

Pipe jacking the N3

The conventional approach to pipeline installation is to dig an open trench, place the pipeline and then bury it. This is another method.

Although this method does not pose much of a problem in rural or sparsely populated areas where vehicle traffic is light, it would have caused havoc to traffic on the N3, the main highway between Johannesburg and Durban. Consequently, pipe jacking is necessary.

The N3 pipe jacking project was undertaken in advance of the construction of a R92 million bulk pipeline project, commissioned by Umgeni Water, to boost the water supply from Pietermaritzburg to Durban by 1 024 l/s.

The proposed pipeline will run from the DV Harris Water Treatment Works in Ferncliff to the World View's reservoir. The route goes under the N3 on Town Hill, between Hilton and Pietermaritzburg, and under the R103, 200 m to the west of the N3 crossing.

Geotechnical investigations undertaken by Terratest, an earth sciences consultancy with their head office in Pietermaritzburg, revealed that the N3 was on unstable talus in this area. The crossing point opposite the Ezemvelo KZN Wildlife head office on Town Hill was identified as being the least unstable and selected as the most suitable area to lay the pipeline. This choice was strengthened by the fact that the existing 787 mm steel Clarendon pipeline had been laid within 30 m of the proposed crossing and that there had been no problems at the crossing in the past 25 years. Trial pits were excavated at each end of the pipe jacks and this confirmed the expectation that the subsoil comprised dolerite boulders in a weak and compressible clayey matrix.

Jacking the N3 crossing became more challenging as the jacking progressed. Initially, the expectation was that the jacked pipes would be far enough below the road layer works for the arching effect over the jacked pipe to be sufficient to support the road surface. Traffic management was initially not considered to be a problem.

Ten metres into the jack, road layer works were intersected at approximately 3 m below the N3 surface. This was probably the original surfaced slip road onto the N3 during



ABOVE Boulders removed from inside jacking sleeve

RIGHT View of jacking pit showing jacks, jacking ring and concrete sleeve

construction in the mid-60s. The bitumen was still tacky after being underground for 40 years, which made excavation difficult, and paving breakers had to be used to break up the road formation. This extended for a distance of 12.7 m.

Immediately following this, the shield entered rubble fill that had been used to raise the level of the N3. Boulders of up to 1.3 m had to be dragged out or blasted into smaller pieces. Inevitably, a void started to form above the sleeve as boulders fell in to replace those removed. The excavation was under the north-bound fast lane and as haulage trucks tend to use this lane at night, the additional load and vibration caused further rock movement. It was decided to seal the void with sandbags and to grout behind these. Unfortunately, one rogue boulder was dislodged above the sleeve and demolished the sandbag wall.



The eventual answer was to close the fast lane for safety reasons and excavate around the clock to reach the median and break through to daylight. This would allow soft material to be backfilled into the shield from the top so that large volumes of grout could be pumped into the voids without its running back into the sleeve. The SANRAL maintenance team did a sterling job in arranging this lane closure at short notice.

Twenty metres further along, the excavation struck a block of reinforced concrete. Three days and nights of intensive drilling, cutting of reinforcement and blasting resulted in the removal of the concrete, which, on



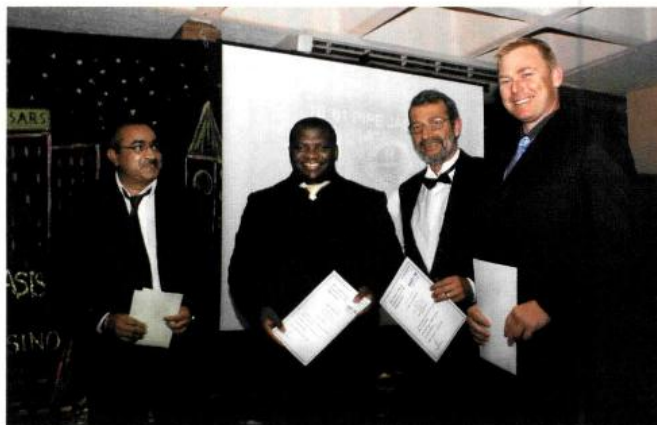
ABOVE Line and level control of pipe-jacking operation

reconstruction outside, proved to have been a New Jersey barrier that had been incorporated into the N3 fill. The removal of the concrete caused an increase in water infiltration from the sides and the top of the face, with concomitant loss of support of the rubble-fill boulders. The shield was bricked up and a further 15 m³ of grout was pumped through the lifting holes in the lead sleeve to stabilise the excavation.

Five metres further (and 5 m below the N3,) the night shift struck an abandoned Armco drain that had filled with water over the years. Two days of pumping allowed access to the working face once more. The ground was totally saturated and grouting the surrounding area was impractical because of the ruptured drain. The solution was to excavate and push the sleeve forward rapidly and simultaneously excavate through the N3 side fill to meet the shield. The open excavation was used to replace the saturated mud with dry material, which in turn would provide support to the sleeve.

Despite all these problems, the project was completed within budget and without affecting the programme of the main pipe-laying contractor.

Tony van Schijndel, team leader and senior engineer on the project, was well supported by Peterson Ndlovu, the assistant RE, and Lungile Zondo, who was seconded by Umgeni Water as an engineer-in-training. 35



ABOVE Presentation of the SAICE Branch Award for Technical Excellence for 2009 (Pietermaritzburg branch) for the Umgeni '61 Pipeline Pipe Jacking. Pictured above from the left are the SAICE KZN branch chairman, Krishna Singh, Julius Mkhize (Umgeni Water), Tony van Schijndel (Jeffares & Green) and Byron Field (Esor)