SAICE SANLAM AWARD WINNERS
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ON THE COVER

Graceful and functional — and securely anchored by foundations unique in concept, design and construction

SAICE SANLAM PROJECT AWARDS

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The foundations for the arch over the Moses Mabhida Stadium in Durban are unique in concept, design and construction, and were completed and successfully load-tested entirely by local engineers and contractors under intense international technical scrutiny and public interest. The timeous completion of this aesthetically limited but crucial component was pivotal in keeping the stadium project on schedule.

The stadium stands on saturated swamp-land that was blanketed with sea-sand in 1920 to eradicate malaria. Used then as an airfield, it has since been engineered into a playground for a variety of sports. In these marshy conditions all heavy structures must be piled down to bedrock, twenty metres below ground level.

Deep foundation piles are very efficient at carrying vertical load, but rely on passive earth pressure to resist lateral load. The horizontal deflection required to generate such pressure could have buckled the thin-walled arch. A

1 Aerial view of a 240 kN diaphragm wall reinforcement cage being lifted for transportation to form part of one of the two southern foundation structures for the arch over the Moses Mabhida Stadium.

2 A view of the northern foundation with the partially complete arch supported off a steel trestle assisted by cable tiebacks onto the concrete foundation.
shear wall was needed to transmit the loads directly into the bedrock, with minimal restraint from the twenty metres of saturated overburden.

To generate confidence and avoid misunderstandings between the South African designers of the foundations and the German designers of the arch it was agreed that the design would comply with the recently introduced international Eurocodes EN-1990 and EN-1997.

The limit-state principles of these codes are difficult to apply to geotechnical structures and there was no precedent in South Africa for their application to such a complex foundation.

Consensus was eventually reached with the review engineers that a shear wall more than forty metres long would suffice for the northern foundation, and thirty metres each for the two southern foundations.
It was decided to vertically post-tension the diaphragm wall panels, never previously attempted in South Africa, and to enforce stringent quality controls to maximise bond across the cold joints between panels.

The arch over the Moses Mabhida Stadium has a ‘wishbone’ topology, with the load at the southern end shared between two springings. The aesthetically imposing, slender, thin-walled, steel box section has an important structural function. The membrane roof over the grandstands is tensioned across a web of tendons that have been stretched between the arch and the 300-m-diameter compression ring-beam encircling the stadium. This complex structure is very sensitive to its support conditions and stringent criteria were imposed on the foundation deflections to control the risk of buckling.

At the northern end the single foundation carries a load approaching 100 000 kN at an inclination of 38 degrees above horizontal. At the southern end the reciprocal reaction is shared between the two legs of the wishbone. In many bridge arches the springings are tied together by a bowstring-like tension member, so that the large horizontal forces balance out. The arch over the Moses Mabhida Stadium could not be tied in this way because the football playing field under the arch is several metres below the level of the springings.

Conventional piles, even of diameters larger than a metre, were found to be too flexible for these horizontal
loads. Lateral movement required to mobilise sufficient passive earth pressure to resist the enormous horizontal force could exceed 200 mm, and deflections of this magnitude would twist and possibly buckle the very slender three-dimensional arch. The practical solution was to support the springings on shear walls keyed into the bedrock, twenty metres below ground level.

To limit the risk of rotation of the foundation, or of over-stressing the underlying weak sedimentary Cretaceous-age siltstone, the north foundation had to be more than forty metres long. Diaphragm wall panels have a practical maximum plan dimension of 7 m, which meant that at least six panels would be required for this foundation. Ultimately two parallel walls were constructed and closed off at each end to form a box section of 14 panels, to ensure lateral, as well as longitudinal stability.

The panels were heavily reinforced with bar-steel and vertical post-tensioned cables and the top of the ‘box’ was closed with a massive post-tensioned cap, but it was not practicable to create a structural connection between the panels below ground level. The vertical interface between panels was scraped during construction to maximise the bond, but the adhesive strength of the vertical cold-joint formed by casting a new panel against a previously cast panel was low, and uncertain.

The major component of the total design load was applied in a controlled fashion by the simultaneous stressing of the fifty tendons that support the cable-stayed roof. A large proportion of the total load was therefore applied in a few days under carefully monitored conditions. Measurement by surface survey and borehole inclinometer as this load was applied showed that, with allowance for creep and the addition of subsequent environmental loads, the deflections should remain within the specified tolerances. The measurements also provide a useful insight into the capacity of discrete-panel diaphragm walls to sustain lateral in-plane loads, and to the large scale strain response of the siltstone in which the walls were founded.

The arch has now been tensioned to three-quarters of its ultimate load and deflections at the springings are less than half of the permitted twenty millimetres.

In total 34 panels averaging 111 m³ each were constructed. The contract ran for five and a half months and required a total of 4 000 m³ of concrete, 9 km of anchor cables, and 800 tons of reinforcing. Work continued for five months on a 24-hour 6-day a week basis.

Although the arch itself is a collaborative product of South African and German engineering, the unique foundations were designed and constructed by Durban-based engineers and contractors.
The Gansbaai project is the world’s first full-scale domestic demonstration sewage treatment works implementing Nereda® technology, a major breakthrough in secondary treatment that forms granules instead of flocs in the reactor. Substantial savings in space requirements, as well as in capital and operating costs have been achieved.
programme for groundwater. Effluent re-use for the irrigation of a large sports facility adjacent to the sewage works became a feasible option at the time when the design was undertaken.

Design approach
Taking the above limitations and opportunities into account, SSI therefore proposed an appropriate and innovative solution to the project.

DHV from the Netherlands, SSI’s parent company, has developed various sewage treatment technologies. For the Gansbaai project the patented Nereda® process for activated sludge treatment was selected. This technology had been developed in conjunction with the Delft University of Technology. It comprises a process where granular sludge is grown compared with flocs from conventional activated sludge. The granules settle much faster than conventional flocs and can operate at mixed liquor concentrations comparable to that of a Membrane Bio-Reactor (MBR), whilst maintaining these high settling velocities. The higher biomass concentration allows for a much smaller footprint than is possible with traditional activated sludge. Another major process benefit of granular sludge is that simultaneous denitrification is possible due to the ‘anoxic core’ in the granule where both nitrification and denitrification during the aerobic phase take place and both nutrients and phosphates are removed.

It is, however, very difficult to introduce new technology in South Africa through the current tender system. Also, as a public body the Municipality could not take unnecessary risks. The technology has only been applied to some industrial treatment plants and pilot studies on municipal sewage effluent in the Netherlands. The Gansbaai works would be the first full-scale...
demonstration application on domestic sewage in the world.

Design proposal
A design concept was proposed whereby the interim solution could become part of the final product and thereby achieve major cost savings. The existing site could also be retained with substantial benefits to ratepayers and residents.

The Nereda® process is similar in operation to that of the conventional Sequential Batch Reactor (SBR) technology. The interim proposal was therefore to design the 2 Mℓ/d plant based on SBR principles and minimise the client risk. Operating the plant on Nereda® principles would, however, increase the reactor capacity to 4.5 Mℓ/d due to greater efficiency. The Municipality accepted the proposal, and other components such as the inlet works and disinfection facilities were designed for a 5 Mℓ/d capacity.

The proposed plant was, due to the reduced footprint, able to fit onto the existing site. Allowance was made in the design to increase the plant capacity by another 3 Mℓ/d on the same site. The modular design of the plant resulted in minimal environmental damage as the relatively smaller components could be fitted between the existing milkwood trees.

The utilisation of the Nereda® process on the existing site eliminated the requirement for the intended 5 Mℓ/d works on a separate site. Considerable cost savings were therefore possible. A new permit application will, however, be required when the sewage flow in Gansbaai exceeds 2 Mℓ/d. This is likely to include a new outfall to dispose of excess flows not being re-used.

CONSTRUCTION ASPECTS
The construction tenders for both the civil and the mechanical/electrical works were awarded in March 2007. The new plant was constructed with the old plant still in operation. The switching over to the new process was phased in over three months with the new plant running independently from September 2008.

Although the Nereda® process represents groundbreaking technology,
standardised methods were used in the construction of the works. Mechanical and electrical equipment are typically as found in other treatment works. Due to confidentiality agreements, the reactor pipework and the process controller were directly designed and installed by SSI. The equipment was set up in such a way that the plant can be controlled remotely by DHV in the Netherlands, SSI in South Africa and by the Municipality.

Due to the sensitivity and importance of the project, special care was taken to ensure that the project would be completed within the set timescale, costs and specifications. A design forum has been established by SSI and DHV to regularly monitor the progress and technical aspects of the project. To this end an SSI representative studied the process and pilot plants in the Netherlands for a six-month period. Regular visits during the construction and commissioning periods were made to Gansbaai by DHV personnel. A full-time SSI engineer is currently monitoring the variable operating conditions and treatment parameters towards a postgraduate thesis.

**PLANT COMPOSITIONS**
The components of the plant are described as follows:
- Inlet works with dual degritters, 6 mm and 2 mm screens specifically selected for the Nereda® process
- Conversion of the old anaerobic tank to a buffer tank and pump station
- Three Nereda® reactors separately operated by the control system
- Chlorine dosing tanks
- Conversion of old reactor into a sludge thickener
- Use of existing sludge drying beds
- Irrigation pump station and rising main to sports fields
- Use of existing reedbeds and reedbeds for polishing effluent
- Blowers for use of fine bubble aeration system
- Motor control centre

**OTHER ASPECTS**
**Granular sludge**
For many years scientists have strived to increase the size and weight of flocs in activated sludge to increase settling velocities and reduce the physical size of treatment plants. The process has now been perfected by DHV and has been successfully implemented at Gansbaai.

As no existing granular sludge was available locally to start the Nereda® process, the sludge had to be grown from scratch. To accelerate the process, activated sludge was imported from the adjacent Stanford WWTW to seed the Nereda® reactors. Within a few weeks, the characteristics of the sludge changed and reached full development after about three months of operation.

**Nereda® cycle**
The Nereda® process is based on the standard SBR cycle. This process provides a very compact and effective treatment system and has proved to be highly appropriate for the Gansbaai WWTW.

**Test results**
Very good quality effluent has been produced to date considering the variable nature of the sewage delivered to the works. Most effluent is carted per tanker from septic tanks to the site. Being a part holiday town, the flow qualities peak during the holiday season. Very high incoming COD loads (Chemical Oxygen Demand) have been recorded at the beginning of peak seasons when most septic tanks are emptied. These variations will stabilise as the sewage reticulation system in Gansbaai is expanded.

Nereda® granular sludge completes extensive biological nutrient removal with consistent phosphate and nitrogen removal to < 1 mgP/ℓ and < 15 mg TN/ℓ, respectively. In other words the DWAF special limits can be consistently achieved, even at installations < 1 Mℓ/d.

**Project costs**
Substantial costs savings have been achieved with the utilisation of the Nereda® process at Gansbaai. The plant is approximately 15 to 20% less expensive than a conventional design and the operating costs are about 50% lower. Another substantial saving applicable to this particular project is that the two plants could be housed on the existing site due to the smaller footprint required.

Comparative construction costs for the plant, excluding land and associated costs, are shown in Table 1.

**Environmental considerations**
The upgrade of the old plant to 2 Mℓ/d required a full environmental process. This was undertaken by EnviroAfrica with input from SSI. No objections were raised by the Gansbaai community and other interested and affected parties. The construction process was further monitored by EnviroDinamik. Special care was required to minimise damage to the unique milkwood forest around the site.

The most positive outcome of the project is that the works could be accommodated on the existing site on a very small footprint of modular design. Other environmental considerations include the re-use of effluent, and the groundwater monitoring programme being undertaken separately by the Municipality.

The project has been very well received by the community and was formally opened by the Mayor on 14 April 2009 after the process had stabilised and acceptable test results had been obtained.

**CONCLUSION**
The Gansbaai Waste Water Treatment Works project provided a worldwide breakthrough in the provision of more affordable sewage treatment with a much reduced impact on the environment. All participants are thanked for their contributions, especially the Overstrand Municipality who facilitated the new technology on a public project.

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Helderberg Coastal Sewer Project

Background
In 2005 GIBB was appointed as the main consultant to investigate the immediate and long-term disposal of sewage within the Helderberg area by the City of Cape Town. At the same time, GIBB was investigating options for Heartland Properties which owns about 700 ha of undeveloped land in the Helderberg Basin.

The conclusion was for the City of Cape Town to invest in its larger Waste Water Treatment Works (WWTW) and minimise having several smaller WWTWs. By having a large WWTW, better control and management would be possible and the option of re-use of treated effluent would also be more viable, because treatment of sewage would take place in the geographic area where it is generated.

The impact of these recommendations meant that all sewers in the Helderberg Basin would flow towards the Macassar WWTW and that the long-term strategy would be to close the WWTW at Gordon’s Bay.

The current bulk sewer connecting the Lourens River pump station to Macassar WWTW, called the N2 bulk sewer, was old, and collapsed several times a year resulting in raw sewage spills. The City of Cape Town and Heartland Properties agreed in December 2006 to jointly install a new gravity sewer, pump...
station and rising main from the Lourens River pump station up to the Macassar WWTW. This would eliminate the sewage spills along the N2 sewer.

**THE APPROACH TO THE DESIGN**

The sewage management needs of three major stakeholders in the Helderberg area – Helderberg Properties, Denel and the City of Cape Town – had to be taken into account. The project was also technically challenging in that it ranged across several kilometres which included eco-sensitive landscape, coastal dunes, wetlands and rivers, as well as Denel’s explosives storage land. Other challenges that had to be overcome included adverse physical conditions, stringent environmental legislation, and challenging design and construction problems.

GIIB implemented innovative environmental and civil engineering design solutions to meet this wide range of requirements.

An approximate route needed to be identified upfront. Issues for consideration included environmentally sensitive areas, geotechnical conditions along the route, and accommodation of the future development plan along the proposed route.

The route chosen along the back of the coastal dunes was not only the shortest route from Lourens River pump station to Macassar WWTW, but also accommodated the proposed development on the Heartland property.

An added benefit to these design decisions was the reduction of the pumping head from the Lourens River
buried has an extremely positive impact on the environment and the aesthetics of the area. Also, the industrial design of the pump station building is such that the building will tie in with future buildings in the area.

**RELEVANT GENERAL FEATURES**
- Total project cost – R120 m (excluding VAT)
- Length of concrete pipe 1200 mm Ø to 1500 mm Ø – 3000 m
- Length of the GRP gravity sewer 600 mm Ø to 800 mm Ø – 2800 m
- Length of GRP pressure main 1000 mm Ø – 2400 m
- Pump capacity – 1600 l/s (peak hourly flow)
  - 3 pumps current (2 duty x 1 standby)
  - 4 pumps future (3 duty x 1 standby)

**UNUSUAL FEATURES**
Due to the size of the project, a full Environmental Impact Assessment was required and the project received a Record of Decision to continue. A Construction Environmental Management Plan had to be implemented, with an Environmental Control Officer to monitor.

Two of the main environmental challenges were, firstly, the pipe bridge with rising main crossing the Eerste River, and secondly, the fact that the route ran parallel to some environmentally sensitive wetlands which needed protection from construction activities.

The environmental advantages of the project for the area are significant. The new pipeline eliminates the risk of raw sewer spills into the highly sensitive local rivers. It was decided to install a return effluent line across the Denel property to bring treated effluent that could be used for irrigation purposes to the Heartland Development. This would eliminate the use of potable water for irrigation purposes. Bringing the treated effluent from the Macassar WWTW ensured that sufficient supply would be available.

In optimising the long-term benefit for the City of Cape Town, pipe material...
selection was critical. The final decision was to use concrete pipes with HDPE lining for the deep sections of gravity line, GRP pipe for shallow sections of gravity sewer, and GRP pipe for the rising main.

Traditionally, a significant complication when increasing capacity of bulk sewers is the impact on existing and current infrastructure while upgrading. But the route chosen for this project meant that only during the tie-in to the existing infrastructure would there be impact on existing services – and it would be minimal. The bulk of the project was constructed without impacting service delivery.

CONCLUSION

Through engineering excellence, the Helderberg Coastal Sewer is adding value to the greater Helderberg area. The nature and scope of the project had seen private developers that needed bulk effluent services successfully join forces with the local authority – the City of Cape Town – in a bid to identify the most cost-effective solution for all parties.
This marine outfall system is the only dense waste water marine outfall in South Africa and one of very few in the world. The main elements of the project are unique in many ways, and these required several design and construction solutions to be developed from first principles, and bold and innovative thinking was required to provide robust solutions within a physically harsh yet environmentally sensitive setting.

Outstanding technical aspects of the new dense waste water marine outfall project include the following:

- The bulk of this large project (R150 million) was carried out either below sea level or below the water table on ‘dry land’ next to the sea.
- High degrees of ingenuity and experience were provided by the large, multi-disciplinary professional team, relevant stakeholders, the end user.

Beach connection and cofferdam for new 1000 mm diameter land-line section; connection was made at 4.6 m below mean sea level at the low water mark.
(Foskor) and the client (Mhlathuze Water) to achieve concurrent goals.

All construction work had to be carried out while maintaining uninterrupted full production of the existing waste water disposal system.

Ingenious discharge and dilution analyses for the outfall pipe and diffuser ports were devised from first principles to improve dispersion of the dense and extremely corrosive and abrasive waste water. This is in comparison to the more common buoyant waste water outfalls, for example sewerage, which has a well established design method.

The bare metal slurry pumps use variable speed drives and multiple...
redundancies to ensure uninterrupted operation at high efficiency (84%).

High quality work was carried out under dangerous and demanding conditions accommodating ocean waves and currents and sudden climate (weather) changes in the marine environment.

Working ‘on land’ was carried out below sea level and required continuous dewatering of foundations.

All environmental requirements were complied with.

Maximum re-use of existing structures was achieved, for example sea intake for mixing of sea water with dense waste water.

PROJECT BACKGROUND AND PURPOSE, AND DESIGN APPROACH

The Client, Mhlathuze Water, disposes waste water via two marine pipelines into the Indian Ocean at Richards Bay. So-called ‘buoyant waste water’ is disposed via the 5 400 m long A-line, and ‘dense waste water’ via the 4 300 m long B-line.

The dense waste water consists of a mixture of sea water and gypsum slurry which is a by-product of Foskor’s local phosphoric acid plant. The effluent is extremely corrosive (pH < 2, also containing chlorides and fluorides) and abrasive due to the presence of suspended gypsum particles (up to 10 000 t/day).

The main elements of this project were first constructed and commissioned approximately 25 years ago. With the A-line operating as expected, the B-line however experienced increasing problems due to insoluble particles accumulating inside the pipe, diffuser ports becoming blocked and the gypsum sediment being deposited adjacent to the pipe on the sea bed.

The Client decided that the risk of extended downtime on this line was unacceptably high. A solution was required to ensure reliable, uninterrupted operation within DWAF’s (Dept of Water Affairs and Forestry, now the Dept of Water Affairs) permit requirements.

Concurrent with the A and B-line, a third pipe section, i.e. the C-line, was installed from the beach, across the surf zone, extending about 700 m into the sea to allow for future use. The installation of
a second dense waste water pipeline and diffuser system, utilising this C-line section, inclusive of a new pump station, was recommended.

Following extensive studies and designs by the principal and coastal engineers, WSP Africa Coastal, and specialist mechanical and electrical sub-consultants, SSI Engineers, the client decided to install a new and improved marine outfall pipeline to handle the dense waste water and also to provide an opportunity to refurbish the existing pipeline as a future back-up (a requirement set by DWAF). Other improvements included a new pump station with associated mechanical and electrical works to provide increased pressure and flow (1500 l/s @ 68 m).

The whole discharge system was reviewed and modifications were proposed to ensure that the new system can effectively discharge the dense waste water in the long term without causing blockages in the pipeline or in the diffuser ports, or forming large depositions of gypsum and ‘insoluble’ materials on the sea bed. Alternative uses of the gypsum waste product were also investigated.

**GENERAL FEATURES (COMPONENTS)**

The project is predominantly civil engineering in nature, but its ultimate success also required a wide range of inputs from other disciplines such as mechanical, electrical and electronic engineering, marine engineering, environmental manage-
ment, project management, health and safety, and quality assurance.

The main components of the project include:
- A new pump station consisting of approximately 2,100 m³ of concrete, requiring 8 m deep excavations to a level of 5.5 m below mean sea level and constant dewatering of the foundations to prevent flooding the work areas.
- The new C-line:
  - Land-line portion consisting of a 400 m long 1,000 mm diameter HDPE pipe from the new pump station to the pre-existing beach connection:
  - To hold back the sea, an earthworks cofferdam had to be constructed.
  - Marine-line portion consisting of 3,200 m long 900 mm diameter HDPE pipe, connected to the pre-existing beach crossing section:
  - The pipe was constructed in the Richard Bay harbour.
  - It includes 462 precast concrete collars ranging from 5 to 2 tonnes each designed to keep the pipe stable on the sea bed.

- New severe duty slurry pumps with a duty flow of 1,500 l/s @ 68 m were installed (two duty, one standby pump configuration).
- The Work was carried out under three separate construction contracts, i.e. civil, marine, and mechanical and electrical contracts respectively.

SPECIAL FEATURES
AND INNOVATIVE DESIGN

The designs required a significant amount of lateral and ‘out of the box’ thinking, as previous methods for conveying and disposing dense waste water at sea had not been successful. Design ingenuity and technical excellence were displayed through the following aspects:

- Dilution in ocean water:
  - This is the essence of the technical solution for disposing of gypsum in the sea. Existing software had to be manipulated based on first principles to predict the shape of underwater discharge plumes (commercial software programs for analysing dense waste water plumes are not readily available). Different port spacings were analysed to ensure that the required amount of mixing in sea water was achieved. Other calculations were carried out to evaluate various ocean current conditions and these were incorporated into the designs.

- Diffusion ports:
  - Simulations showed that velocities of up to 17 m/s are required to disperse gypsum into the sea water so that the waste water can dissolve sufficiently. In order to limit scour at diffuser ports, careful designs and details were prepared for ceramic ports encapsulated in a GRP matrix.

- Diffuser section:
  - To maintain required flow velocities in the diffuser, progressively smaller diameter pipes were introduced after each set of outlet ports.

- Marine pipe diameter and material:
  - Gypsum and ‘insoluble’ particles in the pipes had to be kept in constant suspension to prevent solids from being deposited and thus blocking the pipe. Introduction of dynamic...
mixing mechanisms were modelled and minimum velocities for preventing deposition were set; 900 mm diameter HDPE PE100 was selected for the pipe material due to its proven high resistance to corrosion and abrasion.

- Marine pipe stability:
  - Modelling of pipe stability for expected wave and current conditions on the eastern coast near Richards Bay was carried out according to three different methods:
    - Det Norske Veritas Simplified Stability Analysis
    - Dynamic analysis using software PONDUS (a finite element method to solve movements in the time domain)
    - Scandinavian Design Procedure
  - The pipeline was designed to be dynamically stable during a 1:100 year storm (deep-sea significant wave height of 6.7 m)
  - The effect of tropical cyclones was incorporated in the stability designs, but even with higher wave heights, it was found to be less critical due to different angle of attack

- Pumps and Pump station structure:
  - Completely separate bays were provided to prevent the entire pump station from being flooded in the event of a delivery pipe burst or valve failure.
  - A fourth bay was provided to enable future installation of a second stand-by pump, in the event of the client foreseeing increased risk to his operations.
  - Each bay has an overflow gallery to return spillage to the sea water inlet.
  - The pumps are equipped with variable speed drives to accommodate wear in the system and to prevent overpressurising the HDPE pipes.
  - Each bay is equipped with an emergency, high-rate dewatering pump to avoid unnecessary pumping stops in the event of significant, but not catastrophic, leaks from the pressurised delivery pipes.
The pump bodies and impellers use proprietary, high corrosion resistant metals to prevent the need for rubber lining.

Sea water is used for high rate gland lubrication (7 l/s) to avoid using potable water.

**NOVEL CONSTRUCTION TECHNIQUES AND SPECIAL MEASURES USED**

Any project linked to the coast or involving a large number of role players provides difficult working conditions where innovative construction techniques are essential. The following main construction challenges had to be overcome on this project:

- A cofferdam had to be constructed on the beach to connect the land-side end of the existing C-line section. The core was made up using 500 x 5 ton geo-fabric sandbags (the size of the required cofferdam was increased due to the severe beach erosion during the March 2007 storms). With the tie-in level at 4,5 m below mean sea level, 17 x 100 mm de-watering pumps were operated continuously to control the water inflow into the sheet-piled protected excavations. Around the clock construction had to be timed carefully to make maximum use of the tidal windows and thus reduce construction costs and risks. All this was done with the existing operating B-Line pipeline less than one metre away from the connection!

- The new pump station had to be constructed with a 1,4 m thick base to ensure that the structure is stable at high water tables.

- The marine pipeline, inclusive of concrete weight collars and diffuser were towed out and had to be placed in depths of over 20 m under very difficult working conditions in the marine environment. This called for innovative, experienced and on the spot problem solving to ensure the integrity of the final product. In addition to dealing with strong currents, waves and very few suitable weather ‘windows’, underwater diving work was mostly done in zero visibility. Pipes were placed in strings and connected on the sea bed via special male/female devices.

- All construction areas were rehabilitated to either the same or improved conditions, compared to pre-construction state. Where beach crossings were done, dune rehabilitation was executed to add public benefit to the project.

- Challenging and constant hands-on project management was required due to the many different disciplines working concurrently and the many interfaces, both time-wise and physical, to smooth out construction and phasing (including several electrical shut-downs by the Richards Bay electrical supply authority during commissioning of the pumps and electrical equipment).

Commitment was amply demonstrated by all parties involved in the project. The delivery of a successful and quality product is a hallmark of technical excellence in engineering, and this is the ingredient that ensured a seamless operational switch-over from the old B-line to the new C-line.

**CONCLUSION**

The appeal of this project lies in the sheer size and uncommon design and construction aspects, as well as application of civil engineering insights into the sensitivities and risks associated with the design and construction processes.

A significant contribution was made to technical excellence, and the civil engineering knowledge gained can be applied to further similar projects by all the professionals involved.
The R292 million design and construction of the first phase of the Northern Waste Water Treatment Works Unit 5 presented unique aspects that required an unusual degree of engineering ingenuity and innovation to merge the technical aspects of the project with acceptable construction and environmental solutions. Extremely tight programme deadlines were met through concerted and dedicated efforts by an integrated, multi-disciplinary design team, thereby contributing hugely to the socio-economic development of the Diepsloot area and of the Gauteng Province.

DESCRIPTION OF PROJECT
In 2004 Johannesburg Water (Pty) Ltd, the water and sanitation service provider for the City of Johannesburg, embarked on a project to increase the capacity at the Northern Waste Water Treatment Works (NWWTW). The objective was to provide a first-class waste water treatment works to cater for ongoing increases in capacity demand and to eliminate possible spillage of waste water into the adjacent Jukskei River.

Growth in wastewater flow in the NWWTW drainage basin has resulted in the requirement for additional treatment capacity. The drainage basin extends from Roodepoort in the west, parts of Germiston in the east and the Hillbrow ridge in the south, an area that has experienced enormous development over the past decade. The existing installed treatment capacity is 410 Mℓ/d. The ultimate treatment capacity of the new unit will be 150 Mℓ/d, constructed in three increments of 50 Mℓ/d to pace the inflow to the works. The first 50 Mℓ/d capacity increment is nearing completion with additional capacity anticipated by 2011.

NORTHERN WASTE WATER TREATMENT WORKS UNIT 5 PHASE 1
Technical Excellence category
Submitted by SAICE Wits National

KEY PLAYERS
Client  Johannesburg Water
Consultants  KITU JV comprising Knight Piésold Consulting, Iliso Consulting, Turgis/Lesedi Consulting
Main contractors  Northern Wastewater Construction JV
Botjhe Water, Enzani – IST JV

1 The reactor posed a number of design challenges. Note the slender internal walls and the aerator platforms and bridges.
The NWWTW comprises five units:

- **Unit 1**: A biofilter plant commissioned in 1958 and operating under partial load.
- **Unit 2**: Commissioned in 1963 and using the biological filter treatment process; later decommissioned and partially demolished to salvage material (a feasibility study confirmed the site to be suitable for the construction of additional treatment capacity for Unit 5).
- **Unit 3**: Commissioned in 1980 and initially designed as a five-stage Phoredox process unit; recently upgraded and refurbished to the client’s process configuration.
- **Unit 4**: A biological nutrient removal process plant commissioned in 1993; supplying about 30 ML/d of final effluent to Kelvin Power Station; it also includes a composting plant with a capacity of 90 dry tonnes per day.
- **Unit 5**: To have an ultimate treatment capacity of 150 ML/d, constructed in increments of 50 ML/d to pace the expected waste water flow to the NWWTW.

The new treatment plant includes primary sedimentation, flow balancing, biological nutrient removal, activated sludge treatment with supplemental chemical dosing facilities, secondary clarification, effluent disinfection, an effluent outfall and site services. The plant includes primary sludge fermentation with disposal of the fermented sludge to the previously refurbished digesters at Unit 2. Furthermore, the plant includes waste activated sludge thickening with disposal to sludge dewatering facilities upgraded under a separate project to handle the increased sludge masses from the new treatment capacity.

The sludge fermentation and elutriation process has been designed to produce volatile organic acids from the primary sludge to supplement the readily biodegradable chemical oxygen demand entering the biological reactors. This is necessary to enhance biological phosphate removal.

The Phase 1 project comprised:

- Demolition of existing Unit 2 structures
- An inlet channel from the existing Head of Works
- Bulk earthworks
- Two 35 m diameter primary sedimentation tanks with 4.2 m high side walls; each has a full diameter scraper mechanism and capacity of 4,820 m³
- One 25 m diameter fermentation thickener tank with a 5 m high side wall; it has a full diameter scraper mechanism and capacity of 2,850 m³
- An elutriation pump station with two recirculation pumps, two elutriated liquor pumps and two thickened fermented sludge pumps
- A primary sludge screening plant with two front raked bar screens, a conveyor and screw press, and a mixing tank with one radial flow mixer
- A 77 m long balancing tank, 40 m wide with a 3 m high side wall and capacity of 10,000 m³ plus six dual impeller axial flow mixers
- A 176 m long BNR activated sludge reactor, 35 m wide with a 4.7 m high side wall and capacity of 29,240 m³. Included are thirteen aerators sized between 22 kW & 110 kW, nine 7.5 kW mixers, four recycle axial flow pumps and two Archimedes screw pumps
- Supplementary chemical dosing for phosphate removal using ferric chloride.
Three 35 m diameter secondary clarification tanks with 4 m high side walls. Each has a full diameter scraper mechanism and capacity of 4,820 m³.

A waste activated sludge pump station with two single end suction, screw type impellor pumps, two 5,5 kW radial flow mixers and a 650 m long 300 mm NB rising main.

One 28 m diameter waste sludge thickener tank with a 4 m high side wall. It has a full diameter scraper mechanism and capacity of 3,000 m³.

A 96 m long effluent disinfection tank, 6,7 m wide with a 3,5 m high side wall and capacity of 1,670 m³, complete with chemical dosing of calcium hypochlorite for disinfection.

A 740 m long effluent outfall steel pipeline with a diameter of 900 mm.

Site services (service roads, storm water control, potable water and effluent reticulation, electrical power reticulation and site lighting).

Building work for various structures such as:
- the main incoming switchroom
- substations for the balancing tank/PST and the reactor
- laboratories for effluent and clarifier effluent monitoring
- pump stations for the waste activated sludge (WAS), elutriated liquor & effluent reticulation

Miscellaneous structures

Elements of the plant were designed to provide for the future capacity of Unit 5. These include:

1. Reactor area: Excavations to enable demolition of the humus tanks that formed part of the existing decommissioned Unit 2. The demolition created the space needed for work on the new Unit 5, Phase 1.

2. Storm water bypass: The construction of this bypass channel provided its own challenges. Due to its proximity to the waste water dam to the west, the foundations were saturated for most of the construction period. This channel separates the storm water from the sewage spillage on the various parts of the works.
the flow divider upstream of the primary sedimentation tanks
the flow divider upstream of the reactors
the sludge screens and mixing tank at the fermentation plant
the WAS & fermentation plant pumpstations
the WAS rising main to the thickeners and the effluent outfall
The design also allows for certain pipelines to be constructed during the future construction phases of Unit 5 with minimal disturbance to the infrastructure constructed under Phase 1.

CONSTRUCTION TECHNIQUES
Special construction techniques include:
- Staged construction in 50 Mℓ/d extensions:
  - Pre-excavation for future structures to avoid blasting in proximity to these structures
  - Provision in the first phase for the future extensions
- Demolition of the existing biological filter plant segmented wall construction for circular tanks (prototype shuttering systems)
- Long, thin wall concrete pours
- Adherence to strict health, safety and environmental specifications within the EMP guidelines established in the EIA and ROD processes of the Gauteng Dept of Agriculture, Conservation and Environment
- Development of measures to ensure the durability of the concrete and to protect it from corrosion from the liquids being handled, including those areas affected by the aeration zones in the reactor

OPERATIONAL REQUIREMENTS
The operational requirements for the plant were discussed in detail with the client’s representatives and works management during the design phase. These requirements were incorporated into the Process & Instrumentation Diagrams which served as the common reference of the client’s requirements for the multi-disciplinary design team. Furthermore, the operational requirements were translated into functional descriptions for the various unit processes and incorporated by the nominated subcontractor into the programming of plant control hardware and the SCADA system.

During the course of the project, the client required standardisation of controllers on all its works. This necessitated the revision of the project specifications for the PLCs in the electrical and instrumentation contract and then to negotiate with the contractor to replace the original defined PLCs with units conforming to the revised standards.

ADDITIONAL INFORMATION
The civil contract was based on the SAICE General Conditions of Contract for Construction Works, and the mechanical and electrical/instrumentation contracts were based on the FIDIC Conditions of Contract.

In order to meet the deadlines set by the client, the civil and mechanical contracts were put out to tender simultaneously. This caused various problems with regard to the final design of the civil works and the later incorporation of
In order to meet the deadlines set by the client, the civil and mechanical contracts were put out to tender simultaneously. This caused various problems with regard to the final design of the civil works and the later incorporation of mechanical equipment into the design once construction had already commenced.

KITU JV implemented its and the contractor’s own ISO compliant quality management systems for all administrative and technical controls. Regular audits were undertaken.

**SOCIAL AND ENVIRONMENTAL SUSTAINABILITY**

Positive features of design and construction:

- The footprint of NWWTW has not increased even though the potential treatment capacity has increased by 37%.
- Potential odour impacts have been addressed.
- The aggregate quarry on the adjacent farm (owned by JW) was filled with the demolished concrete from Unit 2 and rehabilitated.
- Potential spills of partly treated waste water have been reduced by diverting storm water runoff around the existing waste water storm overflow storage dam.
- Environmental and socio economic aspects specified in the EMP have all been addressed with the monitored result indicating that satisfactory compliance has been achieved.
- Employment has been provided for 573 people, 342 from local communities.
- In line with the client’s empowerment initiatives, accredited training was provided to 156 historically disadvantaged technical staff.
- Procurement of goods and services from BEE providers stands at R17,3 million.
The design and construction of the Mohokare Bridge over the Caledon River

In December 2004 BKS (Pty) Ltd and BVI Consulting Engineers were appointed jointly by the Department of Public Works and Roads of the Free State Province for the design and construction of a new bridge over the Caledon River near the town of Wepener.

BACKGROUND

Road P6-2 crossed the Caledon River near Wepener over the Jim Fouche Bridge, which was constructed in the early 1960s. The Welbedacht Dam was constructed 41.5 km upstream of the bridge in 1973. Due to the high average sediment yield of the Caledon River, the Welbedacht Dam silted up very quickly, which resulted in substantial sediment deposition in the river itself. The Jim Fouche Bridge had an original opening height of 13 m, but by 2005 it had been reduced to only 1 m, resulting in regular overtopping during floods. A new bridge was required at a higher level to restore the 100-year hydraulic capacity of the river crossing.

DESIGN

The horizontal alignment of Road P6-2 was moved upstream of the Jim Fouche Bridge, which suited the topography and general horizontal alignment of the road.
The vertical alignment was determined by the bridge opening that would allow freeboard over the 100-year flood event.

The flood level study for the new bridge had to include a sedimentation study to determine the stable silt level at the bridge crossing. The study was performed by Dr GR Basson at the University of Stellenbosch and comprised a hydrodynamic and morphological mathematical model simulation of the Caledon River, including the Welbedacht Dam. The study resulted in a road level approximately 12 m higher than the original Jim Fouche Bridge for a bridge length of 200 m in comparison to the 125 m long original bridge.

During the concept development for the new bridge various alternatives were evaluated, and it was eventually decided to construct an incrementally launched bridge. Although an incrementally launched bridge was not the cheapest alternative, it was considered the best option for constructing a 200 m long deck over a river that is known to flood without prior warning.

**DESCRIPTION OF THE BRIDGE**

**Foundations**

Foundations were based on a detailed geotechnical survey comprising two bore holes at each foundation position. Piled foundations using large diameter oscillator piles (1.2 m diameter) were proposed due to the presence of a boulder layer, the silt and relatively poor sandstone bedrock. The piles were socketed into the sandstone to increase stability and load bearing capacity.

The foundations for both abutments and the four piers were designed as stable pile groups consisting of 1.2 m diameter oscillator piles. The ‘as built’ pile lengths vary between 15 m and 28 m. The pile group at the Bloemfontein abutment consists of 8 piles (launching end), while the Wepener abutment has 5 piles. The piers have pile groups of 8 piles each. Raked piles were installed at 1:5. Pile groups were designed as free standing, as the silt tends to go into suspension during floods.

**Abutments, piers and deck**

Small perched abutments were designed

3 Jim Fouche Bridge in 2005 – the original opening height of 13 m had gradually been reduced to only 1 m, resulting in regular overtopping during floods

4 Formwork assembly

5 The completed launching girder
in contrast to the usual wall type closed abutments for river bridges. Wall type abutments for this bridge would be more than 12 m high and very expensive due to the requirement to use oscillator piles. Extensive gabion protection of the embankments up to the 100-year flood level was more cost effective than to construct wall type abutments.

The piers are very slender diamond-shaped wall type structures. The diamond shape was developed to be hydraulically effective and to be able to rotate the pier heads by 15° for the river flow direction whilst keeping the bearings square to the deck for launching.

The deck comprised a 2.7 m deep pre-stressed concrete continuous box girder, and was constructed in 14 segments of 14.3 m long. There are 5 spans with the outer spans measuring 34.75 m and the three internal spans 42.9 m each, totalling 200 m.

Unique upstream embankment design
The Caledon River has changed from a river with a defined watercourse to an almost flood-plain type river due to the severity of the sediment deposition. The bridge would therefore choke the river from a wide flow of more than 500 m to 200 m at the bridge opening. It was prudent to evaluate the behaviour of the river and the hydraulics of the flow through the bridge opening with a model study, which was performed at the laboratory of the Department of Water Affairs.

The study showed that a large area of the river upstream of the bridge on the Wepener side dammed up during a flood event and created eddies. The flow of this portion of water through the bridge opening resulted in the Wepener side span to be ineffective hydraulically. A specially shaped berm was then designed and constructed to guide the flow of this water through the side span.

CONSTRUCTION METHOD
Piling
Piles were installed by the oscillator method through the piling platforms and the thick layer of sediment, and socketed into the sandstone and mudstone bedrock. For each pile the rock socket material was evaluated by an engineering geologist. This evaluation of the quality of the material was used by the bridge engineer to determine the length of socket required for each pile. This procedure was necessary due to the inconsistency of the rock and the presence of soft layers identified during the geotechnical investigations. Concrete for the piles were cast under tremie. Cross hole sonic logging was used to confirm the concrete quality of each pile installed.

Piers and abutments
Instead of casting the slender piers in 3 m lifts with construction joints, the 10 m and 12 m high piers were cast in one operation by using two tremies and a concrete mix similar to that of the piles. The pier heads were cast separately in a second phase. The perched abutment pile caps and walls were constructed conventionally.

Deck construction area
Incrementally launched bridges are constructed in segments behind one of the abutments. In this case the deck was
launched from the Bloemfontein abutment. The deck construction area comprised the spine beams, formwork assembly, reinforcement fixing area and a moveable roof structure. The spine beams support the deck when it is in the construction area and they are extensions of the slide paths of the deck. For this reason the construction tolerances of the spine beams and deck assembly were extremely tight. The deck construction area was founded on piles through the embankment behind the abutment to ensure that there were no differential settlements that would affect the levels during the construction period.

**Launching girder**

The purpose of the launching girder for an incrementally launched bridge is to transfer the weight of the deck to the next support. Structural steel launching girders are used because of the high strength and relatively light weight compared to the concrete deck. The length of the launching girder is usually approximately 60% of the typical span length for optimal efficiency. The launching girder used for the Caledon River Bridge had previously been used for two incrementally launched bridges. It was modified, inspected and all welds were tested before it was transported in sections from Johannesburg. The girder had to be erected in its position at the Bloemfontein abutment before it could be cast into the first deck segment. Special temporary nose blocks were cast with the first deck segment for the attachment of the launching girder.

The launching girder was attached to the first deck segment by means of Diwidag prestressing bars.

**Deck construction and launching**

The deck construction comprised 14 segments. Each segment was constructed and launched in a seven-day cycle. The launching method employed by Concor was a system whereby the deck is pulled by a structural steel trolley fixed to the bottom slab through pockets. Two hydraulic jacks with 500 t capacity each were used to jack a crossbeam through which Diwidag bars were fixed to the jacking trolley.

Temporary bearings comprising specially shaped high strength reinforced precast concrete blocks, covered with stainless steel plates were installed on the abutments and piers. During the launching of the deck, laminated rubber bearing pads with a Teflon coating on one side were fed in
between the deck soffit and temporary bearings by trained personnel. The alignment of the deck was continually checked by the surveyor and if the deck moved sideways, the side guides were used to push the deck back to its intended position.

Innovative safety precautions were built into the launching operation. The slender piers were designed to withstand the design launching forces. For each pier a specific maximum horizontal deflection was calculated and specified. A thin cable was installed and tensioned from abutment to abutment over the piers. At each pier, a limit switch was installed and set to the allowable movement. If the defined deflection at any pier was exceeded during the launching of the deck, the limit switch would automatically switch off power to the hydraulic pump at the jacks and stop the launch. A dead man switch was also installed at each pier so that the launch could be stopped in the event of an emergency.

After the last segment of the deck had been launched and the launching girder disassembled, the internal and end diaphragm beams at the abutments and piers respectively were constructed. The temporary sliding bearings were replaced by the permanent pot bearings and the draped cables were stressed. The nose blocks were demolished and the deck was complete.

Pier head cracks
Deck launching started in October 2007, and at first everything went well. However, as the load on pier 1 increased with the forward movement of the deck, hairline cracks were observed in the transom beam. The launch was stopped and the design engineer consulted. All design calculations were reviewed, but nothing untoward was found. The bridge design engineer consulted with an independent engineer who also reviewed the design without finding any error in the design. Concor refused to continue launching unless an instruction in writing was received. This was duly provided, crack width measuring devices installed, and launching recommenced with all senior staff at the pier head. The launching of segment 5, however, caused all work to come to a dead stop on 16 October 2007 as the transom beam cracks opened still wider. Professor Rudi du Preez, at BKS Advanced Engineering Division for finite element analysis, was consulted and the reason for the cracking was identified after detailed analyses. The narrow 450 mm end sections of the piers and the dead load of the deck combined to cause minute differential elastic deformation between the centre of the pier and the pier ends. This caused unexpected forced curvature in the very stiff transom beam, resulting in high tensile stresses. The differential shrinkage between the transom beam and the pier, which were cast approximately six weeks apart, contributed to the tensile stresses and induced cracking of the transom beam.

The launching of the deck was on the critical path of the project programme and therefore a solution had to be found very quickly. The first option was to keep on launching the deck, accepting that the pier heads would crack and to repair the cracks afterwards. The second option was to provide a preventative solution as soon as possible, while the project was put on hold. The bridge design engineer decided that it was not in the interest of occupational health and safety to launch the deck, knowing that pier heads would crack. A delay of the project was therefore inevitable.

A structurally sound and permanent solution that could be applied in the shortest possible time had to be found. It was very fortunate that the pier heads was rectangular in shape – 2 m wide, 6,25 m long and 1,75 m deep. An innovative solution was developed and tested by introducing it into the finite element model already used in the identification of the problem. External prestressing was applied to the pier heads by means of structural steel stressing beams and Freyssibars (high tensile prestressing bars). It was found that ten Freyssibars would be sufficient to reduce the tensile stresses in the pier heads to acceptable levels. Construction drawings were prepared and Concor pulled out all stops to procure supply and install the prestressing, and on 12 January 2008 launching recommenced. The cracks that had occurred closed partially on the application of the external prestressing and were epoxy-grouted thereafter. Close monitoring since has shown no further movements. All in all only two months were lost due to this delay. The external prestressing system was retained in the permanent works and was encapsulated in a collar of reinforced concrete cast integrally with the original pier heads.

OPENING OF THE BRIDGE
The Mohokare Bridge was substantially completed by 10 October 2008. The then Minister of Transport, Mr Jeff Radebe, officially opened the bridge with a ribbon cutting ceremony on 11 October 2008.
SAFETY IMPROVEMENT MEASURES: KAAIMANS PASS

Technical Excellence category
Submitted by the SAICE Southern Cape Branch

The Kaaimans Pass between George and Wilderness is one of the most picturesque areas along the Garden Route, which draws many tourists to the area. It is unfortunately also increasingly important for the movement of road freight along this National Route between George and Port Elizabeth.

The section of Kaaimans Pass, specifically between the Swart River (km 32,300) and Kaaimans River bridges (km 33,200) includes the infamous horizontal curve at km 32,700 which became known as ‘Death Bend’. Frequent accidents involving local inhabitants, foreign tourists and commercial freight vehicles created a media outcry.
vehicle kilometres was still above international standards. The excessive speed of the east-bound vehicles, while negotiating this horizontal curve, was resulting in encroachment into the west bound lanes with fatal consequences. Certain preventative measures were proposed, including repositioned speed cameras and new road marking/signage, but the main mitigating measure proposed was the construction of a 1.6 m median barrier wall.

The introduction of the median barrier, however, would have the unfortunate consequence of extending the total cross sectional width as a result of the additional stopping distances required for both of the east and west-bound lanes.

This could be overcome by lowering the east-bound carriageway, such that vehicles travelling in the west-bound carriageway would have an improved sight distance, by virtue of the median barrier being only 800 mm high in that direction. The unstable nature of the geology in the area would necessitate the use of rock anchors, rock nails and guniting of the rock face.

**BACKGROUND**

The first wagons to travel between George and Knysna utilised Kaaimansgat in 1778, but surprisingly the original Kaaimans Pass was only constructed in the 1950s. Safety improvements in the 1990s resulted in the doubling of the road from Kraaibosch to Wilderness. A truck stop at km 31.1 was later constructed together with the installation of a speed camera near the western abutment of the Swart River Bridge at km 32.2. Ironically, the best option of re-routing to a new safer alignment was not considered, due to financial and environmental constraints.

In light of the above, during 2002 the South African National Roads Agency Limited briefed their consultants to prepare documentation specifically to include for safety improvement measures in the Kaaimans Pass.

**ANALYTICAL OVERVIEW**

**SAFETY IMPROVEMENT MEASURES**

The existing conditions were summarised as follows:

**Collision statistics:**

- Collisions were mostly due to speeding and ‘out of control’ east-bound vehicles which were essentially exceeding the design speed for the small radius curve at ‘Death Bend’, along a relatively steep gradient.
- The historical collision rate per million vehicle kilometres varied from a high of 8.9 collision per mv kms to 3.6 collisions per mv kms (research norms< 2 collisions per mv kms).

- There was evidence to suggest that the collision rates were decreasing specifically since the installation of the speed camera at the Swart River Bridge (km 32.2).

**Existing geometric alignment:**

- From an analysis of the existing horizontal and vertical alignments through ‘Death Bend’ it was found that the existing Safe Stopping Distance for the east-bound vehicles in the fast lane did not meet the design requirements. In addition, the speed limit for the east-bound fast lane would have to be reduced from 60 km/h to 50 km/h.
Existing road signs and road markings:
- The road signs could be supplemented by additional road markings to alert the driver of the danger ahead.

Existing speeds:
- The existing speeds indicated that drivers approaching ‘Death Bend’ did not perceive the potential danger in terms of the restrictive geometry of the curve.
- The speed camera was very effective in changing driver behaviour and enforcing the speed limit. However, it was not placed close enough to ‘Death Bend’ to affect the entry speeds to the curve.
- The existing truck stop at km 31,18 was ineffective in reducing the speeds of heavy vehicles when they finally approached ‘Death Bend’.

From an analysis of the existing conditions and the interaction of the three main elements of the system, it was found that most of the safety problems could be attributed to the driver (speeding and inappropriate braking techniques), some to the environment (road signs and markings), but very little in terms of mechanical failure.

The analysis further indicated that there was very little evidence to suggest that the mechanical abilities of vehicles were ineffective in stopping the vehicle, even under slippery conditions, from most reasonable locations and under reasonable operating speeds.

The following preventative measures were considered:
- Improving the environment through traffic signs and road markings.
- Changing driver behaviour through increased enforcement, additional compulsory vehicle stops, variable speed signs, and forcing heavy vehicles to descend in escorted convoys.
- Addressing the vehicles by implementing vehicle inspections, and as mentioned above, forcing heavy vehicles to descend in escorted convoys.

Changing the environment through additional road signs and road markings, in combination with increased enforcement through speed cameras to address errant driver behaviour, were the preferred alternatives.

Change in heavy-vehicle driver behaviour could be further emphasised by the introduction of a second compulsory truck stop. However, since this might have had to be considered simultaneously with road widening and/or construction of an arrestor bed to allow for vehicles that cannot stop, the cost would be significantly higher.

The following mitigation measures were considered that would address both driver behaviour and vehicle malfunctioning:
- Median barriers (min height 1,6 m)
- Splitting the level of the east-bound lanes from the west-bound lanes.
- Reversing the direction of travel
- Installing an arrestor bed

Invariably the mitigation measures required widening of the roadway, which
could be done either to the outside of the curve, or towards the inside by widen-
ing the cuttings.

**GEOLOGICAL INVESTIGATION**
After a detailed geological mapping of the existing rock cuttings and analysis of cores, the geotechnical consultants recom-
mended the following:

- It would be advisable to widen the road on the inside of the curve, as the out-
side of the curve had been constructed on an old fill, which had, during the late 1980s, been repaired utilising anchor-
piled segmental block walling.
- The rock cutting on the inside of the curve revealed three separate geo-
logical zones ranging from quartzite in the west to schist in the east, with a possible wedge failure affecting the entire middle zone.
- Despite the weathered and unstable nature of the rock face, the cutting was found to be competent enough to allow the need for rock anchors, rock nails and guniting to be assessed after the blasting had been completed. This process proved vital in the execution of the works.

**ASSESSMENT OF ALTERNATIVES**
As a result of the introduction of the 1,6 m high median barrier, the cross sectional profile needed to be increased to allow for Safe Stopping Distance both in the east and west-bound directions. Unfortunately the expropriation compensa-
tion negotiations with the adjacent landowner failed to reach consensus and it became necessary to confine improve-
ments to the existing road reserve width.

Two further alternatives utilising the median barrier concept were assessed, one being splitting the levels of the east and west-bound carriageways, the other being the construction of a cantilever structure which would partially elevate the east-bound over the west-bound car-
riageways. This second option was later discarded due to cost considerations.

**CONCLUSION**
The project commenced in June 2006 and was completed in March 2008. The lack of any serious accidents during the construction phase was attributable to the contractors’ disciplined approach to traffic accommodation measures. Each of the various construction operations, including blasting, barrier construc-
tion, installation of rock anchors and guniting the rock faces required single lane traffic in both directions, which changed from day to day.

Recent incident data (April 2009) revealed that only 3 incidents had been recorded in the last 3 years between the truck stop and ‘Death Bend’. One of these incidents resulted from an east-
bound truck colliding into the newly completed barrier, without encroaching into the westbound lanes.

This R20 million project has suc-
ceeded admirably in providing cost-
efficient safety improvement measures for Kaaimans Pass, and has allowed the engineering professionals an op-
portunity to display their skills in the analytical, design and construction fields to the benefit of the travelling public.
The upgrading of the Western Freeway in Durban has provided the eThekwini Municipality with an asset which has been highly responsive to community needs. The project involved established and development level contractors, and included a high degree of municipal engineer involvement in fiscal budget and phasing requirements, as well as innovative structural and roadway features and asphalt design. It is the first dedicated public transport lane in KwaZulu-Natal, with significant aesthetic and safety improvements, and minimal environmental impact.

PURPOSE OF THE PROJECT
The first objective was to ease the excessive morning and evening peak hour traffic congestion and operational deficiencies of the entrance ramps to the Western Freeway.

The second aim was to rehabilitate the aging and severely cracked road pavement which was in a state of disintegration and delamination causing unnecessary safety hazards and damage to vehicles.

A third purpose was enhancement of road user safety and general aesthetics, security, noise control, and attending...
to pedestrian needs along the Western Freeway corridor.

The fourth and final objective was the provision of a public transport lane facility to encourage and assist the use of public transport.

**DESIGN APPROACH**

The design approach was specifically aimed at meeting the above-mentioned project purposes. In order to address the capacity and operational deficiencies, the traffic analysis indicated the benefits of increasing the lane numbers from 3 to 4 lanes in each direction, plus adding a fifth auxiliary lane linking entrance and exit ramps. This has significantly improved the capacity during peak hours.

The design approach to address the deteriorating road pavement condition included extensive pavement condition assessment and analysis. The resultant asphalt rehabilitation approach varied considerably, not only along the roadway length, but also across the carriageway.

The design approach to address road user safety, aesthetics, security, pedestrian and community needs included the provision of a continuous concrete median barrier, the provision of new and improved overhead signposting, the use of skid resistant stone mastic asphalt surfacing, appropriate speed limits and concrete barriers on the outer sides of the freeway.

In terms of security, the easy escape routes and hide-aways for criminals in close proximity to the freeway was addressed by closing the disused sub-ground level Berea Road South entrance ramp by means of an 8 metre high integrated retaining wall, backfilling the old ramp and providing aesthetically pleasing landscaping.

Pedestrian needs have been catered for by means of a raised pedestrian walkway under Tollgate Bridge, as well as walkways linking the commercial nodes of Berea Centre, the KZN Technikon and the public transport terminals at Warwick Junction.

**RELEVANT FEATURES**

**Roadway features**

The roadway incorporates a public transport (PT) lane constructed using red asphalt. The red asphalt is a ‘first’ used in a PT lane application in South Africa and is unique in terms of using a synthetic binder instead of a bituminous binder in order to achieve the maximum red colour benefits and maximum contrast with the remaining lanes. A number of options were investigated to achieve a colour contrast between the normal lanes and the new public transport (PT) lane. Best results were achieved using a synthetic binder imported from France and a locally produced red oxide colourant.

The PT lane is the first fully dedicated public transport lane for Durban and has pioneered the implementation of similar dedicated PT lanes at other locations in Durban.

The introduction of auxiliary lanes fully linking the entrance and exit ramps are unusual, but given the urban environment, high traffic volumes and high number of entrance and exit ramps, these auxiliary lanes have significantly improved the operational efficiency of the Western Freeway. The ‘bottleneck’ ramp traffic queues seeking entrance
into already full and congested lanes have been eliminated.

Previously traffic from Ridge Road seeking access to the Western Freeway was forced to make an unsafe right turn in Ridge Road and use a low-standard local street to gain access to Jan Smuts Highway and the Western Freeway. This problem has been resolved by means of a new link road between Ridge Road and Jan Smuts Highway which involved the re-commissioning of a disused viaduct adjacent to the freeway, making effective use of an existing asset.

Rehabilitation features
The existing road pavement assessment and strength analysis clearly showed variable pavement performance and condition characteristics. This variable pavement condition resulted in a variable rehabilitation design which included:
- Variable depth of asphalt replacement depending on location and heavy loading expectancy.
- Strengthening the new asphalt by means of glass fibre reinforcement (Glasgrid) between the new asphalt layers at selected locations.
- The use of bitumen modifier (Sasobit) in the asphalt manufacturing process to allow compaction at lower asphalt temperatures than normal due to colder ambient temperatures experienced during night operations.
- The strengthening of the slow lane subbase layers where inadequate support was in place by means of in-situ stabilisation, using appropriate deep milling, mixing and compaction construction plant.

The final asphalt surfacing layer was not conventional asphalt, but was designed as a Stone Mastic Asphalt (SMA) which has excellent rut resistance, skid resistance, overall performance and noise absorption properties. In the urban environment of this project, with exceptionally high peak hour traffic volumes, SMA minimises road traffic noise and maximises skid resistance, which is essential due to a high percentage of rear-end type accidents. The high performance SMA was achieved by means of stringent stone aggregate grading, flakiness and type of stone, and bitumen content specifications.

Structural features
In order to achieve the maximum number of freeway lanes, a concrete
A single slope barrier was selected based on extensive research and for ease of construction. At the start of the project, coming from the N3, where there are higher entry and departing travelling speeds and the roadway is relatively straight, a 1.1 m high barrier was selected with the benefit of eliminating headlight glare. Where the road curvature results in stopping sight distance limitations on the inside of sharper curves, it was decided to lower the concrete barrier to 0.8 m high to allow sight lines over the top of the barrier. Additionally, around the sharpest curve on the project, the barrier was set back from the inside curve, to achieve maximum stopping sight distance for traffic on the inside fast lane.

On the outside edges of the freeway, concrete barrier walls were provided to ensure safety around the sharper curves, as well as protection to the adjacent Garth Road and Randles Road. The community participation process, which was part of the environmental impact scoping exercise, highlighted the concern of residents living in Randles Road (which is adjacent to the freeway), firstly regarding speeding vehicles that often crashed through the guardrail, crossed over Randles Road and ended up inside their properties, and secondly about traffic noise from the freeway. In order to mitigate these community concerns, the design therefore allowed for a 2 m concrete barrier wall on the outer edge of the freeway to provide security from speeding vehicles and to also act as an effective sound barrier.

**CONSTRUCTION TECHNIQUES AND SPECIAL MEASURES**

**Traffic accommodation**

A major constraint was the effective accommodation of traffic throughout the construction period to allow the construction of a concrete median barrier in the roadway median over the full length of the project, the construction of roadway widening on both the left and right hand sides, and pavement rehabilitation of the existing road, with minimum disruption to the peak hour traffic.

A requirement of the project was that the original full three lanes had to remain available in both the morning and afternoon peak hours. This was practically achieved by programming the widening and structural works for day-time construction, with limited access during the peak hours, and the rehabilitation of the existing pavement layers as a night-time operation.

This approach proved successful and minimised disruption to peak hour traffic. It was particularly gratifying to report that these arrangements did not induce day-time accidents that could be attributed to the construction activities. The night-time operations were fully accident free.

Waterfall bridge widening posed challenges due to the nature of the existing road embankment fill material consisting of non-cohesive sand and large boulders. This sand embankment posed stability problems which necessitated extensive temporary shoring, gunting and piling through the embankment material to competent foundation material rather than the spread footings as used in the original bridge. This process ensured that the roadway remained fully trafficable during the bridge widening operations.

**PUBLIC RELATIONS**

Communication and information to the public, regarding work in progress, was by means of a web portal, updated on an ongoing basis to keep the public informed regarding traffic restrictions, temporary closures, and work areas, as well as an overview of the project programme and objectives. In addition to the web portal, other media releases included information articles in the local press, as well as radio station traffic reports. The introduction of the PT lane received extensive exposure in the local press, particularly being a ‘new’ concept for many local road users. This resulted in a smooth opening with very few complaints.

Other communication endeavours included personal house to house visits to those residents living adjacent to the freeway, advising them of blasting work, as well as of temporary vibration disturbance during asphalt construction. These pre-emptive information visits resulted in very few complaints from residents living adjacent to the freeway.

**PROJECT MANAGEMENT**

The major work components, including the roadway widenings, pavement rehabilitation, structural works and the public transport lane, were substantially completed in June 2008. The project scope was extended during the construction phase with commensurate time for completion extensions, and completed as re-programmed and agreed with the client. Various minor additional works requested by the client were completed in January 2009. The client representative actively participated in the project management of the project resulting in excellent client, contractor and professional team cooperation.
This project is a prime example of the successful cumulative result of vision from the client, architectural creativity, analytical capabilities of the engineer and a highly skilled contractor. In addition, this process of gentrification might just start a ripple effect of upgrading and renewing one of the older industrial zones in East London.

THE DEVELOPER, Slipknot Investments 777, had the vision of upgrading older buildings and giving them a modern 'facelift' through a process of commercial gentrification, where old buildings are renovated and changed to render them more in line with modern aesthetic appeal. The consulting team on the Waverley Park development, including Raleigh Keating Architects and UWP Consulting, together with Slipknot Investments 777, aimed to make optimal use of the structure of the existing but deserted facility, an old blanket factory.

This project proved particularly interesting, especially in light of the request from the architect for a curved glass façade, raked 17° to the vertical, requiring various innovative techniques to make the developer's vision a reality. It has been alleged that this curved, sloped façade is the first of its kind in the southern hemisphere.

The structural design had to meet the requirements set by the architect,
while keeping in mind the variable nature of the original structure. Due to glass being the main material utilised in this project, issues such as deflections, wind force and self weight had to be taken into consideration. The challenges and special measures required to achieve completion of this project are tabulated briefly for comparative purposes in Table 1.

All the adjustable items were designed such, as to have adequate load transfer and pose minimal damage to the galvanising.

Constant site supervision and liaison between the structural engineer, Juan Delport from UWP Consulting, and the contractor, Slipknot Investments 777, together with architect Raleigh Keating, played an integral role in the successful completion of this project. By amalgamating knowledge of various techniques and solutions, all challenges were overcome successfully.

Regarding ingenuity and innovation in engineering, this project required something often understated in engineering circles – taking things back to basics and breaking the forces up into vertical and horizontal components, ensuring that these were securely supported. This was achieved by analysing forces applied to the existing structure, before following them through to their respective supports.

With regard to public appeal, the beauty of a curved glass structure is a break from the mundane vertical straight façade so commonly seen on commercial buildings. Compared to its surroundings of railway lines, silos and older warehouses, this building is fast becoming a landmark as a jewel amongst the rough for East London. The building is being let to various government departments.

Demolishing and reconstruction processes require diverse construction and material inputs which bear on the building-embodied energy and carbon footprint. By retaining most of the original structure, the Waverley Park project has managed to retain many of the classic, historical architectural elements true to the region, while adding modern aesthetic appeal and resulting in minimal detrimental impact on the environment.

This process of gentrification may be just what the area needs to begin a ripple effect of upgrading and renewing one of the older light industry and manufacturing zones of East London.
<table>
<thead>
<tr>
<th>CHALLENGES</th>
<th>SPECIAL MEASURES / SOLUTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>The roof structure had to be supported in such a way to make allowance for drainage to either end of the building.</td>
<td>Vertical support to the roof structure was provided by interlinking beams and strategically positioned columns. Timber stanchions were fixed to cleats on the steel roof beams, which made it possible to adjust for the slope on the roof (Photo 4).</td>
</tr>
<tr>
<td>Allowance needed to be made for wind loading, roof loading and self weight.</td>
<td>Horizontal forces generated by wind loading were carried through the roof beams to a rotated steel beam and fixed to the existing braced steel portal frame.</td>
</tr>
<tr>
<td>Large tolerances of the existing structure had to be accommodated.</td>
<td>Steel roof beams were fixed to the main lattice girder with U-bolts (Photo 5). This allowed for vertical and horizontal support of the beam onto the girder.</td>
</tr>
<tr>
<td>Variable radii existed with the level of the curved façade.</td>
<td>Main lattice girder cleats (Photo 6) had to be adjustable and fixed whilst the circular hollow sections were in place. These could not be welded on the ground as a result of the variable nature of the structure. Custom made cradles (Photo 5) had to be provided at the top and bottom members of the lattice. Again, these had to be adjustable.</td>
</tr>
<tr>
<td>All members had to be manufactured on site, except for the galvanising and bending.</td>
<td>Members had to be designed in such a way to be drilled, welded and cut on site, made possible by using simplistic connections.</td>
</tr>
<tr>
<td>The cantilever concrete slab edges were out of line.</td>
<td>Glass façade aluminium mullions were fixed to the concrete floor slabs with adjustable connectors.</td>
</tr>
</tbody>
</table>
Every once in a while stakeholders in a project mesh to produce something special, something innovative that changes the way similar projects will be engineered and managed from then on. One such project was the introduction of the first Ultra-thin Reinforced Concrete Pavement in South Africa by the Gauteng Department of Public Transport, Roads and Works.

INTRODUCTION

Through its Twenty Township Roads Upgrading Project, extending over a period of two years, the Gauteng Department of Public Transport, Roads and Works (GDPTRW), in partnership with the City of Tshwane, set out to improve the living environment of thousands of residents in townships. However, at the inception of the project, it was clear that the GDPTRW’s objectives could not be realised using a conventional design approach. Special approval was therefore obtained to implement an Ultra-thin Reinforced Concrete Pavement (UTRCP) demonstration project to be undertaken by existing contractors with a CIDB (Construction Industry Development Board) grading below 5 in a learnership environment, through recognition of prior learning. This demonstration project constituted the final phase of the GDPTRW’s Twenty Township Roads Upgrading Project.

UTRCP is an exciting technology from the Centre for Scientific and Industrial Research (CSIR) with tremendous potential for enlarging the government’s Expanded Public Works Programme (EPWP). In short, UTRCP is a system for building a road surface using a very thin (< 75 mm) concrete layer. (The CSIR initiated development of UTRCP after a report on the performance of mesh-reinforced concrete that had been presented at a conference in Iowa, USA, more than 15 years ago.)

The Soshanguve demonstration project, worth R8 690 258, provided the opportunity to introduce new technology to the road construction field. One of the key features of the new technology is its accessibility to a large number of small-scale contractors, in support of the government’s Expanded Public Works Programme (EPWP). Another feature is UTRCP’s emphasis on the preservation of local resources.

The development of the project capitalised on the expertise and cooperation available from, amongst others, the following:
The CSIR’s continuing pursuit of technical innovation
The University of Pretoria’s building materials research programme
The CIDB’s programme of capacity building for emerging contractors
Various established contracting companies’ internal skills training programmes
The community leaders of Soshanguve

DEMONSTRATION PROJECT

The road chosen for the Soshanguve demonstration project was a township bus route – a 1.2 km section of Road 36.11 in Soshanguve L. It is one of the main entrances to Soshanguve, used daily by approximately 600 vehicles per hour and 6 000 pedestrians, affecting around 940 households.

The local community agreed to the use of a ‘new’ technology and to allow small contractors and supervisors from all areas of Tshwane (outside the local wards) to work and receive training on the demonstration project, thereby allowing the spread of knowledge beyond the local environment.

The road was built with 50 mm normal concrete (30 MPa), nominally reinforced with steel (200 x 200 mesh, Ø5.6 mm steel). The concrete was placed on in-situ material that had merely been levelled, ripped and compacted. Machinery was only used for the shaping, ripping and compaction of the in-situ material.

Supervisors from all the contractor companies, with supporting local workers, were employed to construct the V-drains and concrete pavement layer.

The contractors on the CIDB’s learnership programme constructed test sections using the same materials as the proposed demonstration project to be tested by the GDPTRW and CSIR’s Heavy Vehicle Simulator (HVS). To date, all test sections have carried more than 1 million E80s repetitions without failure. The sections were only expected to last for an estimated 300 000 repetitions.

Some general features and benefits of the UTRCP demonstration project
- Increased labour content of an estimated 700%
- Acquisition of training and skills that can be applied in other sectors, e.g. concreting skills – prime example of meaningful execution of the EPWP
- Reduced layer works required, which reduces the amount of work to be carried out by plant
- Reduced depth of layer works (box cut), which limits damage to and need for relocation of existing underground services
- Increased durability, resulting in a reduction of maintenance costs
- Investment in equipment is fairly low (no barrier to entry)

Constructing the Soshanguve UTRCP demonstration road using 50 mm normal concrete (30 MPa), nominally reinforced with steel (200 x 200 mesh, Ø5.6 mm steel)
Construction in progress on the Soshanguve UTRCP demonstration road
Environmental benefits – uses fly ash (a waste product) in the concrete mix; concrete can be recycled; less resources used than for a conventional road surface
- Reduced reliance on imported material (bitumen) – a huge benefit considering the scarcity of road building materials and borrow pits
- Reduced construction costs and contract period

Further development of UTRCP technology
Towards the end of 2008, the CSIR in association with the Cement and Concrete Institute (C&CI) and the GDPTRW embarked on a programme of Heavy Vehicle Simulator (HVS) testing on sections of UTRCP constructed along the R80 to Soshanguve as an extension of the demonstration project. At the end of January 2009, the HVS had completed 1 100 000 plus E80s equivalent loadings on the 50 mm UTRCP, with the pavement showing no signs of failure.

TRAINING AND IMPACT ON COMMUNITY
The GDPTRW enrolled 11 contractors through an open selection process on Construction Contractor Learnerships in January 2007. Over a period of two years, learner contractors had completed road construction projects to the value of R50 million as part of their experiential training. All 11 learner contractors successfully completed their learnerships to enable them to receive the National Qualification: Construction Contractor, a SAQA (South African Qualifications Authority) qualification registered by the CETA (Construction Education Training Authority). The Soshanguve UTRCP demonstration project offered an ideal opportunity to these Construction Contractors to build on their previous training.

In addition, 16 supervisors were also identified for training. These supervisors all completed their formal NQF4 supervisor skills in Labour Intensive Construction Methods training, as well as a 3-day orientation course. They also attended a course, Concrete for the Construction Supervisor, at the C&CI School of Concrete Technology. A total of 403 person-days of training was provided for these supervisors.

The UTRCP technology is very labour friendly, providing ample opportunities for employment and training. During the course of the project, a total number of 71 labourers, comprising 31% women and 34% youth, had been employed. The average period of employment per labourer was 73 days, which meant that he/she earned a total of R5 110 on this project. The total number of person-days of employment created on the project was 4 389.

CONCLUSION
The project is an outstanding achievement for civil engineers, supported by provincial and municipal government and research institutions, in conjunction with the communities they serve. It fulfilled the requirements of the client and the needs of the community within the stipulated time and budget, upgrading basic services and contributing to the training and development of SMMEs (Small, Medium and Micro Enterprises) within the community.
The iSimangaliso Wetland Park Authority has embarked on an infrastructure development programme aimed at creating the much-needed infrastructure required to support a fast-growing tourism industry. This programme extends over a number of financial years and is mostly funded through the Expanded Public Works Programme.

BACKGROUND

The iSimangaliso Wetland Park (formerly the Greater St Lucia Wetland Park) was listed as South Africa’s first World Heritage Site in 1999 in recognition of its superlative natural beauty and unique global value. The 332 000 hectare Park contains three major lake systems, eight interlinking ecosystems and a 220 kilo-metre long coastline that stretches from St Lucia in the south to the Mocambique border in the north.

The Park and surrounding areas have a unique combination of natural and cultural resources, which remain undeveloped outside certain pockets. Industrial activity is virtually non-existent and the economy of the region is largely dependent on agriculture, the informal sector, and government, community and social services. The regional economy is

Labour-intensive construction of prime coat for surfaced roads
experiencing a negative growth rate and the formal employment of the region is reported to have been declining since 1980. However, the tourism sector is making an increasingly important contribution to the economy, both in terms of employment and in terms of contribution to the Gross Geographic Product.

The region is characterised by an inadequate provision of infrastructure and services. This has a direct bearing on the Park, particularly in terms of supporting tourism.

The Wetland Park Authority has therefore embarked on an infrastructure development programme aimed at creating the much-needed infrastructure required to support a fast-growing tourism industry. This programme extends over a number of financial years and is mostly funded through the Expanded Public Works Programme (EPWP).

During the 2008/09 financial year the main focus of the programme was to create a circuit of secondary tourist roads that would act as game drives on the eastern and western shores of Lake St Lucia where, through the re-introduction of several game species, including elephant, buffalo, and black and white rhino, visitors are offered an alternative to the popular beach destination for which the area is well known.

Goba (Pty) Ltd was appointed to plan, design and supervise the construction of approximately 20 kilometers of mainly gravel roads on the eastern shores of Lake St Lucia, as well as the upgrading of a further 20 kilometers of road from gravel to surfaced standard in the Mkuze Game Reserve. In certain areas on the eastern shores, and mainly due to environmental considerations, gravel roads were deemed to be inappropriate, and in these areas alternative technologies had to be employed to provide roads that met the required standards. These included concrete strip roads in ecologically sensitive areas and dish-shaped concrete roads in areas with a high potential for erosion.

CLIENT’S BRIEF
The client’s technical brief to Goba was to build roads that met the following criteria:

- Adopt appropriate design standards in order to retain a 'sense of place' while still providing a safe and functional facility.
- Make use of existing tracks as far as possible.
- Avoid visual impacts, i.e. vehicles on the road must not be visible from other tourist facilities.
- Create a stimulating experience by routing the road through various habitats and areas known to provide good game viewing.
- Abide by the requirements of the Environmental Management Plan.

In addition to the above was the requirement for labour-intensive construction methods to be employed wherever economically and practically feasible. To meet the funding requirements, at least thirty percent of total expenditure had to be paid to labour.

DESIGN APPROACH
Invaluable local knowledge regarding animal movements, habitat distribution and biodiversity in general was obtained from Park management staff. This information together with the extensive use of aerial photography enabled detailed planning of the routes before embarking on intensive in-loco inspections to ensure that the best possible alignments had been adopted.

Aspects of the project lending itself to labour-intensive construction methods were identified, and the design and contract documentation were tailored...
accordingly. The construction aspects catering for the bulk of employment on this project were:
- Bush clearing
- Recovery and re-planting of selected identified plants
- Construction of drainage structures
- Removal of oversize material from gravel wearing course
- Construction of surface seals and slurry seals
- Batching, mixing and placing of concrete
- Trimming and preparation of landscaped areas
- Harvesting and planting of local grass

ENVIRONMENTAL MANAGEMENT
All construction projects within the Park are subject to environmental authorisation from the relevant authorities. Even where projects are exempt from formal authorisation, the Wetland Authority still insists on an independent scoping report being done, followed by the compilation of an Environmental Management Plan to ensure the best possible environmental management compliance.

COMMUNITY INVOLVEMENT AND BENEFITS
The original inhabitants of the land now falling within the Park were forcibly removed from the area during the twentieth century to make way for commercial forestation. As a result, the bulk of the Park was subjected to various land claims, all of which have been settled. In terms of the settlements the claimant communities do not have occupation rights, but instead are set to benefit economically from the success of the Park. As stakeholders in the Park they have the opportunity to take part in the development thereof through formally constituted structures.

One such benefit entails that all labour employed on contracts within the Park will be sourced from adjacent communities. In addition, local businessmen and small contractors are encouraged to take part in contracts by specifying that at least fifty percent of all contract expenditure should be allocated to community-based contractors.

In order to ensure fair and equitable distribution of benefits within the targeted communities, Project Liaison Committees were formed to provide a point of contact between the project and the communities. Community Liaison Officers employed by the Park authority were responsible for all community consultation, and development proposals were presented to and discussed with the Liaison Committees before tenders were advertised. This process ensured that community support for the project was obtained early on in the project life cycle, thereby preventing unnecessary project disruptions and delays.

During the project 368 people were employed from the targeted communities and 21 300 man-days of employment were created. In addition, 11 community-based contractors were employed to do construction work valued at R13 million. The contracts included provision for training of the work force. Approximately 400 people benefited from training programmes dealing with generic issues (personal hygiene and Aids awareness), technical skills (skills required to successfully complete the contract) and business skills (for emerging contractors).

In addition to the substantial immediate financial benefits enjoyed by the communities, the construction of these roads should stimulate the regional tourism industry, which in turn will bring sustainable employment opportunities.

CONCLUSION
The project was completed on time and within budget and all targets for job creation, as well as for the engagement of small contractors from targeted communities, were met. No contractual claims remain unresolved and the completed contracts have received the unqualified approval of the Environmental Compliance Officers.

This project illustrates the benefits of thorough and inclusive community consultation and participation in the initiation, planning and implementation of construction contracts. It also illustrates how successful the government’s EPWP can be in providing employment opportunities to marginalised communities whilst creating infrastructure which will in turn stimulate the creation of sustainable employment.
EPWP Vuk’Uphile Learnership Project for George and Mossel Bay Municipalities

The Vuk’Uphile learnership project of the Department of Public Works, under its Expanded Public Works Programme, offered PD Naidoo & Associates (PDNA) the opportunity to address the lack of training and skills development in coastal areas and realise the adage of “give a man a fish and you feed him for a day, but teach a man how to fish and he’ll eat for a lifetime”. Key to the project was attracting skills from previously disadvantaged communities, and involving skilled practitioners to transfer technical, management, administration and financial skills with the objective to mentor and train learners into becoming independent, skilled contractors.

EPWP VUK’UPHILE LEARNERSHIP PROJECT FOR GEORGE AND MOSEL BAY MUNICIPALITIES

Community-based Projects category
Submitted by the SAICE Southern Cape Branch

THE EPWP VUK’UPHILE LEARNERSHIP PROGRAMME

Aiming to create jobs, the Department of Public Works (DPW) together with the Construction Education and Training Authority (CETA), initiated a labour-intensive contractor learnership programme to train small contractor businesses to execute labour-intensive construction work within the George and Mossel Bay municipalities.

The programme covered every aspect of managing a business, from tendering, purchasing and execution through to payments of suppliers and salaries, as well as:

- Paving of a sidewalk, Sandkraal Road, George, under the EPWP Vuk’Uphile learnership project

**KEY PLAYERS**

**Client** George and Mossel Bay Municipalities
**Consultants** PD Naidoo & Associates
**Main contractors** Nqubela Civil, ARP Construction, Brainwave Construction, Premier Civils, Ikamva Lesizwe, Siyakutwala Construction, Smetana Construction, Vuicani Construction, Ziyanda Civils, Abenyuki Construction, Vigro Construction, Raakvat Kontrakteurs
**Major sub-contractors & suppliers** Rocla, Mobicast, Terblanche Transport, Transand, Civil Corp, Steyns Mica, Enon Brick

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the handover of contracts. The contract disciplines included storm water drainage, road works, sewer networks, water supply lines, water distribution networks and minor building works.

The duration of the Construction Contractor NQF Level 2 programme was 24 months and that of the Construction Supervisor NQF Level 4 programme, 39 months. The project was managed by a committee comprising representatives from the DPW, the public body, CETa, the accredited training provider and mentoring companies like PDNA.

IMPLEMENTATION PLANNING
The mentoring team applied modern project management tools and methods to plan, oversee and control projects in detail. The task descriptions and work schedules were reviewed together with the learner contractors and the relevant municipality prior to the commencement of work. All parties involved had to agree on certain control mechanisms and procedures in line with the Project Management Body of Knowledge (PMBOK) guidelines documented in the project plan. These included:
- Project control authority
- Communication lines and procedures
- Risk management
- Change management and control
- Time control
- Quality control
- Financial control
- Reviews and reporting
- Accountability and responsibility

COMMUNICATION AND REPORTING
An open communication channel was established between the client and the team. Day-to-day management was handled by the learner contractors, supported by the mentoring team, with regular formal and informal meetings being held according to pre-agreed schedules and agendas.

PROJECT MANAGEMENT TOOLSET
Based on established best practice, PDNA has developed a complete project management environment that includes an adaptable project management methodology and toolset to guide the effective management of different types of projects. The toolset was applied to show the tasks and expenditure in relation to time, and formed the baseline schedule used to monitor progress. This approach ensured that the relevant operating procedures were implemented before submitting a bid for a project, and also dictated the operations thereafter.

PROJECT INTEGRATION
The execution of the project plan, together with carefully monitored change control mechanisms, were fundamental in the successful completion of twelve contracts, which had to commence and finish very close to each other in order to allow the classroom training phases to be scheduled optimally as reflected in Table 1.

![Working on a storm water drainage project in George](image1)
![Construction of concrete V-drains at Kwanomqaba, Mossel Bay](image2)

**Table 1 Optimal scheduling of classroom training phases and contract execution**

<table>
<thead>
<tr>
<th>Learnership Phase</th>
<th>Time Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training 1</td>
<td>11 Jan 2006 – 23 March 2006</td>
</tr>
<tr>
<td>Project 1</td>
<td>30 March 2006 – 31 July 2006</td>
</tr>
<tr>
<td>Training 2</td>
<td>1 Aug 2006 – 31 Aug 2006</td>
</tr>
<tr>
<td>Project 2</td>
<td>1 Sept 2006 – 31 Aug 2007</td>
</tr>
<tr>
<td>Project 3</td>
<td>1 Sept 2007 – 30 Sept 2008</td>
</tr>
</tbody>
</table>
Project Scope
The programme required the project objectives and deliverables of each practical contract to be clearly defined, using existing, available information, constraints and assumptions. Verification of the scope of work for each project was formerly requested from the relevant client authority prior to any work being started. Factors which could influence and result in scope changes were identified so that a forum could be established ahead of time to manage all change control during the project.

Information and Knowledge Sharing
A wealth of information, ideas, approaches and strategies were generated during the programme and posed a need for various platforms where these ideas could be shared during the implementation period and beyond. The mentoring team utilised the formal monthly meetings for this purpose and continued to support the update of the learner databases with the latest information sets obtained from the project management toolset.

Quality Control
Quality Management
PDNA identified appropriate quality standards and determined how those were to be met to ensure that each project complied with the objectives and to the satisfaction of the client.

Project Quality Plan
The project quality plans were developed in consultation with all affected parties in order to evaluate project performance on a regular basis. Quality control procedures were implemented to measure compliance with standards. It was also essential that causes of unsatisfactory performance be identified and addressed. The learners realised the importance of adhering to quality standards, as the consulting engineers were instructed not to compromise on quality.

Quality Business Operations
PDNA ensured that the learner contractors adhered to the agreed plans and were not hesitant to implement disciplinary procedures in terms of the Learner Guide and Code of Conduct when deemed necessary. Independent auditors were appointed to guarantee compliance to all statutory requirements and reported back to the mentoring company, PDNA, on regular intervals with regard to the financial standing and status of the learner contractors. Occupational health and safety audits were conducted by independent auditors appointed by the municipalities.

Budgetary Compliance
The State Tender Board permitted contracts to be awarded to the learner contractors as training contracts on a negotiated price basis. The municipalities needed to comply with their internal budgetary requirements and excelled in providing a diverse range of projects totalling more than the projected budget.

Effective cost control had to be maintained throughout the duration of the project as the learner contractors had limited reserves or none at all. The procedures implemented resulted in all projects being completed within budget. Projects were entered into negotiated procurement procedures based on the submission of complete bid documents.

For the George municipality, 30 projects to the value of R21 134 406 were completed, while 32 projects worth R19 770 084 were completed for the Mossel Bay municipality.

Social, Environmental and Economic Sustainability
All workers employed on the EPWP projects were trained in terms of the Code of Good Practice for Special Public Works Programmes, aimed at equipping them with the necessary skills to earn an income after completion of the programme. Life skills training was complemented by technical skills training in an effort to enhance production and the quality of work delivered.

During the execution of the projects, a total of 87 463 days of work were created. Figures varied between 205 and a peak of 509 people being employed in projects in George, and between 140 and 245 people in Mossel Bay. The total sum spent on local labour amounted to almost R7 million.

Due to the limited use of heavy construction plant, and strict adherence to the quality standards, the carbon footprint of the completed EPWP projects was much lower than that of similar projects completed with conventional construction methods.

Although the learnership programme provided access to bridging finance from ABSA as contracted bankers to the programme, the project management procedures implemented resulted in this facility not being required. Credit was arranged from key suppliers, hence the learner contractors were able to build up credit records. Furthermore, all learner contractors were able to create an asset base of key equipment on both a cash and financed basis. This is deemed essential for the long-term success of the contracting entities and will result in achieving the goal of creating sustainable ‘employers’.

All learner contractors were registered with the Construction Industry Development Board (CIDB), with the categories achieved varying between 3CE PE and 4CE PE. It is expected that several of them will achieve a 5CE category on completion of the exit projects.

Client and End User Satisfaction
All projects were completed on time, within budget to high quality standards and without any major incidents. No bank overdraft was required due to sound planning and excellent relations being maintained. Awards such as the Construction Woman of the Year were received and the programme was also featured in the news.

Both municipalities considered the learnership programme a success and have provided further projects as an exit phase to the learner contractors with extended, limited mentor support provided until the end of December 2008. A total amount of R19 million was allocated to this phase, which would have concluded at the end of June 2009. The clients stated the reduced risk of projects not being completed within budget, the high quality of work delivered and the social and economic benefits to the community as key factors in them extending the learnership programme.

Conclusion
PDNA commends the Department of Public Works and the municipalities of George and Mossel Bay for their vision and dedication towards implementing the learnership programme and enhancing it through their commitment to its success. All role players are thanked for their support towards ensuring that the project not only created jobs, but also trained sustainable employers who in turn will ensure continued employment for the benefit of the participating communities, long after the learnership programme has ended.
INTRODUCTION
Rio Tinto recently commissioned its Mandena mine, situated about 10 km north of the small town of Tolagnaro in southern Madagascar. The mine extracts titanium dioxide from mineral sands using the water-intensive dredge-mining process. This requires up to 20 Mℓ of water per day.

The mining site is located approximately 5 km from the sea and is bordered by rivers and shallow estuarine lakes. Water resources studies done by SSI Engineers and Environmental Consultants confirmed that the saline lake system fed by the rivers would supply adequate water for mining. However, the environmental impact of dredge-mining using saline water is unacceptable. Therefore it was decided that a low level salinity barrier should be provided at a downstream site on the Anony River to prevent tidal flows upstream into the lake system, but allowing normal rainfall and flood events to pass with minimal increases in flood level.

SSI was tasked with the detailed design and supervision of the salinity control weir. The environmental impact assessment and monitoring was performed by the on-site environmental team of QtT Madagascar Minerals (QMM). Engineering, procurement and construction management of the project was carried out by a joint venture of Hatch and Flour (Mandena Joint Venture). Eventual construction of the weir was undertaken by Colas Madagascar, with 3CR12 gate fabrication and installation by Genmac and Kentz respectively.
DESIGN CHALLENGES

General weir arrangement
The basic concept for the salinity barrier, to be erected just downstream of Lake Ambavarano, was a wide spillway on the left bank, excavated in a rocky outcrop, and a rockfill weir embankment across the Anony River, constructed using the material excavated for the spillway. At this point overall width of the river is about 120 m with a maximum water depth of 4 m. The wide spillway would allow for the passage of floods.

However, a conflicting requirement was to have the spillway crest level as high as possible so as to minimise the risk of saline flow reversal when downstream estuarine water levels were higher than the spillway level under storm surge conditions. The rockfill weir needed to be impermeable enough to limit seepage of water through the embankment and ensure that no piping occurred in either direction.

The remoteness of the site, its environmental uniqueness and the unusual operating conditions required that each aspect of the structure had to be subjected to rigorous analysis and review to ensure that it would work under a multitude of operating conditions and flow situations.

Geometry of the main spillway
The 164 km² catchment generates a 1:100 year flow of 1 550 m³/s and a PMF of 5 230 m³/s. Flood levels in the river system for the various spillway options were estimated using a HECRAS unsteady flow model.

With a 300 m long spillway with a crest level of RL 1.1 m, the increase in flood levels as a result of the weir ranged from 0.76 m at the structure itself, to 0.28 m at the nearest human settlement, which is considered to be acceptable.

A low flow spillway with a capacity of around 20 m³/s was provided to carry the normal river flow. This spillway is equipped with flap gates to prevent reverse flow when the downstream water level is higher than the upstream level.

Embankment design
The embankment had to be stable under all flow situations, protected from piping failures, and had to be constructed from local materials. Various embankment design options were investigated, and the choice eventually fell on a sand core rockfill embankment.

Allowing for boat passage
Fishing, transport and recreational boats use the river frequently. Two options were considered to allow for the passage of boats – a boat lock and a ramp slipway. Because of the remote location of the site and the fact that the spillway is prone to frequent flooding, any option needed to be operated without a power supply. For reasons that it could pass larger boats with relatively little effort the boat lock option was selected. The width of this was sized on the largest boat currently operating in the river system (4.5 m wide).

Boat lock gates and low flow gates
The boat lock gates are balanced with a top hinge radial bearing that takes both the vertical and horizontal loading on the gate. The bottom hinge is a vesconite-faced bearing. The gates are counterbalanced using concrete blocks to reduce friction in the system and to make them easier to open by hand. The counterbalance also gives the operator purchase to push the gate open once the water levels are equalised. The gates are designed so that they can be removed without having to send divers into the boat lock.

The low flow gates had to be designed to prevent any reverse flow of sea water, but at the same time had to be light enough to open easily and not restrict the normal river flow. This challenge was met by providing a counterbalanced gate constructed of 3CR12 steel, which was also epoxy-coated to protect it from the aggressive environment.
CONSTRUCTION CHALLENGES

The following is a summary of some of the key construction challenges, and the solutions developed:

Blasting and excavation of the rock cut spillway

The contractor had to submit a blast design, including hole arrangement and charges for each blast in advance of drilling. This was reviewed and approved by a blasting specialist to ensure that no mistakes were made. The actual rockfill excavated was well graded and the contractor removed larger stones for riprap protection on the upstream and downstream face of the rockfill embankment.

Accurately laying the grade A7 geotextile underwater

The geotextile was laid on the river bed using a purpose-made barge that rolled the geotextile out as the barge progressed on an alignment set by a preset cable across the river.

Closure of the embankment against the right bank

To limit damage from river flows to the right bank, just prior to closing the embankment, the contractor artificially closed the estuary mouth with sandfill. This effectively prevented all river and tidal flows from entering the river and allowed the embankment to be carefully completed against the right bank.

Floods

In February 2008, 400 mm of rain fell in four days. The partially completed embankment was overtoped on the left bank and the entire spillway construction area was flooded to a depth of about 1 m. Although damage to the embankment was minimal, a 1 to 2 m deep channel was eroded on the downstream side of the main spillway rock excavation where bare excavation had not yet been reinstated with native grasses and reeds.

ENVIRONMENTAL CONTROLS

QMM employed a team of specialists who were responsible for investigating the impacts of the weir on the natural surroundings. Effects considered
included the changes in fish populations, effects on flora and fauna, sedimentation and the effects of the structure on the local community.

Fish populations
The QMM fish specialist confirmed that there are numerous fish species that live in salt water and numerous fish species that live in fresh water, but very few that can live in brackish water. On that basis he estimated that the number of fish in the system would increase after completion of the weir.

Fish passage through the boat lock
The fish specialist recommended that the means of letting water through the boat lock compartments be changed from the originally designed piped system to a sluice in the actual boat lock gate. Apparently fish and eels can sense a flow and then swim towards this flow, allowing them to pass through the opening during boat lock operation. Because of the relatively low head difference, these gates can also be left partly open at night to allow the passage of fish through the openings.

Sedimentation
A floating geotextile silt fence was established in the river on either side of the rockfill embankment to limit the amount of silt that washed into the river during end tipping of rockfill in the river. Professor Albert Rooseboom, from the University of Stellenbosch, visited the site and reviewed the potential for increased sediment deposition as a result of the embankment construction. He concluded that sediment transport within the catchment was very low and the weir would result in a negligible change to the current situation.

COMPLETION
SSI commenced work on the detailed design of the weir in late 2004. The project was completed on time in mid-2008, and has since been operating effectively. The final account for the weir, USD 2,9 million, was well within the original budget, given escalation over the period.
THE R200 MILLION Ntimbale Dam Project was implemented by the Government of Botswana to significantly improve water supply and the quality of life for the 10,000 inhabitants in 52 villages of the North East District and part of the neighbouring Central District. The project has been designed to cater for an expected seasonal peak domestic demand of 11,825 Mℓ/day by 2017. The project comprised four principal contracts:

- Access road
- Ntimbale Dam complex
- Raw water pumpstation & pipeline
- Water treatment plant and distribution pumpstation

Construction work was carried out in stages over a period of four years, starting in January 2005 with the dam complex and access road, culminating with the water treatment plant and distribution pumpstation.

Environmental and socio-economic issues were considered from the outset and special care and attention was given to the archaeological heritage of the site.

Construction in progress on the wall of the Ntimbale Dam. Roller compacted concrete (RCC) techniques were used, with the rollcrete being delivered to the dam wall site by means of a conveyor system.

The completed dam. Due to higher than expected rains, the dam reservoir was completely filled in one season. Discharge over the ogee spillway has been a regular occurrence.

Pumpstation at the foot of the main dam wall.
ACCESS ROAD
A 16 km long gravel road was constructed from the village of Masingwaneng to the dam complex in the Ntimbale hills. The road consists of a short section of 1.4 km to by-pass the village, followed by a 9.3 km long section through undulating terrain to the Ntimbale foothills. The final section, approximately 4 km long, traverses difficult rocky terrain to the dam site. A major culvert crossing at the Vukwe River had to be constructed in addition to a number of smaller stream crossings.

NTIMBALE DAM COMPLEX
The Ntimbale Dam site, located 40 km north of Francistown on the Tati River, was chosen in a steep-sided valley to reduce losses by evaporation. The dam complex comprises discrete impounding structures, namely:

■ A mass concrete dam built across the main river channel
■ A clay core, rockfill, embankment dam, blocking an adjacent major side channel
■ A second clay core, rockfill dam and also two small earthfill embankments, sealing lesser saddles

The reservoir formed by the Ntimbale Dam has a gross storage capacity of 26.4 million m³.

The RCC dam
The mass concrete dam is a roller compacted concrete (RCC) dam constructed in the main channel of the Tati River. It is currently the highest dam and the only RCC dam in Botswana. The RCC dam gave considerable savings over other types without any loss of technical integrity.

The dam wall has a vertical upstream face and a stepped downstream face at a slope of 1:0,75. The dam is 33 m high with the crest 150 m long and 5 m wide. The non-overspill crest level is 1 108 m and a 1,2 m high parapet wall brings the effective retention level to 1 109,2 m. The spillway is an uncontrolled central ogee crest 80 m wide.

A low level outlet for environmental and emergency releases discharges directly onto the spillway apron and a multi-level outlet draws off water for delivery to a raw water pumpstation located at the dam.

The clay-core rockfill dam
The 19 m high clay core rockfill dam blocks an ancient river valley on the right bank of the reservoir. It has a crest length of 190 m, a crest width of 7 m and has upstream and downstream slopes of 1:6:1. Its key is 7 m deep, with a minimum width of 5 m at its base, and is founded in moderately weathered granite gneiss.

The dam is designed so that it will not be overtopped by the safety evaluation discharge.

Rockfill is used for the structural shell of the embankment in which the impervious clay core material forms the central impermeable barrier. Coarse and fine filters are contained within the body of the dam to prevent the impervious clay-core material from migrating into the rockfill material. Riprap protects the upstream and downstream faces from wave action and storm erosion.

WATER TREATMENT PLANT AND DISTRIBUTION PUMPSTATION
The water treatment plant was constructed under a design and build contract to performance specifications prepared by Knight Piésold.

Raw water from the Ntimbale Dam feeds into an elevated buffer tank at the inlet to the works. Flow through the works is set at a control valve at the inlet works by the plant operators and all the other processes, including delivery from the raw water pumpstation, are automatically adjusted to suit.

RAW WATER PUMPSTATION AND PIPELINE
Raw water is pumped from the dam through a 14 km long, 400 mm diameter ductile iron pipeline to the village of Masingwaneng, the site of the new water treatment works. The pumpstation has three pumps (two duty and one standby) and is capable of delivering 180 ℓ/sec through the 400 mm diameter ductile iron pipeline.
The treatment process consists of flocculation, clarification, filtration and disinfection. Chemical coagulants are added at the inlet works and the water continues into a flocculation channel. Three circular shaped clarifiers (two duty and one standby) provide clarification. Sludge is removed from the clarifiers by hydrostatic pressure.

Four dual media rapid gravity filters provide the filtration. A gallery has filter wash consoles on the upper level and filtered water collection at the lower level. Filtered water is pumped from a holding tank to the treated water storage reservoir. Two backwash pumps use chlorinated water from a separate tank below the filter building for backwashing. Two air blowers supply air for the air scour. A pumpstation located in the filter building delivers the filtered and chlorinated water to a 7.9 Mℓ storage reservoir designed for 24 hours of storage at the average annual daily demand.

Backwash water gravitates to sludge lagoons from which water is recovered by a waste water recovery system. Sludge from the clarifiers and overflow from both the storage reservoir and filters are also collected in the sludge lagoons. Four rectangular sludge lagoons provide thickening and dewatering of sludges.

Two storage tanks have been provided to hold enough chemicals needed for 60 days. The chemicals are drawn off, as required, into two mixing tanks provided for each coagulant necessary for each day’s processing. Two dosing pumps deliver the product to the inlet works.

The distribution pumpstation has three pumps which operate against a head of 250 m and deliver a combined peak output of approximately 10 000 Mℓ/day.

An elevated service water storage tank, fire fighting pumps, an administration building, a small laboratory and an HV substation have also been provided.

A SCADA system has been incorporated to monitor and record the various processes taking place in the plant, as well as the raw water and distribution pumpstations.

TECHNIQUES USED
Consortship

The difficult terrain posed problems for the dam contractor who overcame the challenge of access for placement of the rollcrete by constructing an overland conveyor to move the dry mix from the batch plant to the dam wall. With this innovative approach an average pour rate of 350 m² of rollcrete per day was achieved.

With the total lack of any construction resources in the area, the contractor established a quarry on site to provide all the required aggregates.

Emanating from discussions with the contractor to ensure continuity of water supply, the contractor constructed a temporary pipeline (from a borehole 18 km away) to deliver water to the site – another example of proactive thinking on the project.

Since RCC dam construction is a comparatively novel technique in Southern Africa, Knight Piésold and the contractor worked very closely on matters related to technical issues raised during construction. This mutual cooperation was beneficial both in terms of time and expense.

The water treatment plant consists of components of proven design, selected for simplicity, robustness and ease of operation, as the plant is in a relatively isolated location where maintenance servicing could be difficult.

Operational requirements

Fastidious planning by the dam contractor ensured that the contract was completed within the contract period in spite of time delays caused by unforeseen additional rock excavation and heavy rainfall events towards the end of his construction period.

The contractor for the raw water pumpstation and pipeline met all deadlines and handed over the contract for beneficial occupation within the contract period. This was achieved despite the considerable difficulties experienced in the heavily rocky sections of the route.

CONCLUSION

The Ntimbale Dam project is notable as the first of its size and complexity to be undertaken by the Botswana Department of Water Affairs. The project provided the opportunity for the Department’s personnel to gain valuable experience for use on future projects. This is especially applicable to the young engineers seconded to the dam contract and who were mentored by Knight Piésold.

The Government of Botswana can be satisfied that its foresight and systematic planning to enhance the living standards of its people by providing the highest quality potable water from a sustainable resource from within its borders has achieved success. The communities in the North East District and neighboring parts of the Central District now have a reliable supply of drinking water to enjoy a standard of living equal to that of their counterparts in the developed cities and towns of the country. A ready supply of water will also encourage commerce and light industry to develop in the area and employment opportunities will be enhanced as a result.
INTRODUCTION
Dubai’s population is expanding steadily with a corresponding rapid growth in urbanisation and increasing traffic congestion. To address the traffic situation, the then Dubai Municipality Roads Department (now the Roads and Transport Authority) initiated planning for an upgraded, integrated transport network, which included, in March 2005, Project R880 for the development of the Mirdif Interchange.

The core element of Project R880 was the replacement of an existing road bridge at the Mirdif Interchange (which is the intersection of Al Khawaneej and Algiers Roads) with a high-capacity flyover. This intersection services the residential areas of Mirdif, Al Muhaisnah and Al Mezhari.

DESIGN APPROACH
The previous interchange comprised a two lane bridge that carried Algeria Road over Al Khawaneej Road. The two terminals at either end of the interchange consisted of roundabouts in a dumbbell configuration, with three diamond type on and off-ramps and a parclo-type on-ramp from Algeria Road to Al Khawaneej Road westbound. The bridge had two simply supported slabs with a total length of 46 m. The interchange was constructed...
around 1993 and the structure appeared
to be in a sound condition.
The scenarios developed and analysed
as part of the Traffic Impact Assessment
were used to develop alternative inter-
change options. A single point urban
interchange was eventually chosen as the
best possible and most feasible solution
for the Mirdif interchange. This option
would improve traffic flow, while limiting
expropriation of properties and extensive
shifting of services.

Aurecon was responsible for the de-
sign and completion of the Preliminary
Study, Preliminary Design and Final
Design, as well as for the Tender
Analysis. The Joint Venture with Al
Burj entailed providing site supervision
staff to the project.

Aesthetic appeal
Due to the replacement of the original
interchange, which had extensive
landscaping areas surrounding it, it
was decided to create a new landscape
design to complement the Mirdif area.
Various landscape options were studied
in terms of costs and aesthetic appeal.
The approved design included the use
of hard and soft landscaping to allow
for easy maintenance and sustainability.
The UAE water resources are valuable
and proper use of water supply is im-
portant for all landscape designs. The
design was also set up to be noticeable
from the air, since this interchange is on
some of the Dubai International Airport
flight paths.

CONSTRUCTION OVERVIEW
The original dumbbell interchange
was replaced with a single point urban
interchange at the same position as the
original interchange. The new interchange
required the following works:
- The construction and maintenance of
temporary deviations to accommodate
regular traffic at the site
- Demolition of the existing interchange,
including existing earth embankments,
concrete structures and surfaced areas
- Construction of a new bridge deck
over Al Khawaneej Road for the top
intersection, as well as a new deck over
the northwestern on-ramp from the top
intersection; this accommodates grade
separation with the on-ramp from the
southern approach
- Construction of a new link road, which
includes a directional ramp over Al
Khawaneej Road, as well as an under-
pass tunnel connecting to this road
- Construction of approach ramps and
roadways
- Construction of retaining walls for the
reinforced soil embankments for the
approaches to the interchange
- Improvement of the geometry of Al
Khawaneej Road by changing the ver-
tical profile of both carriageways of this
road
- Improvement of the vertical profile
along Algeria Road at the approaches
from Mirdif and Al Muhaishnah
- The relocation and protection of
existing services affected by the

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The original engineer’s estimate
for the interchange was around
AED 234 million (approximately
R490 million). The final construction
cost, after extension of works
and some additional service
relocation works, will amount to
approximately AED 270 million
(R540 million). The project time
has been extended to allow for the
additional services work, as well as
including the building of an access
service road to a new shopping
mall, the Arabian Plaza Mall, along
the main Khawaneej Road.

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Diagram of the road layout for a single
point urban interchange – the option chosen
for the new Mirdif Interchange in Dubai
Preliminary design phase – model of
the Mirdif single point urban interchange
construction and revised interchange configuration; the existing Etisalat GSM exchange was retained, but the generator room and diesel tank for the facility were relocated and relocated.

Installation and completion of appurtenant works, such as signage, road markings and street lighting.

CHALLENGES
The design and construction of the Mirdif Interchange provided many challenges in terms of accommodating existing traffic. The demolition of the original interchange, including original earth embankments, concrete structures and surfaced areas had to be designed, planned and executed within strict timelines and budget in order to ensure the success of the subsequent construction works. Alternative routes had to be planned and constructed to divert traffic away from the construction, a task which was handled successfully by the professional team.

With the help of some of Aurecon’s bridge design engineers in South Africa, the Aurecon team ensured that the construction of the new bridge deck over Al Khawaneej Road, as well as a new deck over the northwestern onramp from the top intersection, were carried out promptly and efficiently.

The construction of a new link road, approach ramps and roadways and retaining walls, together with the improvement of the geometry and vertical profile of Al Khawaneej Road and Algeria Road, with its associated approach ramps and roadways, required careful planning and execution by the professional team. The relocation of the generator room and diesel tank for the Etisalat GSM exchange facility also had to be planned carefully to avoid disrupting the services provided by the Etisalat Tower.

PROJECT COMPLETION AND BUDGETARY COMPLIANCE
Work is currently under way to complete the remaining works of the project, including the underpass, which ensures smooth traffic flow for motorists driving from Emirates Road towards Al Khawaneej Road, a link with the Mirdif-bound Bridge, and landscaping works.

Construction on the project started in May 2007 and the interchange was opened by the RTA in June 2009. The final phase of the project, which entails the opening of the underpass tunnel (to avoid weaving problems between on and off-ramps along the main Khawaneej Road), was planned for October 2009.

The original engineer’s estimate for the interchange was around AED 234 million (approximately R490 million). The final construction cost, after extension of works and some additional service relocation works, will amount to approximately AED 270 million (R540 million). The project time has been extended to allow for the additional services work, as well as including the building of an access service road to a new shopping mall, the Arabian Plaza Mall, along the main Khawaneej Road.

CONCLUSION
The replacement of the previous dumbbell interchange with a single point urban interchange has enabled traffic to flow more freely in this extremely busy interchange. The area has experienced remarkable growth and urbanisation over the last few years, which warranted the upgrading of the inbound and outbound roads.

The implementation of a diamond interchange, especially in the busy Mirdif area, now has the advantage of allowing simultaneous left turn movements through a single traffic signal controlled area. This has helped increase the traffic flow in the directions which led to traffic tailbacks and delays in travelling time, due to the inadequacy of the two roundabouts used in the original interchange.

A complex interchange construction was implemented on time and within budget, without disrupting the multi-lane traffic flow. The new interchange has not only contributed to the free flow of traffic in the region, but has become an aesthetic landmark in Dubai.
SAICE Sanlam Photo Competition

Winners

1. WINNER
   Heavy weight
   Submitted by: Gautrain
   Photographer: Kevin Wright

2. FIRST RUNNER-UP
   Beam placement in progress
   Submitted by: Group Five Civil Engineering
   Photographer: Bruce Sutherland

3. SECOND RUNNER-UP
   Full circle
   Submitted and photographed by: Marc Jarmain
SAICE SANLAM AWARDS

Gallery of winners
3 Joint winner in the category Technical Excellence
Project: Foundations for the Moses Mabhida Stadium Arch
From left: Nino Welland, Jonathan Day and Alwyn Truter

2 Joint winner in the category Technical Excellence
Project: Gansbaai Waste Water Treatment Works
From left: Garth Gademan, Stephen Müller, Peter Scholtz, Francois Gibbons

1 Winner in the category Community-based Projects
Project: Ultra-thin Reinforced Concrete Pavement
Demonstration Road: Soshanguve
From left: Francois Retief, Rafeek Louw, Thabo Rafube, Adriaan Esterhuizen, Adrian Bergh, Alexander Mackay, Andre Kilian, Johan Wiggett

6 Highly commended in the category Community-based Projects
Project: iSimangaliso Wetland Park Infrastructure Development
From left: Llewellyn Pike, Pramala Singh, Freek Serton

7 Winner in the category International Projects
Project: Mandena Mine Salinity Control Weir
From left: Abhijarti Robinson, Mike Mead, Francois Gibbons

5 Winner of the SAICE Sanlam Photo Competition
Kevin Wright

4 Winner of the SAICE Magazine 2008 Most Supportive Advertiser Award
Advertiser: Cobiax (Pty) Ltd
From left: Ali Naidu (SAICE President-elect), Riaan Brits and Mike Kühne from Cobiax
EARMARKED BY THE Western Cape provincial government, and designed by HHO Africa Infrastructure Engineers, the Koeberg Interchange forms part of the national transport planning grid which links provinces and municipalities together in key projects throughout the country.

TRANSPORT CORRIDORS

Strategic transport corridors have been identified as critical zones for investment as part of a countrywide Multi-modal Transport Strategy targeting public transport and road infrastructure, rail upgrades, internodal facilities, the Bus Rapid Transit (BRT) system, inner city mobility and airport city links.

Cape Town’s Koeberg Interchange is one such corridor, serving as a primary freight artery and mobility route between the Cape Town and Bellville CBDs.

The overview for a project such as the Koeberg Interchange, with a total
Transport alternatives beyond 2010
Multi-modal Transport Strategies for improved mobility and quality of life

MARKET CONTRIBUTION

Transport alternatives beyond 2010

Multi-modal Transport Strategies for improved mobility and quality of life

capital value of R730 million, extends beyond the question of how to improve mobility between the M5 and N1 south and northbound. It is part of the broader transformation to formalise public transport services and to remodel South Africa’s skewed transport infrastructure, much of which has not been significantly developed in decades.

INFRASTRUCTURE INVESTMENT

Without the infrastructure spend designed to alleviate congestion and the resulting deteriorating air quality, a city such as Cape Town would be under mounting pressure to manage the increased vehicle load, which currently stands at more than 1 million registered motor cars.

The Koeberg Interchange alone has about 200 000 vehicles passing through its network every day. An economic analysis of the upgrade revealed that significant savings in travel time would be achieved through its development, translating to direct benefits for the province.

The scope of the project, divided into a two-part process, entails the provision of additional traffic lanes along both N1 carriageways between Marine Drive and Sable Road Interchange, and the construction of two new, third-level ramps – Ramp A, which will carry traffic directly from the N1 to the M5, and Ramp B, which will ferry traffic from the M5 to the N1.

It includes the widening of the M5 Viaduct with two single-span sections over the railway tracks and the realignment of the Salt River Canal, as well as provision for future BRT infrastructure development on the N1.

HHO AFRICA

The engineering solutions for the project required not only bringing a concept to reality, but also reflecting the aesthetics of a gateway icon. The preliminary and detailed designs produced by HHO furthermore had to account for the accelerated delivery of Phase 1 by May 2010.

“2010 drove the project and focused on getting substantial portions of it completed with just-in-time design information as we constructed,” says Brian Dreyer, Director of HHO. “We had to ask ourselves how we were going to build the superstructures with the current traffic volumes and decided to use precasting in order to minimise the disruption to road users.”

Group Five and Power Construction, the contractors who together form the consortium known as Paarden Eiland Joint Venture, developed a trailer system to transport the 70-ton U-beams from the casting yard to site. The beams are lifted over the canal using an 800-ton crane with a 78 boom and placed on the completed piers.

The construction of the third-level ramps included the manufacture of 27 spans of precast, post-tensioned U-beams supporting cast in situ decks and 4 in situ post-tensioned bridges with a maximum length of 137 m over existing rail lines and freeway.

The southbound ramp is due to be completed by May 2010 and the northbound ramp by November 2011.

DESIGN AND SOFTWARE

The fast-tracking of Phase 1 to meet delivery targets for 2010 has meant that a large part of the design process has run parallel with construction. For the preliminary and detailed designs, Graeme Warrin, Associate of HHO, used a South African software package developed by Knowledge Base for application across their projects.

Says Graeme, “I used Civil Designer software to come up with the vertical alignment and to produce a design that
was geometrically sound. To do this I had to make sure that all the geometric parameters were satisfied. For an 80-km design speed I had to get all the constraints using maximum grades and the K values.

The World Cup has been the catalyst to leverage partnerships and resources to advance the timetable of the Province’s Strategic Infrastructure plan. This accelerated delivery has meant that severely congested nodes such as the Koeberg Interchange will benefit beyond 2010, towards the longer-term goals of a more efficient urban transport model.

GLOBAL, GREENER MODELS
The move towards a more sustainable transport solution is part of an international trend to greener, smarter and traffic-free ways of commuting where alternative modes to the single occupancy vehicle are being sought.

Drawing from examples of successful implementation in South American cities such as Curitiba, Bogota and Sao Paulo, Cape Town’s IRT infrastructure will comprise upgraded Metrorail services and the BRT bus-only lanes with stations at strategic intervals, working on a system of trunk and feeder routes. Smart-card technology will ensure that commuters have one mode of payment for their entire journey, be it by train, bus or taxi.

The advantage of the BRT lies not only in the comfort and convenience passed on to passengers, but also on its value versus alternative transport modes - on average 4 to 20 times cheaper than a tram or light rapid transit system, and 10 to 100 times more cost-effective than rail.

HHO’s involvement in the BRT comprises the project management, design and construction aspects of the stations, stops and depots for the route covering the full length of Blaubwberg Road, up to Potsdam Road just north of Du Noon, as well as the sections through Culemborg under the N1 freeway, through Paarden Eiland (along the Old Rail Spur) and along the R27.

BEYOND 2010
Beyond the immediate needs of 2010, the government is also currently putting in place a major policy initiative on public transport, the National Transport Master Plan (NATMAP), which it plans to implement in five-year cycles, from now through to 2050.

According to the Minister of Transport, Mr Sibusiso Ndebele, the transport modes must be integrated to deal with the challenge of ‘the last mile’. This refers to the uneven distribution of public transport that leaves many commuters stranded at stations and taxi ranks after peak hours.

CONSTRUCTION PARTICIPATION GOALS
The Koeberg Interchange has been a pilot project in many respects and also reflects a new approach by the Departments of Transport and Public Works towards an Affirmative Procurement Policy, which targets local labour and more aggressive procurement of raw materials from suppliers with BEE status 1 to 4.

The objectives are to pass on benefits to local subcontractors to the value of R100 million, of which 10% will be allocated to businesses owned by women. Additionally, 500 hourly-paid construction workers would hail from the surrounding areas, and receive life skills and technical instruction in line with the Construction, Education and Training Authority (CETA) programmes.
The use of Elematic prestressed hollow-core concrete slabs has helped speed up construction on the Oakfields shopping centre in Benoni. The existing centre is undergoing a major extension which includes the construction of new premises for Pick ‘n Pay, as well as the addition of several new line shops on a previously undeveloped portion of the site.

The new Pick ‘n Pay will be some 3 300 m² in extent, while the line shops will take up an additional 1 300 m² around the anchor tenant’s position. Elematic hollow-core slabs, which are manufactured and supplied in South Africa by Elematic SA (ESA), were used for the full 4 600 m² of floor area in the new structures.

Simon Griffiths, director at L&S Consulting, and the design engineer on the project, explains that the Elematic slabs have been laid on top of castellated steel beams on a 7,5 metre grid to form the roof of the new 500-bay parking basement below Pick ‘n Pay, as well as the mezzanine flooring for the line shops. “Considerations we took into account when specifying the Elematic slabs included the fact that the product was cost-effective for our purposes. The price of building materials, including steel, has come down, so we could use the two in combination successfully.”

Griffiths adds that the main benefit of the product has been the speed with which construction can progress, because of the fact that the slabs are prefabricated off-site. Construction commenced at the end of August, and the Pick ‘n Pay component is expected to be open by the end of February 2010. “This system has definitely saved us time in comparison to a conventional concrete slab. The slabs also result in a lighter structure, which is beneficial where the weight of the structure is important,” says Griffiths.

Anver Arnold of M&F Giuricich offers the contractor’s point of view, and concurs about the time-saving benefits of using Elematic slabs. He comments that the installation has gone smoothly and quickly, saying that the speed of using this system has saved time on site. “We also found ESA very accommodating and we worked well together. We got all the information we needed easily and communication was excellent at all times,” he adds.

Griffiths comments further that ESA was very helpful in resolving any design queries with the engineers. Craig Webber, director at ESA, says that one of the challenges encountered was the fact that Pick ‘n Pay requires a high loading tolerance on the slab – 7,5 kN/m² on the floor slab in the trading area, and 12 kN/m² in the storage and dispatch area. There were also longer than average spans to be covered. The solution was to cast a 30 MPa reinforced concrete structural screed 75 mm thick on top of the 250 mm Elematic slabs to create a floor which could withstand the specified loadings.

ESA manufactures its hollow-core slabs using state-of-the-art technology. It also has the R&D support of Elematic in Finland, which has a solid reputation based on five decades of experience. The benefits of using Elematic slabs include the fact that the prefabrication process under controlled conditions assures clients of consistent quality; the fact that the slabs can be installed quickly on site without the need for
back-propping or curing time; and the fact that they typically require very little finishing once installed.

In conclusion, Griffiths notes: “We were already familiar with the generic system, but when ESA quoted on this job, we realised how cost-effective it could be, and we have proposed its use on future projects.”

INFO
Craig Webber
Director: Elematic SA
craigw@elematics.co.za

ESA manufactures its hollow-core slabs using state-of-the-art technology. It also has the R&D support of Elematic in Finland, which has a solid reputation based on five decades of experience. The benefits of using Elematic slabs include the fact that the prefabrication process under controlled conditions assures clients of consistent quality; the fact that the slabs can be installed quickly on site without the need for back-propping or curing time; and the fact that they typically require very little finishing once installed.
OCTOBER MARKED THE beginning of a new chapter in the history of the Institution. The formerly known SAICE Wits Branch was revamped and renamed the SAICE Johannesburg Branch. With the name change comes a change in governance – the committee of the new Johannesburg Branch consists entirely of young graduates. The decision was made to directly involve young engineers in the governance of the Branch so as to attract fresh ideas and to provide a platform for SAICE’s younger Johannesburg members to meet the needs of their fellow young bloods. The plan envisaged was to involve more young people in the leadership of SAICE and to allow them the opportunity to participate in carving the future of the Institution.

Due to the absorption of many of its members into the various technical divisions within SAICE, the SAICE Wits Branch eventually lost impetus and remained dormant for several years. The bold decision to revive the Branch was made earlier this year – a necessary intervention, especially when one considers the boom in engineering activity that has recently come over the Gauteng area in preparation for 2010 and beyond.

The new Johannesburg Branch is especially committed to attracting and retaining young professionals, as well as engaging with university students and introducing them to the many opportunities within SAICE. To this end, the Branch is focused on liaising with student forums from several tertiary institutions in the Johannesburg area, and is devoted to aiding the professional development of its members by means of mentorship and career guidance facilities.

Besides attracting young professionals, the Branch is also fully committed to retaining and, in fact, increasing the numbers of our more experienced members. We thoroughly recognise the value of good mentorship, and so it is our intention to facilitate the mentoring of our younger members with the help of our more experienced colleagues.

Notwithstanding our greenness, we as the committee of the Johannesburg Branch have willingly taken on the challenge of guiding the Branch to uncharted heights, and are confident that we will achieve what we have set out to accomplish.

THE LAUNCH EVENT

The official launch of the new Johannesburg Branch took place in Melville on 2 October. The event saw the gathering of both young and experienced engineers from across the civil engineering fraternity, and provided a much-needed platform for networking.

SAICE past president Johan de Koker’s address to the gathering was expectedly insightful. He commended the committee on a job well done in organising the event, and encouraged the young committee members to continue to serve the Institution with the enthusiasm and commitment already shown.

It was truly remarkable to witness the free interaction that lasted the evening as attendees shared experiences with one another – ‘bridging the gap’ in true SAICE fashion.

ORGANISATION OF THE JOHANNESBURG BRANCH

The committee of the Johannesburg Branch comprises six members, as well as a student forum representative and an advisor. The organisation of the committee is as follows:

Chairman: Trevor Ncalo

Trevor Ncalo was born and bred in Pretoria, but moved to Johannesburg to study Civil Engineering Technology at the University of Johannesburg, and is currently employed by Genrec Engineering Pty Ltd. Trevor brings a rich leadership background to the SAICE Johannesburg Branch. After having been the second black head boy in his high school (Willowridge High in Pretoria), he went on to become the
student representative of his department in his first and final years at the University of Johannesburg. He is also the co-founder of the Student Chapter at the University of Johannesburg’s Doornfontein Campus (DFC), and currently holds the position of Advisory Chairman of the student chapter. Trevor’s motto in life is: “Never give up, because all things are possible in God.” With that in heart and in mind, he believes that the Johannesburg Branch is ready to take on every challenge that will come its way.

Vice-Chairman: Maxwell Vavana
Maxwell was appointed to SAICE’s Membership Committee in 2007. He is currently employed by Jeffares & Green Consulting as a Geometric Design Technician.

Secretary: Phuti Seopa
Born and raised in Polokwane, Phuti obtained her BSc in Civil Engineering from the University of Cape Town in 2008. She was a bursary student of Goba (Pty) Ltd Consulting Engineers & Project Managers and currently works for the company as a candidate engineer in their Structures Department. Phuti has since gathered bridge design experience on small bridge structures in KwaZulu Natal and in Botswana. She is a graduate member of SAICE and registered as a candidate engineer with ECSA. She also plans to further her studies. Away from the office Phuti leads an active life, loves the gym, plays netball for the Goba social team, and enjoys socialising.

Projects Coordinator: Zukiswa Mvoko
Zuki joined SAICE in 1997 and was appointed to the Institution’s Membership Committee in 2003. She currently works for Allyson Lawless and Associates as a civil engineering technician. Zuki enjoys aerobics and reading.

Communication: Ozuem Okecha
Ozuem is a Civil Engineering graduate from the University of Cape Town. He is currently employed by Murray & Roberts, and relishes his involvement in Eskom’s Medupi and Kusile Power Station projects. As a registered candidate engineer with ECSA, Ozuem hopes to achieve his PrEng in the not so distant future.

Treasurer: Precious Thoka
Precious completed his National Diploma in Civil Engineering at the University of Johannesburg, and is currently studying towards a B Tech in structures. He works for Aurecon.

Student Forum Representative: Matimba Ngwenya
Matimba joined SAICE in early 2009, and has since contributed a lot of time and effort toward the growth of the Institution. He is currently completing his second year of the National Diploma in Civil Engineering at the University of Johannesburg, while also serving as Chairman of the Student Chapter (Civil Engineering Forum) at UJ’s Doornfontein Campus. One of Mat’s personal goals is to ensure that the younger generation in the civil engineering industry are active and visible. He believes that such activeness will improve the industry as a whole.

Advisor: Johan de Koker
After a career in the railway industry, Johan de Koker became head of department of Civil Engineering Technology at the University of Johannesburg. In 2008 he served as president of SAICE. Johan is active on a number of ECSA committees, is enrolled for further studies and has presented numerous papers at local and international conferences. Johan acts as patron for the SAICE Johannesburg Branch, supporting and advising as required.
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PLEASE NOTE THAT COURSE DATES ARE SUBJECT TO CHANGE
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KBY = Kimberley // SCD = Secunda // RUS = Rustenburg // PLK = Polokwane // NEL = Nelspruit // GEO = George // RCB = Richards Bay
SAICE’s magazine, Civil Engineering, won the prestigious PiCA Award for the third year running on Thursday evening 26 November at a gala event held in Johannesburg. The PiCA Awards are known as the “Oscars” of the South African magazine industry, so we feel very happy, indeed, at bringing this award home again. The category in which we won, was “Construction, engineering and related industries”. The following is what the judges had to say about our magazine:

“Civil Engineering is a supremely informative magazine with a clean, sophisticated layout (the judges loved the generous use of white space). As the official mouthpiece of the South African Institution of Civil Engineering, it effectively communicates its objectives and showcases innovative and challenging projects, methods and products. All the while, it subtly promotes the principles of best practice and professional growth. Actively encouraging member contributions and feedback, Civil Engineering can proudly proclaim to be a true peer publication. But it hasn’t only increased reader participation which boosted book sizes; advertising revenues were up by 23 percent in the period under consideration.”

Our heartiest congratulations go to SAICE’s magazine team. However, none of this could have happened without input from YOU, our members. Most of the articles in our magazine come from SAICE members who give freely of their time to submit quality material. This is what makes our magazine so unique. Sincere thanks, therefore, to each and every SAICE member who has participated in our magazine, in whatever way. You have won us our PiCA!

Dawie Botha
SAICE Executive Director
dbotha@saice.org.za

Book on Ninham Shand to appear soon
Reserve your copy before 31 January 2010!

A NEW BOOK, Ninham Shand – the Man, the Practice, will appear early in 2010. This history of the great South African civil engineer and the consulting group he founded was commissioned by the directors of the firm which has now been absorbed into the company known as Aurecon. It describes the career and achievements of Ninham Shand which began in a small way and culminated long after his death in the giant Lesotho Highlands Water Project. Stories, anecdotes and details about the man himself, his colleagues and the various projects carried out by the firm have been researched and compiled by Tony Murray and form a valuable and very readable addition to South Africa’s engineering history.

The book of approximately 220 pages is copiously illustrated with photographs of personalities and projects and will retail for about R240. It will not be published commercially, but to assist in determining print runs, persons wishing to reserve a copy are, without obligation, requested to notify Charlene Scott at the following addresses:

E-mail: Charlene.Scott@af.aurecongroup.com
Post: Charlene Scott, Marketing Dept, Aurecon, PO Box 494, Cape Town, 8000
Ordering deadline: 31 January 2010

Ninham Shand
THE MAN, THE PRACTICE

The Story of the great South African Civil Engineer and the practice he founded

Tony Murray