**PROJECT NAME: NWAMITWA DAM**

**PROJECT LOCATION: LIMPOPO PROVINCE**

**PROJECT VALUE: R 5BN**

**PROJECT SUMMARY:**

**PROJECT BACKGROUND**

The national Department of Water and Sanitation (DWS) has prioritised the development of the Nwamitwa Dam project. It forms the backbone of the Groot Letaba Water Development Project (GLeWaP), a national high priority project. This project is part of a greater strategic imperative to ensure resource security in South Africa. Six proposed dams and related infrastructure were highlighted, including the Nwamitwa Dam, increase of the dam wall at the existing Tzaneen Dam in Limpopo, new dams at the Mzimvubu River in the Eastern Cape, the expansion of the Clanwilliam Dam in the Western Cape, the Hazelmere Dam in KwaZulu-Natal and the Polihali Dam in Lesotho which will provide water to Gauteng

**CONTINUE TO DETAILED PROJECT SUMMARY**

**LOCALITY AND CONFIGURATION**

The dam is located at the junction of the Janetsi and Groot Letaba Rivers, some 37 km east of the town of Tzaneen in the Limpopo Province of South Africa.

At the preliminary design stage, the Nwamitwa Dam was configured as a zoned earthfill embankment with a central RCC gravity section accommodating the spillway and outlet works. The embankment/concrete interfaces would be formed with the embankment ends wrapping around concrete tongue walls. Considering the length of the dam, the relatively poor founding conditions, particularly on the flanks, and significant flood discharge requirements, the basic configuration of a central concrete section flanked by earthfill embankments as defined in the preliminary design was retained.

The Nwamitwa Dam site is characterised by a locally incised river channel of approximately 10 m depth and approximately 50 m width, with flanks on the adjacent flood plains rising at approximately 1:80 (V:H) on the left and 1:50 (V:H) on the right. Despite these apparently gentle slopes, an obvious dam alignment is readily evident immediately downstream of the confluence of the Nwanedzi and Groot Letaba Rivers.

While the straight spillway gravity section of the preliminary design was retained, the dam wall was moved approximately 100 m downstream to provide construction access and to simplify the river diversion during construction. This resulted in the spillway remaining straight, but the last approximately 40 m on the left hand tongue wall was kinked upstream at an angle of roughly 7°. To follow the most efficient line on the left flank, the embankment alignment will turn through approximately 45˚ upstream for approximately 400 m of the left side of the concrete section while, on the right flank, the embankment turns through approximately 30˚ upstream over the last 360 m for the same reason

**PRINCIPLE COMPONENTS OF THE DAM DESIGN**

In principle, Nwamitwa Dam indicates a maximum height of 43 m above river elevation and will comprise the following components:

* A central concrete section of 350 m length and a maximum height above lowest foundation of 43.5 m, comprising a 54 m long tongue wall on the right flank, a 190 m long gravity spillway in RCC, an 11 m wide inlet works and a 96 m tongue wall on the left flank
* A zoned earthfill embankment on the right flank of approximately 1850 m in length (maximum embankment height = 23 m)
* A zoned earthfill embankment on the left flank of approximately 1300 m in length (maximum embankment height = 24 m)
* An outlet works, with a dry well and a maximum discharge capacity of 18 m3/s
* A spillway with a maximum discharge capacity of approximately 6 400 m3/s
* The interface between the embankments and the central concrete spillway is created with wrap-around embankments

**DETAILED DESIGN COMPONENTS**

**Dam Configuration & Classification**

Although the Tender Design was initiated on the assumption of the full validity of the findings and decisions of the Preliminary Design studies, it proved beneficial and more economical to relocate the dam approximately 100 m downstream, while the embankment will comprise earthfill materials and soft rockfill sourced from the dam basin. The Nwamitwa Dam will comprise a central roller compacted concrete (RCC)/Concrete gravity section, accommodating the spillway and the inlet/outlet works, flanked on either side by extended earth and rockfill embankments. The maximum dam height will be 43.5 m and the total crest length of 3 500 m will be made up of a 1 300 m embankment on the left flank, a 350 m central concrete gravity section and a 1 850 m embankment on the right flank. The interfaces between the central concrete section and the embankments will be formed with wrap-around sections.

The main concrete structures for the dam comprise the spillway, the inlet/outlet works (which includes an inlet tower) and the sections around which the embankments are wrapped at each end (wrap-arounds). All concrete components were designed to facilitate maximum RCC construction efficiency, which required that the wrap-around sections are constructed in conventional mass concrete (CVC) and that the inlet tower is constructed immediately upstream of the mass gravity RCC structure. Nwamitwa Dam is classified as a large dam with a high hazard potential and consequently registered as a Category III dam.

**Hydrology**

After a comprehensive review of earlier studies, a definitive hydrological study was completed to define the inflow flood hydrographs to be applied for the dam design and the river diversion during construction. Existing studies were used to establish the level of sediment accumulation in the reservoir that can be anticipated over the lifetime of the dam.

**Geology & Geotechnical Investigations**

An extensive programme of geotechnical investigations and testing was completed to prove the anticipated founding conditions, to demonstrate the adequate quality and quantity of available construction materials and to define appropriate founding depths for the various structures that comprise the proposed Nwamitwa Dam. In addition, preliminary RCC mix development testing was undertaken, with the primary objective of establishing whether the marginal-quality granite rock available within the dam basin could be used for RCC aggregates. While initial indications are favourable, finalisation of testing is awaited to allow a definitive decision.

**Hydraulics & Spillway Design**

With tailwater and headwater curves, the dam spillway design was developed and optimised through hydraulic model testing at the DWS hydraulic laboratory. Adequate energy dissipation was demonstrated with a stepped spillway chute, combined with a slotted roller bucket at the dam toe.

**Inlet/Outlet Works**

The dam outlet works were designed on the basis of typical DWS standards, in terms of operational and maintenance requirements, and to provide for releases into a pipeline for the project water users, to return water of adequate quality into the river course for environmental releases and to provide safe reservoir drawdown in the case of an emergency situation. Beyond the hydraulic design, the inlet tower layout was designed for maximum economy and rapid construction, in line with the requirements of an RCC dam, while a comprehensive structural design analysis was completed to verify the stability of the tower under all applicable loading conditions. Performance design and associated specifications were prepared for all necessary mechanical and electrical aspects of the works.

**Dam Design**

The dam concrete structures and embankments were designed in accordance with international best-practice and to comply with acceptable local and international standards.

Sliding, overturning and seepage analyses were completed for all critical hydraulic, construction and seismic loading events. A thermal analysis was undertaken for the RCC section of the dam to demonstrate maximum joint spacing and to demonstrate that forced cooling would not be necessary as long as the construction programme allows the start of RCC placement to avoid the hottest time of the year.

Consideration of the RCC requirements and the most appropriate approach and methodology for RCC was undertaken with the objective of ensuring the maximum quality of product at the most economical implementation cost. Optimisation of the fill embankment design identified a zoned embankment, with an upstream shell comprising soft rockfill, a central impervious core and a downstream shell of semi-pervious fill. The soft rockfill was found to be available in abundance immediately upstream of the proposed dam alignment and will be sourced from the granite aggregate quarry.

**Instrumentation & Ancillary Works**

Appropriate instrumentation and ancillary items were designed and included in the construction tender documents, including a complete suite of structural, pressure, seepage and temperature measuring instruments, a flow gauging weir, crest balustrades, permanent access roads, parking areas, fencing, a boat slipway and a spillway safety boom.

**HYDRAULIC MODEL STUDY**

A hydraulic model study consisting of a physical scale model was commissioned to verify the hydraulic behaviour of the spillway and slotted roller bucket, as well as to evaluate the scour downstream of the dam A unit flow (2D) model at scale of 1:20 was constructed within the flow and height constraints of the DWS Hydraulic Laboratory in Pretoria West. The width of the model was 0.45 m. The model was completed at the end of October 2016.. The aim of the model study was to verify the theoretical design of the spillway.

The following conclusions were drawn from the study:

* The modelled stage discharge curve of the ogee spillway agreed with the theoretical values.
* The observed behaviour of the designed level and dimensions of the slotted roller bucket confirmed that the selected configuration operates as theoretically predicted.
* Sweepout, as predicted by the USBR Monograph No 25, occurred and, in some cases, the sweepout level was even lower, indicating an additional margin of safety.
* The maximum water level (Tmax) associated with the roller bucket did not influence the functioning of the bucket, i.e. diving of flow did not occur.
* Scour measurements downstream of the roller bucket indicated limited scour and deposition of material at the RDF and SEF. It is not expected that scour will undermine the toe of the dam.
* The proposed spillway training wall height proved to be sufficient to contain the flow at the RDF and SEF.
* The downstream steps dissipate energy as theoretically predicted.
* The location of the PI shows that air entrainment occurs up to the RDF, but not at the SEF due to the relative low height of the dam and the unit discharge.

The model study results show that the configuration of the ogee crest, downstream steps and slotted roller bucket, as per the tender drawings, can be considered to be appropriate and will function as intended by the design.

**CONCLUSION**

The detailed design of the proposed Nwamitwa Dam have been concluded and accepted by DWS. The tender documents and drawings have been issued to DWS and are ready to be issued for procurement processes.

Like all large scale projects, the role of the community has been prioritised, both from a public engagement and consultation perspective. The reality of community, graves, farming lands and tribal land encroachment and relocation has been addressed with all stakeholders. The benefits to the region have been carefully weighed up against the impacts on the environment, social and socio-economic factors.

LTE is proud to continue our building legacy as a Level 1 BEE firm, working together on the forefront of service delivery and infrastructure development to Build a Better South Africa. Our project-delivery mantra is one that intends to insure our development as a leader and responsible role-player in the country by incorporating local labour and contractors, improving peoples everyday lives and ultimately skill transfer throughout our community, on strategic, large and mega-scale projects in South Africa