Spring Grove Dam and Appurtenant Works, as part of the Mooi Mgeni Transfer Scheme Phase 2 (MMTS-2)

Project Overview

The Mgeni Water System in KwaZulu-Natal supplies water to approximately five million people, as well as the industrial sectors in the Durban and Pietermaritzburg regions, the economic hubs of the province. The growth in water demand and intermittent drought periods since 2003 made it necessary for the Department of Water Affairs (DWA) to implement Phase 2 of the Mooi Mgeni Transfer Scheme (MMTS-2) as an emergency project to address the need for augmentation of the supplies to these downstream areas. The Minister of Water Affairs directed the Trans-Caledon Tunnel Authority (TCTA) to fund and implement MMTS-2, which consisted of the construction of Spring Grove Dam, three guaging weirs and the realignment of access roads.

TCTA appointed AECOM to undertake the design and construction monitoring services for the project, which included a 37 m high roller compacted concrete (RCC) dam with an earth embankment; three gauging weirs, re-alignment of private access roads and the construction of a fish barrier.

The project featured prominently at the annual SANCOLD (South African National Committee on Large Dams) conference in 2012 and is a solid testament to the high standard of South African dam design and construction.

Spring Grove Dam is expected to increase supply to Umgeni Water by 60 million m³ per year to 390 million m³ at a 99% level of assurance of supply, meeting the demand of five million people and industries in the Durban and Pietermaritzburg areas.

Project Team

- **Project Developer and Owner:** Department of Water Affairs
- **Implementing Agent:** TCTA
- **Design and construction monitoring:** AECOM
- **Contractor:** Group Five-Pandev Spring Grove Joint Venture
- **Sub-consultants to AECOM:** Knight Piesold (geotechnical), ILISO (environmental), Water for Africa (social aspects), F Ortega (RCC Specialist) and the University of Pretoria (heritage aspects)

Project Status

Construction commenced in February 2011 and impoundment started in March 2013. The Taking-Over Certificate was issued on 25 October 2013 marking the end of construction. The Dam was officially opened by President Jacob Zuma on 19 November 2013, who said "South Africans should remember that the country was one of the driest on earth. Not a drop must be wasted, not a drop must be polluted, and all infrastructure developed must be cared for."

With good rain over the past few months, the dam reservoir's level has increased from 10% in November 2013 to 85% in April 2014.

The construction of Spring Grove Dam also provided short- and long-term benefits for the region, especially the nearby towns of Mooi River, Rosetta and Nottingham Road. Guesthouses, restaurants, entertainment facilities and suppliers in the towns benefited from the influx of site staff and various sub-contractors. The project also generated employment opportunities for the local communities, and specific performance targets were included in the contract to ensure that socio-economic objectives were achieved.

The project has generated approximately 720 job opportunities, specifically to people from the local municipalities.

General Characteristics of Spring Grove Dam

Hydrology	
Catchment area	339 km^2
Mean annual precipitation (MAP)	1 007 mm
Mean annual runoff (MAR)	131 Mm^3
RDF peak inflow (200 years)	580 m^3/s
SEF peak inflow	2 900 m^3/s
RDF hydrograph volume	31,8 Mm^3
SEF hydrograph volume	159,0 Mm^3
Main Characteristics	
Full supply level (FSL)	RL 1 433,50 m
Minimum operating level (MOL)	RL 1 412,00 m
Lowest draw-down level (LDL) (invert of outlet pipes)	RL 1 407,10 m
Gross storage volume at FSL	139,5 million m^3
Water surface area at FSL	1 021,8 ha
Total length of dam wall	607 m
Non-overspill crest level	RL 1 438,70 m
Maximum height (above river level)	37,7 m
Concrete Structure	
Type	RCC Gravity
Total length of concrete section	285 m
Length of left bank wall	101 m
Length of right bank wall	96 m
Crest length of spillway	70 m
Width of outlet works	18 m
Crest width: left bank	5,0 m
right bank	5,8 m
Total freeboard	5,2 m
Embankment	
Type	Earthfill
Embankment crest length	315 m
Upstream slope	1V:3H
Downstream slope	1V:2,5H
Outlet Works	
Outlet systems	2
Multi-level intakes	6
Diameter of outlet pipes	1,80 m
Offtakes for transfer to Midmar Dam	2
Sleeve valves for controlling river releases	2 x 1,20 m dia and 2 x 0,4 m dia
Outlet capacity	
- Maximum (both systems)	25 m^3/s (river) + 4,5 m^3/s (transfer)
- Minimum	<0,4 m^3/s

Hydraulic model studies

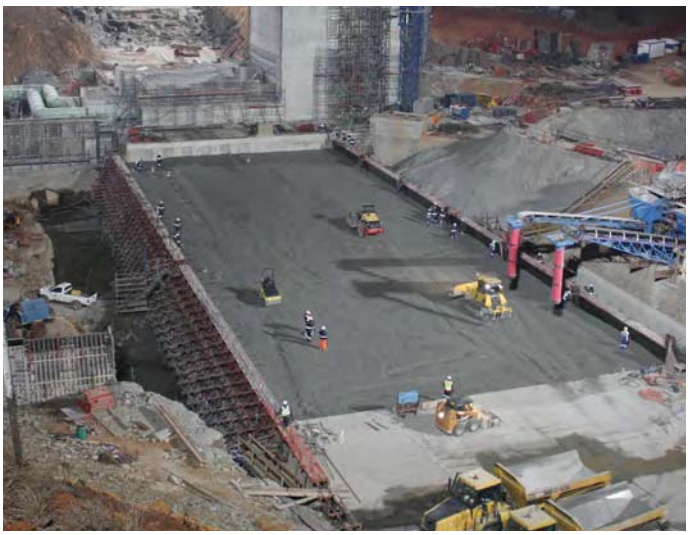
A hydraulic model study to dissipate the energy of overflowing water formed part of the design of the spillway. The hydraulic model study included large-scale and small-scale physical models and was carried out to test the hydraulic conditions. The shape of the steps on the crest of the spillway and the layout of the downstream training wall were also optimised during the testing.

Hydraulic models were also undertaken to verify and optimise the design of the fish barrier weir.

Challenges Addressed during Construction

The multi-faceted success of this project is evident from the project teams' ability to:

- Design and construct to prevent the migration of small mouth bass to migrate to upstream trout waters through the construction of the fish barrier,
- Provide cost and placement (time) savings through the optimisation of the RCC mix design,
- Meet the client's requirements for the provision of skills development and employment,
- Successfully mitigate the significant social and environmental impacts that result from a project of this nature,
- Provide fast-track engineering design and construction to meet downstream user's water needs.



The dam foundation was investigated during the design phase using specialised geophysical techniques and core drilling. The design founding level and the final founding level after excavated during construction were similar due to the proper investigations.

The dam was designed using RCC (roller compacted concrete) to save cost and time during construction. An RCC trial mix programme was conducted during tender design stage in a laboratory and a full-scale (60 m long by 12 mm wide by 6m high) trial section during construction. The investigation, testing and development of the RCC design mix in the laboratory was carried out with aggregate from a different quarry than proposed by the Contractor, which also motivated for additional testing during construction. The cost comparison between the tender designed RCC concrete mix and the mix developed during construction, using Spring Grove contract prices, indicated a saving of R85 per cubic metre of RCC for the new developed Spring Grove Dam mix, which means that the Spring Grove Dam mix saved R8,5 million for the 100,000m^3 RCC volume placed.

The environmental Record of Decision of the MMTS-2 required a fish barrier structure in the Mooi River, upstream of the Spring Grove dam reservoir, to prevent the migration of small mouth bass. Inchbrakie Falls is a natural barrier between these two fish species, which will be inundated by the high Spring Grove Dam reservoir levels after its construction. The small mouth bass can out-compete the upstream brown trout, threatening the sport fishing and tourism industries in the area, which would be adversely affected should the trout become extinct.

Although cost management was an important aspect of the project, providing infrastructure in terms of international standards was non-negotiable. AECOM combined its extensive practical experience in dam safety and design with the theoretical expertise of its top engineering specialists, and ensured accurate data was available and that tests were carried out thoroughly to ensure that the design parameters were correct, thus reducing the need for expensive redesign and unnecessary project delays.

Unusual Aspects of the Project

Public participation

Public participation was a structured, transparent inclusive and objective process. During the Environmental Impact Assessment (EIA) stage, Interested and Affected Parties (I&APs) were identified through networking with local business owners, famers associations, non-governmental organisations (NGOs), community-based organisations and local representatives. This database of I&APs is being maintained during the implementation of the project.

Public meetings were held at regular intervals to communicate project progress and to attend to specific matters and challenges during the course of the project. Information-sharing newsletters were also distributed to I&APs at regular intervals.

Land acquisition and Relocation Action Plan

Land acquisition is always a sensitive issue, particularly when arable land, homesteads and sensitive natural habitats will be inundated. AECOM worked closely with TCTA using a phased approach to acquire the portions of properties that would be inundated by the dam, giving priority to properties with dwellings that lay below the purchase line and in the construction domain. Throughout this process, the team was careful to ensure that landowners were properly communicated with and that the process was fair and clear.

As some landowners had to reduce their agricultural operations following the expropriation of portions of their land, employment opportunities would change and measures had to be devised to compensate and relocate those who would be affected and the team developed a Relocation Action Plan (RAP), under the proviso that the relocation process had to be completed before impoundment. Because the circumstances, history and 'relationship to the land' of the various categories of people to be affected by land acquisition differ so greatly, the RAP could not apply uniform and standard principles and procedures. The international standards and procedures for the relocation and compensation also do not apply because there is no homogenous community in the area (only individuals and families) and because the affected properties are all privately owned.

A phased approach was adopted to acquiring the portions of properties, giving priority to properties containing dwellings that lie below the purchase line and in the proposed construction domain. The valuers started the site inspections and valuations of Phase 1 properties in December 2009 and the acquisition of all properties was successfully completed.

The RAP process ensured that affected tenant labourers were relocated on the owners' land or that they received alternative accommodation elsewhere, as appropriate. Ultimately, the RAP ensured that the affected individuals and their families were fairly compensated for their loss of employment and homes.

Traffic mitigation

The Midlands Meander is a popular tourist destination and the Nottingham Road-Rosetta corridor is developing as a residential area. The area is served by the R103, a route that, prior to construction, already carried a high volume of heavy vehicles. During construction, the R103 became a major travel route for vehicles hauling construction materials to site, and much time was spent in consultation with local residents of Nottingham Road and Rosetta to find a solution that suited everyone.

A traffic management and mitigation plan was developed to address the risks associated with an increase in traffic on the R103. Although the construction-traffic impact is temporary and will peak during the construction of the dam wall, a stringent plan was required to mitigate traffic impacts and ensure that the transportation of supplies to site was well managed.

The conditions of approval of the Traffic Management Plan stipulated that all vehicles hauling processed rock be fitted with GPS devices to track, among others, speed, and that the construction trucks had to follow a loop system so that no trucks passed each other on their way to/from site.

The construction trucks transporting the material from the commercial quarry was limited per day on the road and impacted the commencement date of the RCC construction due to the contract stating that 60% of the materials had to be on site before RCC construction could commence. AECOM contractually managed this limitation very well.

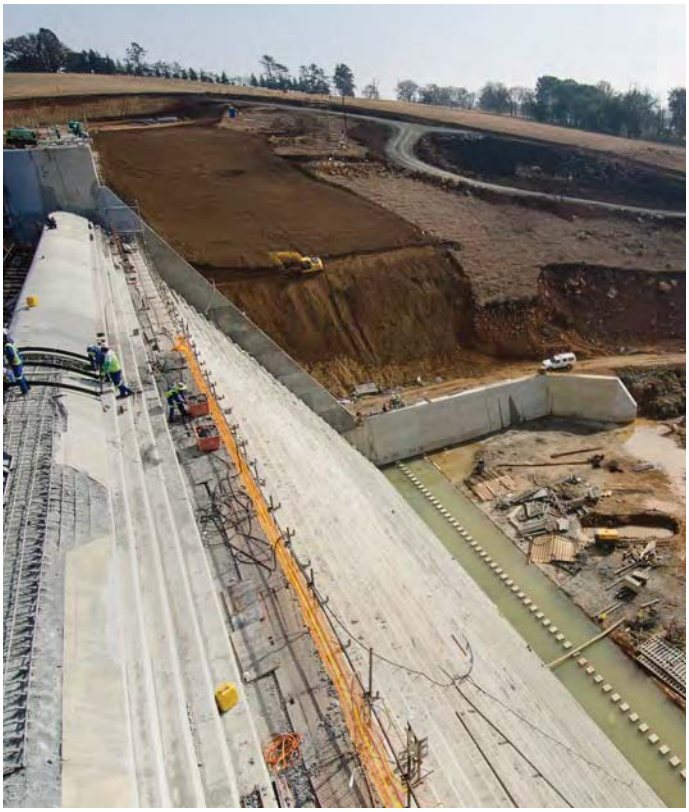
The project team maintained and upgraded the D146 road from the R103 to the dam construction site during construction so that it could accommodate the extra traffic burden.

Cultural and heritage impact mitigation

The KwaZulu-Natal Midlands has both tangible and intangible cultural and heritage importance, and the project documented the 'sense of place' in and around the dam's basin. The dam's basin was formally occupied by settlers of English decent in the late 1800s and was primarily used as farming land. The dam basin also included part of the wagon trail that led to the interior of the country and was part of historical events such as the Langalibalele rebellion, the Anglo-Zulu war, the Anglo-Boer war and the Bambatha rebellion.

The presence of San / Bushman inhabitants was evident in the dam basin. Three rock paintings below the Inchbrakie Falls, known as the Vaalekop Rock Art Site, would be inundated. The artwork was carefully removed by archaeological experts and was taken to the Natal Museum for preservation.

More than 180 graves were identified in the basin and were relocated in consultation with families, heritage and archaeological specialists, as well as traditional spiritual leaders. The necessary measures to identify appropriate reburial sites was taken as well as consulting with the affected families and authorities on the processes to be adopted for the exhumations and reburials.



Budgetary compliance

AECOM implemented severs cost control measures, such as:

- Comparison of construction materials and construction procedures
- Sourcing materials from local sources or, where unavailable locally, from the most cost-effective supplier and location that met the standards and specifications
- Re-design of portions of work to reduce the cost.

The Contract Amount excluding contingencies, escalation and VAT was R520 million. The final amount in the Statement at Completion certified, including R56 million in variation orders and R38,5 million in Claims, was R582 million. This represents a 12% total cost increase which was mainly due to additional work associated with land expropriation and relocation/ construction of new roads and services.

Unforeseen circumstances on site such as time effects of the community's requirements regarding haulage, inclement weather including heavy snow falls, delayed the programme and increased the project budget to cater for these circumstances.