problems, and for PE his solution was to build a weir on the Van Stadens River, linked to the town by a 30-mile long pipeline. John Hamilton Wicksteed, a MICE, was selected for the post of Resident Engineer and arrived in Algoa Bay on 29 December 1877 aboard the vessel Edinburgh Castle.

Wicksteed, born at Leeds on 21 January 1851, was the fifth son of the Reverend Charles Wicksteed. When he was fourteen he was sent to the University College School in London. Two years later he was articled to the engineer Edward Filliter, MICE, of Leeds, with whom he remained as a pupil and assistant for a period of ten years and by whom he was employed on several works of water supply and sewerage engineering.

It is interesting to read his comments on seeing Port Elizabeth for the first time: “Port Elizabeth, I am sorry to say is rather like a quarry in outward appearance. Nothing more uninviting could be conceived: ugly houses and warehouses, and broad, hot streets creeping up the side of the hill, and not a spot of green anywhere.”

On his arrival and full of enthusiasm, John Hamilton Wicksteed proceeded to the Town Hall, making himself known to the Town Clerk, whom he described as “a nice old gentleman with a white beard”, and to the Mayor, Pearson.

A few hours later Wicksteed was in the saddle for a rough ride, under a hot sun, to the Nali Waterfall in the Van Stadens River Valley, where soon afterwards he set to work on the necessary surveys for a complete determination of the pipe track. With the contracts awarded, work on the scheme commenced in 1879. He was meticulous in his supervision, the strictness of which proved often trying to the men. But Wicksteed had an easy, good-humoured way of securing adherence and industry among his motley gangs of labourers.

An example of this once occurred when he himself, working in the unceasing rain to set out the pipe route, scrambling over slippery rocks and plodding through long grass and drenching bush, encountered one of the European workmen, lately arrived from the Bay, who announced his intention of going back as such work was not “fit to turn a dog to”. He was answered that he was quite right, that men were wanted and not dogs and that if the aggrieved person did not feel himself as good a man as the rest, he had better go home. After meditating five minutes on these words, the man set to work again and accomplished more than any of the other workmen that day, also working well subsequently.

During the three year contract period Wicksteed stayed at Lukin’s Camp near the weir site. The weir was constructed across the bed of the river, damming up the water to a depth of seven feet. He had many discomforts to endure. Once, after two damp nights, fifty loaves of bread in a bag went mouldy; salt meat often rotted; a water cart broke a wheel and spilt all its contents when they were working on the pipeline some distance from the river. On another occasion the cook fell asleep and burnt the bottoms out of a kettle and two saucepans!

Access to the pipeline route was naturally difficult and various methods had to be adopted to get the pipes to their positions. Where it was found practicable to form a track of sufficient width amongst the rocks, oxen were employed to drag the pipes into position. About one-third of the pipes had to be brought down a steep decline of about 300 feet into the gorge, by way of a narrow path cut diagonally down the side of the gorge.

In the descent the pipes were lashed to sledges and manoeuvred down by labourers, at some places at considerable speed. The path was narrow and the gorge precipitous, and it was feared that many of the pipes and their handlers might come to grief, but the work was carried out with remarkably few casualties.
Off duty in Port Elizabeth, Wicksteed appears to have been a sociable young fellow. He became a member of the Port Elizabeth Club of which he wrote:

“Our Club is the best in South Africa. It is the only institution that makes the town liveable in for single men. Anybody who is anybody belongs to the Club. I dine there as a rule for company. There is a large common dining room table as well as small ones. Dinner costs me four shillings a time.”

In one of his several letters, Wicksteed mentions that he had called on Miss Virginia Isett, Principal of Collegiate School. At weekends he went out to the River Club at Swartkops where he found a “regular clubhouse with beds and private rooms and an excellent table d’hote. It is a favourite resort on Saturdays for local merchants. There is a little jetty in front from which you can take a dive before breakfast.”

At length the contract was completed and the first water was delivered to the Market Square in September 1880. For the unofficial opening, four fountains, playing at one time with a jet of 90 to 100 feet, watered dry and dusty Port Elizabeth. “It must have been a proud day for Mr Wicksteed”, wrote the Eastern Province Herald. For many of the residents, to have running water in their homes after years of struggling to obtain clean water, must have brought much joy and wonder.

Wicksteed took up permanent residence in Port Elizabeth and was appointed Town Engineer, which was surely a fitting reward for his diligent service. Sadly, however, he did not enjoy his success. In a letter to his mother on 11 August 1881 from Humansdorp, he complained of feeling ill and told her that he had resigned as Town Engineer due to overwork and it was evident from the letter that he was suffering from extreme depression.

On 16 August 1881 he left his office at the Town Hall in the middle of the morning and was never seen alive again. After he had been missing for three days, search parties scoured the district and it was not until the following Tuesday, 23 August, that the search party found his body close to the bush in Happy Valley. He had shot himself and the revolver was still gripped in his right hand. He was buried in the cemetery at St George’s Park. Rocks were brought down specially from the Van Stadens River gorge and laid on his grave, and his family in England sent a marble tablet.

In his condolences to Mr Wicksteed’s father, the Mayor wrote:

“By the death of your much-lamented son, this Corporation has sustained the loss of one of its ablest, most diligent, and most useful officers; one, moreover, whose name will for all time be associated with one of the greatest and most efficient enterprises ever yet undertaken by a Colonial Municipality.”

It was a sad ending to a promising career.

Researched and written by Dave Raymer and edited by Tony Murray
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Write down your memories for a special new book

Jeffares and Green Pty (Ltd) is compiling a book on anecdotes and fascinating stories of engineering. They have approached the SAICE History and Heritage Panel to call on all members, as well as civil engineers around the country, to submit stories and memories for inclusion in this book. Proper acknowledgement will be given to all authors whose contributions are included in the publication. Please e-mail your contributions, with photographs where possible, to SAICE National Office, for the attention of Marie Ashpole (mashpole@saice.org.za), or send by post to Private Bag X200, Halfway House, 1685. Should you have any questions, please call Marie on 011 805 5947.
PORT ELIZABETH, in common with many other South African cities, has experienced periodic crises in the supply of potable water. Over the years the problems have been addressed by engineers with the result that, while the city has sometimes been thirsty, it has never actually been dry.

David Raymer, who spent 27 years as an engineer in the Water Division of the City Engineer’s Department of Port Elizabeth Municipality (now Nelson Mandela Bay Municipality) has produced a fascinating history of the development of the water supply sources of Port Elizabeth and Uitenhage. His book, *Streams of Life*, which has recently been published, gives a comprehensive picture of the inspiration, perspiration, dedication and occasional intense drama that have kept the taps flowing from the founding of Uitenhage in 1804 until the present time.

The stories of the major schemes are reported in detail, and some of the great personalities of South African municipal and water engineering appear in the pages: Tom Stewart, the country’s first consulting engineer; William Ingham, who went on to become head of the R and Water Board; Ninham Shand, who played a large role in the construction of Impofu Dam; George Begg, William Moffett, Doug McCallum and many others. The book deals in detail with various technical problems encountered and the resourceful ways in which these were overcome, but it also clearly illustrates the challenge to engineers of convincing and persuading decision-makers to act – and to act timeously!

The book has some 400 photographs – perhaps too many, as to keep costs down, many have been reduced to thumbnail size, but the records are there for all to see, and researchers can obtain digital copies from the author. The book is non-technical, but it does include some accurate detail of obsolete engineering processes – such as the description of using hemp and pig lead to seal the joints of cast iron pipes.

There are most useful annexures, including a comprehensive list and brief biographies of people who over the years have been closely involved with municipal water supply in the region.

Dave Raymer has done a great service to South African engineering history by researching and publishing this book. It can be enjoyed by not only water engineers, historians, and academics, but in fact by anyone interested in the history of our country.

Copies at R200, including postage, are obtainable from the author (041 581 2916 or elraymer@telkomsa.net), or from SAICE National Office (R180 excluding postage, but including VAT – contact Angelene Aylward on aaylward@saice.org.za).
IN BRIEF

TWO AWARDS FOR UWP CONSULTING IN EASTERN CAPE

THE EAST LONDON BRANCH of consulting civil engineering firm UWP Consulting has received two awards for excellence from the Border Kei Chamber of Business and Amatola Water in the past six months.

The most recent was the President’s Award for business excellence from the Border Kei Chamber of Business. UWP Consulting was nominated to participate in the inaugural business excellence awards and, based on a presentation and an interview, was selected as a finalist before going on to win the award.

UWP Consulting’s East London branch was also named Best Consultant for 2008 in the Amatola Water Vendor Awards. This award was based on services provided on the challenging...
Eastern Cape Schools Water and Sanitation Infrastructure project.

Amatola Water, acting on behalf of the Eastern Cape Department of Education, appointed UWP Consulting to manage this project, which required the construction of ablution blocks and water facilities at 70 schools. The schools were selected from a priority list in the cholera-affected areas of Dutywa, Mthatha, Libode and Lusikisiki.

The appointment was extended to include project management of a separate programme using SMME contractors to empty latrine pits at 500 schools with existing ablution facilities. UWP Consulting’s involvement included field assessment of all the school sites, including geo-hydro and geo-environmental assessments. Management contractors were appointed to supervise the emerging subcontractors who were awarded the tenders. On-site training was provided in technical skills, supervisory techniques, health and hygiene and environmental control.

UWP Consulting formed joint ventures with local consulting firms Sektor Consulting and Izizwe Consulting Engineers, as well as with AGES SA for specialist geotechnical studies, for the planning and supervision of the R33 million project.

UWP Consulting’s Director and Eastern Cape regional manager, Craig Northwood, said, “These awards reflect the manner in which the UWP team in the Eastern Cape does business. We are fortunate to have a winning team, every member of which has contributed to this recognition from the Eastern Cape government and business sectors.”

CMA PUBLISHES SEWER DESIGN MANUAL

THE CONCRETE PIPE, Infrastructural Products and Engineering Solutions (PIPES) Division of the Concrete Manufacturers Association (CMA) has published the first edition of a design manual for concrete pipe outfall sewers (available free of charge from the CMA).

Aimed at specifiers, consulting engineers and contractors, the purpose of the manual is to provide the designer with the basic guidelines and tools needed for the cost-effective design of concrete sewers, including the selection of the most appropriate pipe materials.

CMA director, John Cairns, says that although the containment of sewer corrosion and corrosion assessment is its main focus, the manual also covers hydraulic design, material strengths, pipe loading and field testing. There is also a chapter on existing sewers and how best to assess them. All the salient features required for selecting, specifying and testing concrete pipes are included. Related topics such as sewer size and jointing are also addressed and the chapter sequence follows the typical design procedure used on a sewer project.

Much of the material included in the manual has been scientifically researched, including a predictive theory known as the Life Factor Model (LFM) which was developed in the United States. It is used to predict the corrosion rate of piping material under a given set of conditions, and the appropriate design procedures to be followed under those conditions are outlined.

INFO

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The manual draws on extensive South African and overseas research on sewer corrosion, such as the Virginia Sewer Experiment in the Free State, which began in 1989 under the control of the CSIR, and earlier research begun in 1950 by the former National Building Research Institute (NBRI) of the CSIR. In this early research, J H P van Aardt of the NBRI found that resistance to pipe corrosion was improved when siliceous aggregate was replaced by calcareous aggregate, a finding which was subsequently implemented in sewer pipe production worldwide.

The CSIR’s involvement in sewer corrosion terminated on completion of Phase 1 of the Virginia Sewer Experiment in 1994. From the published results of this phase various pipe materials could be rated on a scale of 1 to 10, where 1 yielded the best resistance and 10 the worst. The research continued, initially under the auspices of the University of Cape Town (Phase 2), and after that by an independent consultant (Phase 3), which is still ongoing.

Although the manual focuses on the design of outfall sewers, the principles included can also be applied to reticulation and collector pipelines which transport effluent to the outfalls. However, designers of these smaller components should familiarise themselves with local requirements before embarking on any design work, as several of South Africa’s larger municipalities have compiled guidelines and procedures based on local experience.

Concrete pipes and manholes are the most frequently used products for the construction of outfall sewers. South Africa’s concrete pipe industry has grown enormously over the past 80 years to meet the country’s sewer and other piping requirements. Modern technology and SABS standards, to which all CMA manufacturers adhere, ensure that concrete pipes and manholes are manufactured to consistently high standards.

INFO

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CAPE TOWN PARTNERS WITH DUTCH GOVERNMENT TO PROVIDE TOILETS FOR INFORMAL SETTLEMENT

THE CITY OF CAPE TOWN has been selected by the Dutch Government and its associated companies for the testing of a prototype toilet that is easily installed, uses almost no
water and does not have to be connected to a mains water supply or sewerage system. The facility was funded by a R4-million external grant from the Dutch partners.

The Dutch Minister for Development Cooperation, Bert Koenders, Dr Bulumko Msengana, the City’s Executive Director of Utility Services, City officials, representatives of the Dutch consortium responsible for the project and community leaders attended the installation of MobiSan dry sanitation technology toilets in the Pooke se Bos informal settlement in Rylands Estate, Athlone.

The Dutch companies that developed the concept say that this is the first project of its kind to be piloted in Africa. This pilot project is part of the long-standing cooperative agreement between the City of Cape Town and the Dutch government and its associated companies.

Consultation between the Dutch companies and the City’s Water and Sanitation Department began three years ago with the investigation of alternative sanitation systems for informal settlements. The companies, all of which are industry leaders, are Landustrie Sneek BV, Lettinga Associates Foundation and Vitens-Evides International. They formed a consortium and received finance for the project amounting to R4 million from the Dutch government’s “Partners Voor Water” programme and the funding agency, EVD (Agency for International Business and Cooperation).

A suitable location for the project had to be found so that the research team could obtain the required data. The Pooke se Bos informal settlement was found to be ideal for conducting further research. The community leaders and local councillors were consulted and, since this settlement was located on private land, the permission of the land owner, Kantie Patel, was obtained.

A small-scale MobiSan mobile sanitation system utilising dry sanitation technology was designed and presented at the Sanitation Challenge International Conference in the Netherlands in May 2008. The system was then built to full scale and housed in a shipping container. It consists of a row of 13 toilet closets and 12 separate urinals. It is a mobile unit and can easily be transported to informal settlements. Since it is a modular system, various other features can be added depending on the requirements. In this application, a small office for the maintenance staff was added. Once the first unit was manufactured, the 12-m container unit was shipped to Cape Town for transport to the Pooke se Bos informal settlement. When testing of this prototype is complete, the intention is to introduce the concept in other parts of Cape Town and South Africa.

The MobiSan system has many advantages over existing sanitation systems. It is an independent, self-contained system which does not affect the groundwater. Urine is channelled away and faeces drop into a ventilated chamber. A handle on the outside of the cabin is used to stir the solid waste which speeds up drying. The waste is then channelled into a second compartment where the drying process is repeated. The end product is dried, pathogen-free manure that can be safely used to fertilise local vegetable gardens.

The MobiSan project promises to provide a more aesthetic and hygienic sanitation system for residents in informal settlements until other accommodation can be provided. Community involvement is strong and local residents will be employed to oversee the operation. Two researchers from the Dutch consortium will monitor the project for the next six months, specifically the social impact of the project and how the community interacts with it in order to determine its acceptability in such communities. The researchers will submit their report to the City’s Water and Sanitation Department.

“This groundbreaking project has the potential to improve sanitation problems in Cape Town’s informal settlements and also provide employment,” says Dr Msengana.

AQUALINER LTD WAS set up at the beginning of 2007 to commercialise and deliver a unique, novel and patented pipe-lining technology for the water and sewerage industries. Although new, the company has been able to fall back on the collective experience and strength of a number of the UK’s leading water companies along with UK and industry contractors worldwide.

The consortium of companies included in the product development programme were:
- Severn Trent Water Ltd
- Anglian Water Ltd
- Yorkshire Water Ltd
- NCC Construction Danmark A/S
- EPL Composite Solutions Ltd

Aqualiner has recently carried out trial installations with Wessex Water and OnSite, a UK-based pipe rehabilitation contractor. Approval for potable water is also under way.

CIPP lining (cured in place pipe lining) requires a dry fibreglass fabric or felt tube impregnated with a liquid resin which places limitations on its shelf life. The Aqualiner process does not use a liquid resin, which means that the material effectively has an infinite shelf life. Thermoplastic fibres are an integral part of the Aqualiner material. The material that arrives on site for installation contains glass fibres for stiffness and strength, and thermoplastic polymer fibres which, after
processing, become the matrix that surrounds the reinforcing fibres. The self-contained Aqualiner equipment lines the pipe with a thin, but extremely strong, thermoplastic polymer composite.

The material used in the Aqualiner process is an intimate mixture of polypropylene (PP) fibres and glass fibres. When heated, the PP fibres melt and flow around the glass fibres which, on cooling, form the finished composite. These bundles of fibres are woven to form the fabric of the liner. To form the liner tube, the fabric is folded and stitched to form the liner ‘sock’ which consists of up to three layers of fabric formed inside each other. Outside these composite socks is a protective plastic tube, usually 140 µm thick polyethylene, which protects the material from dirt ingress during storage and installation. The absence of liquid resins and their mixing gives Aqualiner many advantages.

The key benefits of the Aqualiner process over existing methods include:
- Simplicity – no complicated storing and mixing of chemicals
- Long shelf life – there are no liquid resins
- Potability – no harmful chemicals that can be leached out of the liner
- High strength – it can withstand a water pressure up to 16 bar
- A thinner liner with a smooth inner surface which can aid water flow
- Sustainability – liners can be recycled at the end of their operational lifespan
- Low energy consumption and short lining times

The essential equipment elements of the process are:
- Heating pig – heats the composite material using hot air
- Temperature controller – controls the heating pig air-exit temperature
- Compressor – for heating air and pressurising the inversion drum
- Generator – provides electrical power for the heaters
- Thermoplastic composite sock
- Inversion drum to pay out inversion bag
- Inversion bag to push the heating pig along the pipe and consolidate the material
- Umbilical connecting the air, power and temperature sensors to the heating pig

Initial set-up is very easy. In principle, there is no limit on the length of the lining since the material is heated by the heater element moving along the length of the pipe. One of the major benefits of the use of thermoplastics is that they can be reheated and reformed. Internal joints can be easily formed by thermally joining (welding) pipes together, either during the lining process itself or by additional joints using electrofusion.

Aqualiner currently has two main material types, one for gravity pipelines and another for water and pressure pipelines.

An area that is gaining attention from water companies is the environmental impact of different lining systems. The Aqualiner lining process has a low overall energy burden, leading to a very low environmental impact. Also, the short set-up and breakdown times reduce the effects on socio-economic costs.

At the recent International No-Dig Event in Toronto, Canada, Aqualiner was presented with the ISTT Innovation Award for product of the year.
SWAGELINING™ AIDS INCREASE IN OIL PRODUCTION IN THE DEMOCRATIC REPUBLIC OF CONGO

ALTHOUGH IT IS NOT RECOGNISED as one of the world’s most high-profile oil producers, the Democratic Republic of Congo (DR Congo) relies heavily on the oil industry owing to its production of about 261 000 barrels/day which generates in the region of 40% of the country’s wealth.

M’Boundi is a DR Congo oilfield some 55 km from the coast which is looking to utilise seawater to pump into its wells to increase oil production, a practice recognised by the oil industry. To achieve this goal a new 600-mm diameter pipeline is being constructed to bring seawater from the coast to the oilfield.

The client for this project is ENI of Milan, Italy, and the main contractor is SOCOFRAN, which will do the main civil engineering and excavation works for the project. BEENDER Ltd has been engaged as the contractor to complete the pipeline fabrication and installation works.

To ensure that the steel pipeline has an adequate economic lifespan, it has been decided to install a plastic pipe liner in the steel pipe to protect the inner wall from the salt water environment. The installation of the plastic liner will be carried out on the construction site using Swagelining™ techniques.

The Swagelining™ system is a close-fit relining system (developed in the UK by British Gas and now licensed by GL Industrial Services UK Ltd, formerly Advantica) which uses PE (polyethylene) pipe with an outside diameter slightly larger than the inside diameter of the pipe to be lined.

The PE pipe is pulled through a reduction die to temporarily reduce its diameter, thereby allowing it to be pulled into the original pipeline. When the pulling load is removed the liner pipe returns to its original diameter which gives it a tight fit against the inside of the host pipe. It is suitable for gas, water, sewage, slurry and other pipelines (such as Taiwan’s seawater pipeline) from 75 mm (3 inches) to 1 200 mm (48 inches) in diameter.

The Swagelining™ equipment for the M’Boundi project is being provided by Pipe Equipment Specialists Ltd of the UK, a company licensed by GL Industrial Services UK Ltd as the sole worldwide operator to manufacture and supply equipment for the Swagelining™ process. The full range of Swagelining™ equipment comprises:

- Swagelining™ rigs
- Gauging pigs
- Swagelining™ dies
- Pipe-cleaning pigs
- Power packs
- Towing heads
- Winches
- Pipe expanders

Each Swagelining™ rig is designed to be used with a number of pipe sizes as required, which in the case of the M’Boundi project is the 600 mm diameter steel pipeline.

Preparations for construction on the M’Boundi project, which is believed to be the longest-ever Swagelining™ project undertaken, have begun with the laying out of the first pipes. Once pipeline installation starts, lengths of pipe as delivered will be laid out along the route. These will then be welded into sections above ground, known in the oil industry as stalks. The individual stalks will then be Swagelined. The pipe that will be used for the Swagelining™ process is some 60 km of PE100 SDR 33, 610 mm diameter polyethylene pipe manufactured and supplied by GPS PE Pipe Systems (Huntingdon, Cambridgeshire in the UK).

The final stage in the pipe preparation is to weld together the individual Swagelined stalks into a complete length using special connectors. Only at this stage will the trench for the pipe be excavated alongside the pipeline. The pipe will be lowered into the trench and buried.

The welding process using the special connectors is a vital part of the construction process as it ensures that not only are the steel pipe ends welded successfully, but also that the plastic liner...
pipe ends are also sealed to provide a continuous protective internal liner for the pipeline.

Pipe Equipment Specialists Ltd has several years’ experience of large-scale Swagelining™ of this type. To ensure that the process is carried out to the highest possible standard, a Swagelining™ supervisor will provide constant support on site.

The timeframe of the project requires the work to be completed very speedily. It was decided that there might be difficulty meeting the production schedule with normal winching products, so Pipe Equipment Specialists investigated how to overcome this problem.

Using basic technology employed in the pipe bursting sector, the company developed a ‘continuous pull’ rod winch with the capacity to winch 35 t at speeds of up to 10 m/min. Whereas normal rod winches are reciprocal and require the hydraulics to be reset at the end of each stroke, the new winch has a pair of pulling jaws and hydraulic cylinders which operate such that while one set is pulling the second set is resetting for the next pull stroke, thus allowing continuous pulling.

It is believed that the new winch technology will enable the M’Boundi project to be completed within the given timeframe.

The first shipment of equipment from the UK was due to arrive on site in April 2009. The first scheduled installation operation was planned for May 2009. The Swagelining™ operations for the pipeline are scheduled to run for approximately six months.

Steve Kent, Managing Director of Pipe Equipment Specialists Ltd said of the contract: “The equipment order is the largest that we have ever had to fulfil and production of the necessary rigs and support equipment is running to schedule. Although this is a major production and logistical effort for us, we are very confident that we will be making our deliveries on time and on budget for this very important oilfield project in the Democratic Republic of Congo. Our operatives will be available throughout the project to offer their experience and technical know-how and they will be fully supported by our UK staff for the duration of the works.”

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HOLLOW-CORE SLAB SEMINARS TO BE HELD NATIONALLY

THE CONCRETE MANUFACTURERS Association (CMA) will present three afternoon seminars on prestressed and reinforced precast concrete hollow-core slabs at different centres around the country during the coming months.

Aimed principally at civil engineers, architects and property developers, the seminars will be held in Bloemfontein in September, and Cape Town in October.

They are being used as a forum to launch the CMA’s hollow-core slab information manual and to promote hollow-core slab technology as an alternative flooring material for multi-storey buildings. Demonstrations will be given on how to design in situ columns and beams in combination with precast hollow-core flooring and still achieve a monolithic, structurally sound building.

Presenters will include: John Cairns, CMA director; Monique Eggebeen, managing director, Echo Prestress; Daniel Petrov,
An identical seminar was successfully presented to more than 120 delegates at the Bytes Conference Centre in Midrand, on 31 March. Topics covered were: history and design philosophy; general design; composite floors; case studies; health and safety aspects; and alternative applications such as foundation systems, security and retaining walls, attenuation tanks and reservoir roofs.

John Cairns observes that hollow-core slabs were originally developed as South Africa’s alternative to in situ concrete floor panels for multi-story buildings some 25 years ago.

“In many instances the hollow-core slab is a preferable alternative to more conventional building methods. Besides the obvious advantage of simpler, faster construction, not to mention a more durable end-product, the secret of applying the material successfully lies in the pre-planning. Get one of our member companies involved at the conceptual stage and their advice and input comes at no charge.

“The system was recently used in the construction of two medium-rise apartment block developments in Gauteng. Hollow-core slabs are widely used in Europe and North America on buildings as high as 40 storeys.

“Ignorance about its true potential and the fear of using something unfamiliar has led to a reluctance to specify precast slab technology locally. In situ construction is perceived by some engineers to be more effective, mainly because labour is considered ‘cheap’. However, no contractor currently places a value on the lack of productivity and re-working required due to a lack of skills. Likewise, no value is placed on using time-saving products such as precast panels. Some of the advantages of precast flooring include speed, quality of manufacture to the SANS 1879:2001 standard, a solution to the skills shortage and cost-effectiveness.

“Running to 36 pages, the CMA’s manual addresses typical concerns about the use of...
hollow-core slabs in medium-rise buildings and demonstrates the flexibility of hollow-core slabs as a flooring material. It covers aspects such as recommended design loads for common classes of building and includes various load span tables and prestressed concrete design details. Other items such as structural topping and down-lighting are included.

“Some of the alternative uses of hollow-core panels, such as security walling, warehouse walling, retaining walls, suspended ground floor slabs, and walls and roofing for reservoirs, are also covered,” observes Cairns.

The manual includes brief company profiles on those CMA member companies that produce hollow-core slabs. These are: Echo Floors, Echo Prestress, Echo Prestress Durban, Fastfloor Botswana, Shukuma Flooring Systems, Stabilan and Topfloor.

The seminars have been registered with SAICE for CPD (continued professional development) points.

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TERAFORCE IN TURKEY

GEODUVAR, TERRAFORCE product licensee in Istanbul, Turkey, has always been a steady performer, providing the designs and applications for some impressive retaining walls using Terraforce blocks. So it comes as no surprise that they can be credited for designing the highest Terraforce earth retaining wall in the company’s history, an impressive 20.5 m wall stabilising cut and fill slopes for the Karlitepe Road Project in the Beykoz region of Istanbul.

The client, Cihangir Construction, needed a cost-effective solution to stabilise the resulting slopes created during substantial roadway construction with minimum excavation and filling work, while maintaining good aesthetics. Geoduvar proposed the construction of an L15 block retaining wall with high strength geotextile reinforcement to stabilise the exceptionally high slopes, constructed at impressive wall inclinations of 70°. Another advantage the Terraforce system provided was that installation of the walls could coincide with construction of the road, saving time and money.
WITH ONE YEAR TO GO before spectators queue up to enter the Soccer World Cup stadium, the office of Goba Consulting Engineers’ Gauteng branch is abuzz with activity, due to the company’s involvement in the five-phase Nasrec development project.

The R350 million project was commissioned by the Johannesburg Development Agency (JDA) and is being funded by the national Department of Transport and the City of Johannesburg. The venture is aimed at developing the existing area into a world-class sport, tourism and exhibition node by using the 2010 FIFA World Cup Final venue as a catalyst for investment.

Significant upgrades, estimated at around R180 million, are planned for the transport network and bulk services alone, and include the provision of a public transport hub and the extension of the Golden Highway by 2 km. In addition, a pedestrian bridge has been proposed between the transport hub and the main entrance to Soccer City.

Leon Mbongwa of Goba gives an overview of the project: “The venture comprises five separate but interrelated phases. The first phase involves the pedestrian promenade which will create a bridge link from the stadium to the public transport hub. The design will allow for ease of pedestrian movement between the two anchors on site. In addition, a 25-m-wide bridge will be constructed across the widened Landbou Road and the railway tracks onto a series of ramps which lead down to Stadium Avenue.”

The pedestrian promenade bridge link has a height of around seven to eight metres. The platform also has to be large enough to accommodate an area where visitors can be searched, tickets checked and officials stationed near the gate area.

Preliminary and detailed designs were completed with the use of infrastructure design software Civil Designer. The team made extensive use of the program’s terrain module to handle the earthworks modelling for the project, as well as the storm water and roads modules when preparing detailed designs for the services.

A challenge during the design phase was the steep ramp. The ramp is between 10 and 15 m wide with an incline of 8% from the top of the bridge to the natural ground. It is also more than 8 500 m², which means that there has to be allowance for storm water attenuation. The storm water system and storm water attenuation pond were designed simultaneously and have since received JDA approval.

The second phase of the project involved the transportation hub, housing the taxi and bus rank. This required widening of the existing road to make it a dual carriageway with two lanes either side. The third phase of the project is part of the 2010 FIFA compliance, which requires all the roads around the stadium to be upgraded. Leon explains the challenges during phase three: “We had to make provision for 40 mm overlay with sidewalks. Providing access to the stadium site while construction was in progress was, however, not easy. We had problems with roads being closed due to construction, which meant that we could not gain access to any of the existing manholes. Project delays like these placed great pressure on the team.”

Other tasks performed during the fourth and final phases of the project included a holding area for the media, commercial affiliates, emergency services and broadcasting facilities. A 25 ha hard-surfaced, relatively flat holding area was created for this purpose.

The final phase of the project involves the extension of the Golden Highway from Randshow Road to the Soweto Highway. As part of the precinct upgrading, a traffic study had to be conducted to assess whether the existing roads could cope with the anticipated traffic. This leg of the project was handled by Goba’s traffic engineering department. The first set of drawings has since been issued and construction is currently under way.
FOLLOWING IN Allyson Lawless’s footsteps, Bob Pullen, SAICE president of 1989, and currently Senior Specialist in water engineering at BKS (Pty) Ltd, received the 2008/09 NSTF Award in Category C (for activities other than research and its outputs over the last five years or less).

What makes this such an outstanding achievement is that there were only 13 winners out of a group of 46 finalists, who in turn were selected from a record-breaking number of nominations. Bob (together with Allyson) now finds himself in the top echelon of people who have been recognised and awarded in the fields of science, engineering, technology and innovation in South Africa.

Bob received this prestigious award, at the NSTF’s eleventh awards event, held on 26 May 2009, for his contribution to the regulation of the engineering professions, as well as for his contribution to civil engineering and environmental practice.

As the longest-serving president of the Engineering Council of South Africa (ECSA), covering three terms from 1994 until 2006 (elected unanimously on each occasion), and as vice-president until 2008, he was instrumental in the drafting of the policy document which led to the seven Built Environment Professions Acts promulgated by Parliament in 2001. Paul Roux, past chief executive of ECSA, said...
that Bob is the consummate diplomat who always finds the middle of the road to make difficult tasks easier. Hence he was also actively involved in the initiative to formally bring technicians and technologists into the engineering fold.

As civil engineer, even before the term environmental sustainability had been defined, Bob was one of the first to promote the natural environment as part of the engineering equation. In the 1980s, with Bob’s involvement, the SAICE Environmental Division inculcated a value system in the engineering profession for engineers to manage the environmental aspects and consequences of their work.

Bob was the technical editor of the first major policy document published by the then Department of Water Affairs in 1986 – *Management of the Water Resources of the RSA*. This document has been updated since, but is still regarded as the South African ‘water bible’. He was also involved in investigations of major floods in South Africa and the development of national policy on flood management, as well as being instrumental in establishing the National Disaster Management Centre and the supporting legislation, covering not only flood management, but all disasters.

As consulting engineer, Bob had primarily been involved in the fields of water resource evaluation and development, hydraulic engineering, and environmental and institutional management, while also contributing towards the design of the Drakensberg pumped storage scheme.

In his short acceptance speech, Bob thanked the NSTF for its recognition of effort and excellence in the science, engineering, technology and innovation (SETI) environment. “Recognition,” he said, “is in fact worth much more than any award.” He believes that the effect of the NSTF Awards will undoubtedly and increasingly spill over to, and encourage younger researchers.

This train of thought was echoed by Mrs Naledi Pandor, whose attendance was her first official engagement in her new position as Minister of Science and Technology. While delivering a very well received address, she emphasised that the development and mentoring of young scientists is key to job creation, and hence to the future of our country. She believes that “we cannot relax while science is on the periphery” and therefore actively encourages not only the continued growth of the sciences, but also finding “more effective methods of interesting capable school children in carving out careers in the sciences, in mathematics, in engineering, and in established and emerging technologies. This is just one of the areas in which the NSTF has an important role to play.”

The NSTF is indeed fulfilling various important roles, not the least acting as a bridge between the Department of Science and Technology and the SETI environment. Established in 1995 and comprising the country’s top SETI organisations, the Forum has grown from strength to strength in a relatively short span of time.

Just being selected as an NSTF Awards finalist is a major achievement in itself, and SAICE salutes every one of the 46 finalists. In particular, of course, we extend our heartiest congratulations to category winner Bob Pullen, who is a highly respected and ‘much-loved’ member of our Institution!
THE 106TH SAICE AGM

PROF ELSABÉ KEARSLEY, current SAICE president, presided over the 2009 AGM. The following summary of the meeting is intended to be a brief report back to members regarding the most important matters covered at the AGM. The official minutes of the meeting are available from National Office on request. In this regard please contact Linda Erasmus (lerasmus@saice.org.za).

REVIEW OF THE YEAR 2008 BY JOHAN DE KOKER, OUTGOING PRESIDENT

Johan remarked that the year 2008 had been a watershed year, not only for the engineering profession as a whole, but also for SAICE, as the Institution had outgrown previously set limits. Membership numbers had grown beyond the 9 000 mark for the first time towards the end of 2008, gross income passed the R14.4 million mark, and only four years after having moved into SAICE House, it was bursting at the seams.

He highlighted the unveiling of a plaque during the October 2008 Council meeting, commemorating the merger in 1994 between the old South African Institution of Civil Engineers and the South African Institute of Civil Engineering Technicians and Technologists, forming our present South African Institution of Civil Engineering. He also noted that the Institution of Civil Engineers, London (ICE), had extended feelers to enhance the existing agreement between SAICE, ECSA and ICE by also including professionally registered Civil Engineering Technicians and Technologists.

Johan reported further that several opportunities had arisen during 2008 for SAICE to strengthen international ties. In August 2008 SAICE hosted David Mongan, president of the American Society of Civil Engineers (ASCE), and his party. Through the efforts of SAICE’s History and Heritage Panel, ASCE bestowed International Landmark status on the Woodhead Dam, situated on top of Table Mountain. Also during August, Sarah Buck, president of the Institution of Structural Engineers, London, visited South Africa and it was a memorable occasion to have the presidents of ASCE, IStructE and SAICE together at a splendid banquet hosted by the Joint Structural Division to commemorate IStructE’s centenary year.

SAICE’s Executive Director, President-Elect and President reciprocated by visiting ICE, IStructE and ASCE during November, attending the inauguration of Dr Jean Venables, ICE’s first lady president, and the International Round Table at the ASCE Congress in Pittsburg, USA.

The Department of Public Works introduced the Draft Bill on the Built
Environment Professions in March 2008. The preparation of considered response to the Bill brought the engineering societies much closer together, growing a level of unity never experienced in the profession before.

Johan thanked SAICE for the opportunity to stand at the helm of the Institution during 2008. Being president of SAICE is a horizon-broadening experience afforded a fortunate few only, and one that offers the opportunity to serve the profession while growing personally in unexpected ways.

**REVIEW OF THE YEAR 2008 BY DAWIE BOTHA, EXECUTIVE DIRECTOR**

In presenting his review for 2008, Dawie used Newton’s Laws of Nature as departure point.

Newton’s first and second laws talk about inertia and motion: A body at rest remains at rest, and one moving in a straight line maintains a constant speed and same direction unless it is deflected by a “force”.

Both these laws are patently correct if one applies it to the events around the Draft CBE Bill of the Department of Public Works, which mobilised and galvanised SAICE members into action as never before. Once this SAICE machine was in motion it accelerated and ultimately only slowed down when the Bill was withdrawn, albeit temporarily.

Dawie also reported that the SAICE reaction, and now also pro-action, in terms of Infrastructure Report Cards, media releases and presentations were already well known. The pro-active Numbers and Needs, and the subsequent roll out of interventions by SAICE, with funding from National Government, the DBSA, LGSETA and many others proved that IT CAN BE DONE.

At the end of the day, when the moon is already in the sky and the weary SAICE volunteers and employees struggle through the traffic to get home, a letter from Ms Lindiwe Hendricks, Minister of the then Department of Water Affairs and Forestry, makes the struggle worthwhile. The Minister wrote: “I have enormous respect for the South African Institution of Civil Engineering and would be very happy to meet with you in person to discuss the skills challenges we are facing in our country and the contribution you believe you can make in this regard.”

In closing, Dawie expressed his sincere appreciation to the 9 000 SAICE members, his staff, the Executive Board, Council and other governors, for making it possible to report on a positive-plus year. He also expressed his thanks to his wife, Ria, family and friends who made it possible to be such a privileged member of the Civil Engineering team.

**REVIEW OF THE YEAR 2008 BY PROF CHRIS ROTH, CHAIRMAN FINANCE AND ADMINISTRATION COMMITTEE**

In his presentation Chris highlighted the following points:

1. Qualified opinions from the auditors for 2008 only extended to bookkeeping by Branches and Divisions, whereas in 2007 these had extended to Branches and Divisions, as well as unallocated receipts.
2. The balance sheet and income statement for 2008 clearly indicated a substantial growth in income. The surplus raised was substantially more than in 2007, and year end balances looked vastly improved compared to 2007.
3. The vast difference in actual income vs budgeted amounts was mainly due to improved membership income, a substantial amount owed to SAICE by ICE which had eventually been paid, increased income from the magazine, and excellent sales of technical documents.
4. The Special Projects Fund was stronger than in 2007, and unallocated receipts and bad debts had reduced substantially from 2007.

In conclusion Chris emphasised that SAICE was in good financial health, but he extended a call to Branches and Divisions to employ more diligent financial management and reporting procedures.

**ELECTION OF AUDITORS FOR 2009**

It was decided that PriceWaterhouseCoopers Inc would be retained as auditors for the 2009 financial year.

**ELECTION OF LEGAL ADVISORS FOR 2009**

It was decided that SAICE would not appoint any particular legal advisor at this point in time, but that such advisors would be appointed by the Executive Board as and when required during the course of 2009.

**2008 PRESIDENT’S AWARD**

This prestigious award is made annually by the immediate past president in recognition of meritorious service rendered to the South African Institution of Civil Engineering and for significant ongoing contributions towards the civil engineering profession. This year the award was shared by Dudu Mkhize and Marthelene Buckle.

**Dudu Mkhize**

With SAICE’s centenary in 2003, the 100 for 100 project came into being when the highly motivated Dudu Mkhize approached Allyson Lawless to consider the possibility of identifying 100 students with exceptional mathematics skills from previously disadvantaged backgrounds for studies in civil engineering to match SAICE’s 100 years. Dudu, the holder of a Master’s degree in mathematics teaching, offered to provide the...
necessary career assistance to guide them into civil engineering.

Starting in October 2003, Dudu did all the footwork and visited many schools in the rural areas, amongst others the Mazinga area in KwaZulu-Natal and Gijane in the Limpopo Province. Some of the students also came from the Dinaledi schools. At the time, the learners had only just written the matriculation examinations. At that stage the University of Johannesburg (then RAU) funded the project. Dudu used SAICE brochures and Allyson’s input, to give extensive background on the profession and all its sub-disciplines.

To identify suitable learners, Dudu used a mathematics test to ascertain if they had the necessary basic skills and problem-solving capabilities. Those that passed the test then completed a questionnaire with biographical detail, which also determined their readiness. This was followed by an interview. Learners with potential for civil engineering, but lacking the financial means, were then selected. The first intake of students in 2004 followed the university degree-course. The first university of technology student intake was in 2005.

November 2007 saw the first nine of these students graduating. To achieve this, Dudu faced daunting challenges. Any lesser person would have thrown in the towel. ‘Her’ students were at one stage left without financial aid to even buy food, because of CETA problems. She provided them with the necessary herself. She scouted for money to keep these students at university – an immense effort. All this time, when the students were threatened with evacuation from residences, she was the one who encouraged and ‘mothered’ them into persevering.

Throughout this project, Jones & Wagener (Pty) Ltd played a crucial part in assisting Dudu and the students. Other companies which made major contributions are Goba, the South African Institute of Steel Construction, Anglo American, W’HBO, Pat Roberts, as well as the University of Johannesburg.

Dudu’s passionate message stresses the crucial importance of timely intervention at high school level and a well-grounded programme to give the necessary career guidance at the right time, before learners have to make subject choices, which ultimately would determine if they would be suitable for studying civil engineering or not.

**Marthelene Buckle**

Marthelene Buckle has provided invaluable support to various SAICE and Civils Masakheni initiatives over a number of years.

**SPEBS**

In May 2005 Marthelene took over the SAICE SPEBS bursary scheme that provides financial aid to underprivileged students. Within the constraints of the existing budget she accommodated and assisted many students.

**LGSETA bursary scheme**

Marthelene has very successfully implemented the LGSETA BTech bursary scheme, where civil engineering technicians working in local government are given the opportunity to become technologists. She handled the full spectrum - from advertising, to the selection of candidates, supporting these students at various levels, making all the arrangements and just being ‘Auntie Marthelene’ for whatever problems arose. A total of 73 students have benefited from the scheme to date.

**Sector Skills Plan**

Marthelene is a researcher par excellence. Both SAICE and Civils Masakheni have benefited from her expertise. She was party to the extensive research carried out in the built environment for the preparation of the CETA ‘Sector Skills Plan’ (2005 – 2009) and the Construction Charter Scorecard.

**Numbers & Needs**

Marthelene was a key player in the research carried out in the preparation of Numbers & Needs: Addressing imbalances in the civil engineering profession. She was in contact not only with consultants and contractors, who are traditionally thought of as the major employers of civil engineers, but expanded the search to the mining sector, manufacturers, suppliers, and the public sector, including parastatals, national, provincial and local government. This wide range of employers ensured that Numbers and Needs became the most authoritative publication of its kind in the field.

For Numbers & Needs in Local Government: Addressing civil engineering – the critical profession for service delivery, Marthelene researched the legislative framework extensively and carried out much of the international desktop study. Allyson remarked that, without Marthelene’s research inputs, both the Numbers & Needs publications would not have been as comprehensive as they presently are.

**SADC**

After initial negotiations by Allyson and DWAF with the SADC Water and Sanitation Capacity Building Unit in Botswana, Marthelene was instrumental in getting the project off the ground. She established the networks throughout the region, identified the appropriate experts and organised the first two workshops in South Africa. She finalised and polished the early training material, and compiled and edited the new courses developed for the recent workshop.
Marthelene has developed all the orientation material for candidates, supervisors and mentors involved in the DBSAs Young Professionals Training Programme, which is implemented by the SAICE-SABTACO Joint Venture, administered by Civils Masakheni.

EXECUTIVE DIRECTOR’S SPECIAL AWARDS FOR 2008
Two special awards were presented by SAICE’s Executive Director, Dawie Botha, to acknowledge and express appreciation for excellent service rendered to SAICE by Elaine Orpen and Natasha Niemandt of Allyson Lawless’s office, an office that SAICE deals with on a regular basis, also regarding the SAICE Section 21 Company. 

Elaine Orpen had been the helpful and gracious frontline person at Allyson’s for over nineteen years. Known as the squeaky wheel – as the squeaky wheel always gets the oil – she pioneered many of SAICE’s relationships with central government. It was Elaine who in 1999 persuaded Jacob Zuma to open the 2000 Conference at which Allyson Lawless was the first female president. When his office phoned the afternoon before to say that he could not make it, she refused to take no for an answer, and after many nagging calls they agreed that someone would be there.

In the end the then Deputy Minister of Science and Technology was woken at four in the morning and told that she had to catch the early plane to Johannesburg to open a conference! Our resulting relationship with Bridgette Mabandla opened up funding for the AEF (Africa Engineers Forum), and many other projects.

Later in 2000 Elaine also tracked down Patrick Flusk, then DDG in the Department of Provincial and Local Government, and organised a breakfast for him in Allyson’s office. From the relationship that formed and grew over the years, the ENERGYS concept and initiative was finally launched. (ENERGYS is short for Engineers Now Ensuring Roll-out by Growing Young Skills.)

Elaine also wasted no time in getting SAICE an appointment with the previous Minister of Education, Mrs Naledi Pandor, when she was newly appointed. The relationship blossomed to the point where the Minister attended the recirculation workshop, and when the HE engineering research had been completed, some R0,5 bn was released to engineering departments for expanded facilities.

Without the squeaky wheel many of these achievements and projects may never have seen the light of day!

Natasha Niemandt, on the other hand, is the quiet one who has beavered in the background for many years, handling the layouts of all of Allyson’s major documents and reports. The drama associated with the final days of layout and typesetting of both the Numbers and Needs publications, required her quiet perseverance to ensure that quality documents were finally sent to print. Natasha is now responsible for the collation of all qualitative and quantitative reports and schedules associated with most of the support projects run by SAICE Professional Development and Projects.

CLOSURE
After the meeting members and guests enjoyed cocktails and one another’s company. The AGM, after all, comes but once a year!

SAICE immediate past president Johan de Koker with the two ladies who share the 2008 President’s Award, Marthelene Buckle, left, and Dudu Mkhize

Executive Director’s Special Awards – Dawie Botha with Elaine Orpen (top) and Natasha Niemandt (bottom)
Stalwart Paul Nicolaysen
member of SAICE for the last 60 years

AT THE AGE OF 84 GOING on 85 (in July), Paul Nicolaysen still attends branch meetings and site visits and never misses the presidential visits to his local SAICE branch (Bloemfontein).

His association with SAICE dates from June 1948 when he joined as a Student Member. He was elected as Fellow in 1973, and is now a Senior Member. Throughout all these years he actively engaged in SAICE activities, first in the Western Cape branch, and since 1967 in the Bloemfontein branch where he occupied various portfolios, such as branch delegate to SAICE Council meetings, branch PRO, and chairman in 1969/70.

Paul, who was born in Bloemfontein in 1924, matriculated from Sea Point Boys High in Cape Town in 1942. After serving in an Artillery Regiment in the Sixth Division in Italy during the Second World War, he graduated in civil engineering from the University of Cape Town in 1949. His first job was with the Roads Department of the then Cape Provincial Administration (CPA) where he spent the first three years in the Bridge Design office.

In April 1953 Paul arrived in George as the Resident Engineer of the Construction Unit, which was then working on the present N9 in the western reaches of the Langkloof. In 1955 he moved the construction unit to Oudtshoorn and commenced the construction of the present N12 towards George.

In 1956 Paul was promoted to District Roads Engineer at Oudtshoorn. His office acted as advisor and supervisor of the then various Divisional Councils’ road maintenance and construction projects. The area that was involved stretched roughly from Laingsburg to Three Sisters in the north, and Knysna to Riversdale in the south.

In July 1958 he was delegated by the CPA and the SA Road Federation to study traffic engineering at the Yale University in the USA. At the end of this study period, and as a result of friendships made while in New Haven, Paul was able to travel by road from the east to the west coast of America and back, visiting numerous state and city authorities to see and learn the practical applications of traffic engineering.

In 1966 Paul resigned from the CPA and opened an office in Bloemfontein for BS Bergmann & Partners, a Johannesburg firm of consulting engineers. His work here included the design and contract supervision of two major road projects for the then Free
State Provincial Administration, as well as contract supervision of a departmental store in the CBD and a factory enlargement in an industrial area of the city.

Paul joined the Bloemfontein City Engineers Department in 1971 where he was involved in numerous projects. During the last few years before compulsory retirement in 1989, he was responsible for contract administration and supervision. After retirement, he joined BV Consulting Engineers and was engaged on a variety of projects until a second retirement in February 2000. Thereafter he still assisted the firm on odd occasions until December 2005 (81 years of age!), mainly with administrative work.

Paul’s working life within the civil engineering profession stretched over a period of more than fifty years, roughly divided into thirds between provincial administration roads, municipal infrastructure, and consulting engineering practices and projects. And now, in his old age, he still engages with the profession through the activities of his SAICE branch. Paul’s amazing dedication is indeed an inspiration to the rest of us!

And if that is not already a big enough contribution to the profession, he recently donated an amount of money to the Institution “as token of my gratitude for uninterrupted membership of SAICE over the past sixty years”. We thank you sincerely for this gesture, Paul! Your donation has been channelled to the SPEBS bursary scheme to assist and grow more engineers like yourself!

Paul Nicolaysen – still actively interested in the civil engineering profession at the age of 84 – pictured here on a site visit during the 2008 presidential visit.

**SOMETHING FOR FREE!**

Possibly the largest single database on roads in South Africa

The 4th edition of *Mountain Passes, Roads & Transportation in the Cape – a Guide to Research*, by Dr Graham Ross, is now available in CD format from SAICE National Office. The CD is available FREE OF CHARGE on request, and Dr Ross has given permission to allow any other interested person to also make a copy of the disk, for his/her own purposes, the only requirement being that the author be kept informed, so that his list of holders of this edition of the Guide to Research is kept comprehensive.

**Copies available from:**

Linda Erasmus  
Manager: Executive Office at SAICE  
011 805 5947  
lerasmus@saice.org.za
Online communication – is print media losing ground in the civil engineering industry?

ONLINE MEDIA AND technology has grown in leaps and bounds in the last decade. Although not so popular ten years ago, online media usage has also been growing steadily in the engineering industry. In this article we take a brief look at how this trend is affecting the profession in terms of effective communication.

INTERNET ACCESS – SCOPE AND LIMITATIONS
Of SAICE’s 8 466 members (May 2009), a confirmed 5 625 have e-mail addresses, which means that a little more than a quarter of our members do not have e-mail, and it is very probable that these members then also do not have internet access, as they might be living in rural areas where the internet is not easily accessible.

At SAICE National Office we regularly send out e-mail notices to our members and place information on the website. With the increasing information overload, we find that a number of our members with e-mail addresses may not have read the e-mail yet, if we follow-up telephonically.

Most members nevertheless seem to manage to read their e-mails regularly, and/or login to the website. In recent years, these members have been growing in number. More about the relevant statistics a little further on.

SAICE TECHNICAL PAPER
In 1998 SAICE member Nico Vermeulen wrote a technical paper titled “Civil engineering in cyberspace” (SAICE Journal 40(2) 2-4). Nico found that, at the time, there were approximately 45 million internet users across 165 countries worldwide. He predicted that by 2010, everyone in the age group 25 to 55, certainly in developed countries, would have an internet connection.

On Internet World Stats (http://www.internetworldstats.com) we see that internet users at the end of 2000 totalled 360 985 492. The internet user growth from 2000 – 2008 was 342.2%. The latest data shows that the number of internet users currently stand at 1 596 270 108 worldwide.

Nico also predicted that network literacy would be “forcing itself into the very texture of everyday life, including that of the civil engineer”. His prediction here was spot on.

CIVILS WEB STATS
Let us take a look at the SAICE website (civils.org.za) to see how online media has affected the civil engineering industry. In March 2002 online web statistics recorded that the SAICE site had received an average of 25 visits a day, and a year later, in March 2003, this had increased to 62 visits per day. In March 2004 the average number of visits per day was 137, and by January 2007 this number had increased further to 178. Currently civils.org.za receives an average of 355 visits per day. This seems proof enough that civil engineering professionals and members of the built environment industry are increasingly accessing online information.

ENGINEERING NEWS STATS
One of the most popular and well-known web and print media distributors in the engineering and mining industry is Creamer Media’s Engineering News. In the latest survey done by Engineering News, it was found that 59% of their readers belong to an association or institute. SAICE makes up 13% of this total. Of the remaining 46% of the institutions, many form part of the built environment professions, thus incorporating civil engineering in some way.

In the light of these interesting figures, I contacted Terence Creamer from Creamer Media for more information.

Terence’s comment on the issue of electronic media versus print media in the industry was that the engineering online website is growing exponentially, although it is not in any way encroaching on the print version of Engineering News. Engineering News (including Mining Weekly and Polity) sends out in the region of 9 000 e-mails a day to recipients, and the number is growing every day. The number of e-mails sent out to Engineering News Online alone totals about 50 000. The ‘opt out’ option on these e-mails is hardly ever used.

Terence’s experience is that people requiring immediate information will access the website, even though for most people it is easier to read printed copy. This is true especially if the article is long. Few people want to sit in front of a computer screen and read an article that is longer than a couple of paragraphs.

Engineering News found that of the 75% of professionals who use engineeringnews.co.za, several do not necessarily subscribe to the weekly printed media. The Engineering News survey shows that 40% of those that access the website do so every day. With this in mind, it would be wise for a company wanting to communicate with this particular target market, to combine both print and electronic media for a wider reach.
THE WAY FORWARD

It seems obvious therefore that support for electronic media is steadily increasing in the civil engineering industry. In the SAICE Communications Department we have had to review our manner of communicating, and for a number of years now we have been using both traditional and electronic media to reach stakeholders. The magazine and journal continue to have strong support, but civils.org.za is being utilised increasingly. The magazine and journal are also available electronically on the SAICE website. Online stats reveal that between 1 May 2009 and 18 May 2009, the electronic editions of the magazine were accessed 138 times and journal papers 118 times.

As our members obviously utilise both the print and the electronic options available to them, it makes sense to continue reaching out to our members via both channels of communication. We have recently installed an sms distributing system that will allow us to reach those members that own cell phones. Of our total membership of 8 466, cell phones are owned by 6 847 members, according to our records, making it 1 222 more than the members that own e-mail addresses. This figure could, however, be substantially higher, as most people nowadays own cell phones but do not necessarily make their numbers available to the organisations that they belong to.

Certain advantages come with the type of media one uses and some of these are listed below:

Benefits of electronic media:
- News is up to date (real-time reporting)
- The information is available immediately once one logs into the relevant website
- Information can immediately be updated and corrected
- The internet is more interactive and makes it possible for users to participate then and there if they choose to
- The internet can contain a variety of visual multimedia (such as video)
- Searching and comparing information is easier in electronic media
- In South Africa it is cheaper to distribute information via the internet
- Electronic advertising is generally more cost-effective than print advertising
- Electronic media overcomes the limitations of space and time
- The often quoted “No trees were harmed in the production of this website” carries considerable weight
- Electronic media is not limited by print run
- Digital media is not materially bound and therefore challenges established regulations and notions of intellectual ‘property’ (this may or may not be a ‘benefit’, depending on the reader’s perspective)

Benefits of print media:
- More people can afford to buy paper than electronics
- Print media is more capable to deliver localised news that may interest city or district residents
- Print media allows readers to store away articles that can be used any time in the future
- Generally print media is produced with more research and thought than electronic media, which makes it more reliable
- Reading newspapers, magazines and books improves vocabulary and grammar
- Reading long articles is easier for most people in print
- Print media does not rely on electronics and electricity
- It does not rely on internet access and service provider contracts
- Print-based media is grounded in physical space, consisting of solid elements that can be ‘owned’ and held (this may or may not be a ‘benefit’, depending on the reader’s perspective)

Graphic novelist Warren Ellis gets to some of the key differences between print and electronic media when he comments that “the web isn’t a replacement medium, it’s another medium”. The gist of his observations is that the web is a ‘burst’ medium - information (or opinion) is served up in quicker helpings.

SAICE’s experience seems to support Ellis’s view - despite the proven substantially increased use of online media by civil engineering professionals, print media does not appear to be losing ground.

REFERENCES

Please contact the editor for the list of references.
The competition is open to the general public to submit photographs. It is essential that entries portray people and/or projects in civil engineering. Photographs will be judged in ONE general category only. Entries must be colour prints and in A4 size. Only quality prints will be accepted. Please supply electronic copies of the print/s in jpeg format, 300dpi. Please complete an entry form for each entry and supply an appropriate title & short description of each project. It is essential that the photographer’s name is included. Please supply details of the client, consultant and contractor involved in the project. The entrant is responsible for obtaining permission for the use of the photographic material as well as subject material from the authority or project manager concerned. Entries submitted by organisations must be accompanied by written consent of the photographer. Permission for the reproduction of photos for any exhibition or publicity is assumed unless the entrant specifies otherwise. Due recognition will be given to the photographer. No responsibility will be accepted for any loss or damage to entries. Closing date: 22 July 2009

Please complete the entry form and send to: Private Bag X200, Halfway House, 1685. Fax: (011) 805 5971. This form is available on the SAICE website: http://www.civils.org.za/portals/0/pdf/pc/pc-entry-form.pdf
UPCOMING COMPETITIONS
FOR LEARNERS

Bridge Building Workshop / Competition
A Bridge Building Workshop / Competition will take place at the University of Pretoria on 23 July 2009 starting at 8:00. This competition is aimed at setting up school learners from disadvantaged backgrounds to compete effectively in SAICE Bridge Building Competitions. Ten of the finalists will go through to the Pretoria regional competition at the Moreleta Plaza on 31 July and 1 August 2009. A number of the finalists will also go through to the BKS-SAICE International Competition which is the final in the series of annual competitions.

For more information please contact
Inge Steinmann, 084 329 8577, ingesteadmann@gmail.com

BKS-SAICE International
Bridge Building Competition
Teams that won the regional competitions, as well as teams from Namibia and Zimbabwe, will compete in the international competition on 28 August 2009. The event will take place at St Albans College in Pretoria. The teams will start building their bridges at 09:00. The testing of the bridges will take place in the St Albans College Auditorium at 18:00. We urge all engineers and aspiring engineers to please diarise this exciting event.

For more information please contact:
Zina Girald, 011 805 5947, zgirald@saice.org.za

SAICE-DFC Centenary
Schools Water Competition
Finals for this interesting competition will be held at the Sci-Bono Discovery Centre in Newtown, Johannesburg, on 24 July 2009 at 9:30.

For more information please contact:
Marie Ashpole, 011 805 5947 or 082 870 9229, mashpole@saice.org.za

UPCOMING FUN EVENT!
Big prizes to be won!

Annual action cricket day organised by the SAICE Pretoria Branch
Date: Friday 21 August 2009
Time: 12:00 – 20:00
Venue: Silver Lakes Action Cricket Courts
Contact: Hennie Barnard, 083 785 0852, hennie.barnard@af.aurecongroup.com
A maximum of twenty teams will be competing against one another in a round robin. Sponsorship opportunities are still available for interested companies.
TO: ALL CORPORATE MEMBERS

NOMINATIONS FOR ELECTION OF COUNCIL FOR 2010

THE SOUTH AFRICAN INSTITUTION OF CIVIL ENGINEERING – Nomination for election of Members of Council for the year 2010 in terms of Clause 3.1 of the By-Laws

Clause 3.1.1 of the By-Laws reads as follows:

“Every candidate for election to the Council shall be a Corporate Member and shall be proposed by a Corporate Member and seconded by another Corporate Member.”

Nominees accepting nomination are required to sign opposite their names in the last column of the nomination form. Nomination for election to Council must be accompanied by a Curriculum Vitae of the nominee not exceeding 75 words. The CV will accompany the ballot form, and the format of the CV is shown below in Sections A and B. According to a 2004 Council resolution, candidates are requested to also submit a focus statement. Please see Section C in this regard.

Section A: Information concerning the nominee’s contribution to the Institution.

Section B: Information concerning nominee’s career, with special reference to civil engineering positions held, etc.

Section C: A brief statement of what the nominee intends to promote / achieve / stand for / introduce / contribute, or preferred area of interest.

Please Note: Nominations received without an attached CV will not be considered.

Closing date: 31 July 2009. Acceptable transmission formats - email, fax and ordinary mail. All nominations are treated with due respect of confidentiality.

If more than 10 nominees from Corporate Members are received, a ballot will have to be held. If a ballot is to be held, the closing date for the ballot will be 31 August 2009. Notice of the ballot will be sent out using two formats, i.e.

1. By e-mail to those Corporate Members whose electronic address appears on the SAICE database, and
2. By normal surface mail to those members who have not informed SAICE of an e-mail address.

In accordance with Clause 3.3 of the Constitution, the Council has elected Office Bearers for the Institution for 2010 as follows:

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>President</td>
<td>Mr AM Naidu</td>
</tr>
<tr>
<td>President Elect</td>
<td>Mr CJ Campbell</td>
</tr>
<tr>
<td>Vice President</td>
<td>Mr TW McKune</td>
</tr>
<tr>
<td>Vice President</td>
<td>Mr W Jerling</td>
</tr>
<tr>
<td>Vice President</td>
<td>Mr SN Makhetha</td>
</tr>
<tr>
<td>Vice President</td>
<td>Prof H Gräbe</td>
</tr>
</tbody>
</table>

In terms of Clause 3.2.4 of the Constitution, the following are ipso facto members of the Council for the year 2010:

<table>
<thead>
<tr>
<th>Position</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>The immediate Past President</td>
<td>Prof EP Kearsley</td>
</tr>
<tr>
<td>The two most recent Past Presidents</td>
<td>Mr JJ de Koker</td>
</tr>
<tr>
<td></td>
<td>Mr NA Macleod</td>
</tr>
</tbody>
</table>

DB Botha Pr Eng
Executive Director
21 April 2009
<table>
<thead>
<tr>
<th>SURNAME</th>
<th>FIRST NAMES</th>
<th>PROPOSER</th>
<th>SECONDER</th>
<th>SIGNATURE OF NOMINEE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Signature</td>
<td>Signature</td>
<td>Name in block letters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Name in block letters</td>
<td>Name in block letters</td>
<td></td>
</tr>
</tbody>
</table>

Please fax this form, *plus the CV of the nominee*, to SAICE National Office, for attention Memory Scheepers, by 31 July 2009 – Fax number (011) 805-5971
<table>
<thead>
<tr>
<th>Date</th>
<th>Event and CPD validation number</th>
<th>Presenters</th>
<th>Contact details</th>
</tr>
</thead>
<tbody>
<tr>
<td>24 August Cape Town</td>
<td>Ridding Stormwater of Litter</td>
<td>Prof Neil Armitage</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td></td>
<td>SAICEwat08/00361/11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27-28 July Bloemfontein</td>
<td>Handling Projects in a Consulting Engineer’s Practice</td>
<td>Wolf Weidemann</td>
<td>Dawn Hermanus <a href="mailto:dhermanus@saice.org.za">dhermanus@saice.org.za</a></td>
</tr>
<tr>
<td></td>
<td>SAICEproj08/00404/11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27 July Port Elizabeth</td>
<td>Structural Steel Design Code to SANS 10162: 1-2005</td>
<td>Greg Parrott</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td>21 September East London</td>
<td>SAICEstr06/00050/09</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 July Port Elizabeth</td>
<td>Reinforced Concrete Design to SANS 10100-1</td>
<td>Greg Parrott</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td>22 September East London</td>
<td>SAICEstr09/00432/11</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-10 July Cape Town</td>
<td>The Application of Finite Element Method in Practice</td>
<td>Roland Prukl</td>
<td>Dawn Hermanus <a href="mailto:dhermanus@saice.org.za">dhermanus@saice.org.za</a></td>
</tr>
<tr>
<td>15-21 August</td>
<td>SAICEstr06/00018/08</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16 July Midrand</td>
<td>Essential I.T. Knowledge for Business Executives</td>
<td>Dr James Robertson</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td></td>
<td>SAICEit08/00345/11</td>
<td></td>
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</tr>
<tr>
<td>22-23 July Midrand</td>
<td>Basics of Track Engineering</td>
<td>Ed Elton</td>
<td>Dawn Hermanus <a href="mailto:dhermanus@saice.org.za">dhermanus@saice.org.za</a></td>
</tr>
<tr>
<td>11-12 August Durban</td>
<td>SAICErail09/00496/12</td>
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<td></td>
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<tr>
<td>30-31 July Bloemfontein</td>
<td>Business Finances for Built Environment Professionals</td>
<td>Wolf Weidemann</td>
<td>Dawn Hermanus <a href="mailto:dhermanus@saice.org.za">dhermanus@saice.org.za</a></td>
</tr>
<tr>
<td></td>
<td>SAICEfin08/00405/11</td>
<td></td>
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</tr>
<tr>
<td>08-09 September Johannesburg</td>
<td>Project Management and MS Projects Hybrid Course</td>
<td>Les Wiggill</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td>15-16 September East London</td>
<td>SAICEbus09/00427/12</td>
<td>Les Wiggill</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td>17-18 November Port Elizabeth</td>
<td>SAICEbus09/00427/12</td>
<td>Les Wiggill</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td>16-17 September</td>
<td>Technical Report Writing</td>
<td>Les Wiggill</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td></td>
<td>SAICEbus09/00495/12</td>
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<td></td>
</tr>
<tr>
<td>24-25 August Johannesburg</td>
<td>Coastal Engineering and Management</td>
<td>Keith Mackie</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td>08-09 September Port Elizabeth</td>
<td>SAICEbus09/00427/12</td>
<td>Keith Mackie</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td>01-02 September Durban</td>
<td>SAICEbus09/00427/12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-16 September Cape Town</td>
<td>SAICEbus09/00427/12</td>
<td>Keith Mackie</td>
<td>Sharon Mugeri <a href="mailto:cpd.sharon@saice.org.za">cpd.sharon@saice.org.za</a></td>
</tr>
<tr>
<td>30 September Midrand</td>
<td>Bridge Maintenance</td>
<td>Ed Elton</td>
<td>Dawn Hermanus <a href="mailto:dhermanus@saice.org.za">dhermanus@saice.org.za</a></td>
</tr>
<tr>
<td></td>
<td>SAICErail09/00495/12</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For more information on courses, venues and course outlines please visit [http://www.civils.org.za/courses.html](http://www.civils.org.za/courses.html) or contact cpd.sharon@saice.org.za