



Badly eroded stream bed and sides

### Infrastructure challenges in Swaziland

During 2004, the Swaziland Electricity Board (SEB) of Mbabane was faced with an infrastructure maintenance question that had to be attended urgently, in a sustainable and cost-effective manner.

Holger Rust, CEO of Terraforce cc says: "A feeder canal in the Sigangeni community, that is feeding water to two hydro-electric power stations was being undermined by an adjacent stream, which caused the canal to develop cracks, with consequent leaks

compounding the erosion and collapses on the stream embankments. Total collapse of the canal would have meant substantial loss of electricity generating capacity in the area."

"The stream has a catchment area of 2,5 Km<sup>2</sup>, with an anticipated 1 in 10 year flood of 10m<sup>3</sup>/sec. Average flow in the summer months is 3 to 3,4m<sup>3</sup>/sec. Soil in the area is considered dispersive, which led to the collapse of gabion weirs that were installed previously."



Progress on worst affected side, below feeder canal



Looking downstream from stilling basin

Consultants Knight Piésold, international consulting company providing engineering and environmental services for the mining, power, water, transportation and construction sectors, were appointed to carry out a site survey, design remedial measures and to prepare tender documents.

The 5 tenderers who had to submit their bids during October 2004, following a compulsory site inspection, were specifically encouraged to submit alternative solutions, designed by specialists and backed-up by the necessary design calculations.

MiLiTo Precast, one of the bidding parties and Terraforce licensee in Swaziland and Mpumalanga, approached Johan Joubert, an expert in slope stability and foundation design, to propose an alternative design, which was ultimately accepted by the SEB.

Tender prices of the original proposal went up to and over R3 million, with alternatives ranging between R1.5 and R2.5 million, the former submitted by MiLiTo Precast, based on Johan Joubert's design. Since work had to be carried out during the dry winter months, there was time to fine-tune remedial measures and costs were brought down by



Weir and stilling basin - close-up

setting up a joint-venture between the SEB and MiLiTo Precast.

Michael Toepfer, owner of MiLiTo Precast adds that another determining factor that favoured Joubert's proposal was the minimal heavy earthworks that would be involved in carrying out the remedial work:

"Our proposal would have the least impact on Albert Dlamini's farm, a local and dynamic farmer who in the last 25 years has managed to quadrupled the acreage of his farm, a request that had been specifically made before planning started. The high-risk nature of the undertaking made solid professional indemnity insurance absolutely necessary."

MiLiTo supplied Terraforce L11 retaining blocks for the side slopes and weirs and Terracrete erosion control blocks for lining the invert. They also supervised the installation by a team of SEB employees and temporary workers.

Work commenced in May 2005 with the removal of as much unstable clay as safely possible on the critical section of the embankment, just below the feeder canal on the right hand side, facing up-stream. To avoid any unexpected collapses in this section, MiLiTo used recycled cement bags from their production plant, filled with a 3%

sand-cement mix, stacked in lifts of three bags high and wrapped in geo-fabric (tied back into the coarse backfill for a distance of up to 4m) for additional stability.

Says Teopfer: "This measure forms an integral part of the design and is connected to the outer layer of CRB's with protruding geo-grid and wick-drains, to prevent a build-up of subsurface water."

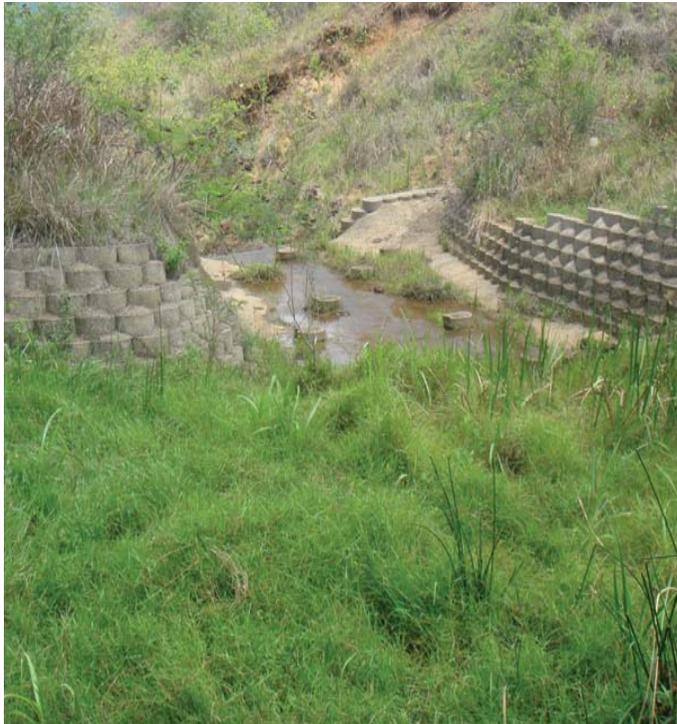
"A concrete foundation was cast on both



Weir under construction

sides of the stream, with protruding Y12 steel reinforcing rods to anchor the first row of concrete filled L11 crb's (concrete retaining blocks).

The following rows of crb's were filled with crusher waste to ensure superb interlock between rows, as well as allowing vegetation to take root. At the same time, coarse



Last weir with velocity reducing buffers

backfill from a nearby borrow pit was introduced and compacted to each level of blocks.

Behind every third row a layer of geo-grid fabric, that was previously wedged in between the 'wrap around' layers, was rolled out and tensioned with transverse wick drains below at two metre intervals, draining through the face of the blocks into the river.

A further drainage measure was necessary in the form of longitudinal subsoil drainage pipes - 110 mm diameter, slotted as well as wrapped into geo-fabric and coarse gravel - behind the crb's at foundation level and one meter above foundation level."

A series of four weirs, one of which functions as a stilling pool just below the original concrete foundation that supports the aqueduct where it crosses the stream, were constructed. These were built with single or double rows of concrete filled Terraforce L11 crb's, to slow down the substantial water velocity of the stream.

"Lastly," adds Toepfer, "the four metre wide invert was protected against erosion with Terracrete interlocking erosion control blocks. The uneven river bed was filled with coarse gravel from the borrow pit, with a subsoil drain incorporated, and then compacted.



Second weir and stilling basin

Next the stream was filled to a level above that of the sidewall foundations and in-between the weirs and a protective layer installed with Terracrete blocks on a spun-bonded filter membrane and filled with 15 Mpa. no-fines concrete. The longitudinal subsoil drains proved to be a good investment as the water is constantly flowing from them in substantial quantities."

Total construction time was three and a half months, and involved the use of one hired



One of the sub-soil drain outlets

tipper truck, a TLB and a tractor drawn trailer, supplied by SEB to deliver backfill from the borrow pit. Since no machines were able to operate in this tricky location, it was necessary for SEB to hire a substantial temporary workforce along with their permanent staff.

Toepfer feels that the SEB team is now familiar with the installation of Terraforce products: "I am confident that they can work on their own on future projects. We were able to set up our camp within the

boundary of the servitude for the canal, and impact on Dlamini's farming operation was minimal, as he requested."

A recent visit to the site revealed an installation that is fully functioning as intended by Joubert and as professionally

carried out by MiLiTo Precast with the help of the SEB team. An "unintended" maintenance of excessive vegetation is provided by Dlamini's cattle that frequent the stream bed. They are causing negligible damage and so far the advantages seem to outweigh the drawbacks.



Looking upstream from stilling basin