water affairs

Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

KWAZULU-NATAL COASTAL METROPOLITAN AREA WATER SUPPLY SYSTEM

POSITION PAPER ON RAISING OF HAZELMERE DAM

1. INTRODUCTION

The reconciliation strategy developed for the KwaZulu-Natal Coastal Metropolitan Areas by the Department of Water Affairs (DWA) identified a sequence of interventions to make water available to supply the projected water requirements of the Mdloti and Mvoti River Systems. The interventions included the raising of the Hazelmere Dam, supply of water from the Lower Thukela Bulk Water Supply Scheme (BWSS) and the construction of the Isithundu Dam on the Mvoti River. The raising of Hazelmere Dam was the first augmentation scheme to be implemented due to the comparatively low capital cost and the time frame in which the raising can be implemented.

Since the development of the initial reconciliation strategy, DWA has identified geotechnical issues related to the stability of the Hazelmere Dam wall. This has resulted in an increase in the capital cost to raise the dam wall and an increase in the implementation time frame. This makes the raising of Hazelmere Dam less attractive and potentially comparable to other augmentation schemes.

The situation regarding the raising of the Hazelmere Dam was presented at the Technical Support Group (TSG) meeting on the 7 February 2012, at the Strategy Steering Committee (SSC) of the 14th March 2012 and the extraordinary SSC meeting held on 23rd May 2012. A high level preliminary assessment of the economics of the augmentation options was undertaken for the SSC meeting of the 14th March and for the extraordinary SSC meeting of the 23rd May 2012.

The options considered in the economic analysis instead of Hazelmere Dam were Phase 2 of the Lower Thukela BWSS, desalination of seawater and the re-use of treated sewage effluent. The results showed that the Lower Thukela BWSS was financially more attractive than the Hazelmere Dam raising. However aspects of the water supply infrastructure favored the Hazelmere Dam raising. The seawater desalination and re-use of treated sewage effluent were shown to be significantly more expensive than the Lower Thukela BWSS and the Hazelmere Dam raising.

The results of the preliminary assessments showed that the decision to be made was between two scenarios. Scenario 1 was Hazelmere Dam raising followed by the Lower Thukela BWSS Phase 2 and Scenario 2 was Lower Thukela BWSS Phase 2 followed by Hazelmere Dam raising. The decision on the augmentation scheme to implement after Hazelmere Dam raising and Lower Thukela BWSS Phase 2 could be Isithundu Dam, seawater desalination or re-use of treated sewage effluent. The decision on these augmentation schemes would be the subject of a future study in which this scheme designs and costs are brought to the same level so that the economics can be compared on the same basis

This position paper presents the results of the financial analysis on the sequencing of the Hazelmere Dam raising and the Lower Thukela BWSS Phase 2.

2. DESCRIPTION OF AUGMENTATION OPTIONS

2.1 Raising Hazelmere Dam

The raising of Hazelmere Dam involves the installation of gates on the dam spillway. The original cost of the raising was R160 million and could be completed in 2 years. A due diligence review of the design revealed that the dam requires work to stabilize the dam to meet dam safety requirements. The cost will increase to an estimated R359 million. However the dam wall requires stabilization even if the wall is not raised. Of the R359 million, R277 million is directly attributable to the raising. The design and construction period will increase from 2 years to 3 years. The raising of Hazelmere Dam provides an additional yield of 8.9 million m^3/year

The raising of Hazelmere Dam will also require the upgrade of Umgeni Water's Hazelmere Water Treatment Plant (WTP) and the pump station pumping water into the distribution network. Umgeni Water is upgrading the Hazelmere WTP and pipeline system currently as the existing WTP is under capacity to fully utilise the existing Hazelmere Dam yield. The final WTP and pipeline capacity will be adequate to treat and distribute the full yield of the raised Hazelmere Dam. The costs of the WTP and pump station upgrade directly attributable to the raising was considered insignificant and the decision was taken at the SSC meeting of the 23 May 2012 not to include the costs in the analysis. The water from the WTP is pumped via a 20 km long 700 mm diameter pipeline into a distribution reservoir 93 m above the pump station.

2.2 Lower Thukela BWSS

The Lower Thukela BWSS involves the construction of an abstraction works and weir on the Thukela River. The water is treated at the Thukela River before distribution. The water is pumped from the treatment plant through a 3.15 km pipeline up 208 m to a reservoir before distribution.

The BWSS is being developed in two phases. Phase 1 is currently being designed with construction commencing in 2012. The Phase 1 scheme will deliver 20 million m^3/year (55 ML/d) by December 2014. Phase 2 can deliver a further 20 million m^3/year (55 ML/d) to give a total of 40 million m^3/year (110 ML/d) and can be implemented in 2 years. Phase 1 is estimated to cost R900 million which includes the pipe infrastructure to convey the full scheme capacity of 110 ML/d. The implementation of Phase 2 involves an upgrade of the pump station and the WTP to handle the additional 55ML/d. The capital cost of the phase 2 upgrade is estimated at R300 million.

The Water Reconciliation Strategy Study for the Kwa-Zulu Natal Coastal Metropolitan Areas (**DWA, 2008**) investigated the excess/available yield in the Lower Thukela and concluded the following:

- Excess/available Yield: 45 million m^3/year
- Currently unused allocation of Mhlathuze Water: 32 million m^3/year

DWA has indicated that the capacity of Sundumbili WTP, which abstracts water from the Lower Thukela River upstream of Mandini, is in the process of being increased by approximately 5 million m^3/year. The total capacity of the Lower Thukela BWSS is 40 million m^3/year, resulting in an additional demand of 45 million m^3/year, which is equivalent to the excess/available yield available in the Lower Thukela River. It is thus important to note that if the future water requirements in the area north of the Thukela River (Northern iLembe District Municipality) exceed the upgraded Sundumbili WTP capacity, then additional resources will be required in the Lower Thukela. Options for additional resources include utilizing the unused allocation of Mhlathuze Water and using Spring Grove Dam to support the Lower Thukela once the Mkomazi River Development (Smithfield Dam) has been implemented.

2.3 Summary of cost information

The costs of the different schemes were collated from design reports for the Hazelmere Dam raising and from Umgeni Water for the Lower Thukela BWSS Phase 2. The costs are summarised in Table 1 together with comments on the source and assumptions.

Table 1: Summary of cost information

Scheme	Scheme Capacity (million m^3/year (ML/d))	Capex (R million)	Opex	Delivery time period (years)	Comments
Hazelmere Dam raising (full cost – stabilising and raising)	8.9 (25)	359	Maintenance– R0.89 million/year Pump costs – R0.25/m^3 WTP costs – R1.5/m^3	3 years	Maintenance calculated at 0.25% of Capex Pump cost based on pumping static head of 93 m, 0.7 m pipeline diameter and a 20 km long pipeline. Electricity cost of R0.6/kwh
Hazelmere Dam (raising only)	8.9 (25)	277	Maintenance– R0.69 million/year Pump costs – R0.25/m^3 WTP costs – R1.5/m^3	3 years	Maintenance calculated at 0.25% of Capex Pump cost based on pumping static head of 93 m, 0.7 m pipeline diameter and a 20 km long pipeline. Electricity cost of R0.6/kwh
Lower Thukela BWSS - Phase 1	20 (55)	900	Pump cost – R0.48/m^3 WTP costs – R1.6/m^3 Maintenance – R2.25 million/year	3 years	Pump cost based on pumping a static head of 208 m, 0.9 m diameter pipeline and a 3.15 km long pipeline. Electricity cost of R0.6/kwh Maintenance at 0.25% of Capex
Lower Thukela BWSS - Phase 2	Additional 20 (55) to give a total of 40 (110) for both phases	300	Pump cost – R0.48/m^3 WTP costs – R1.6/m^3 Maintenance – R0.75 million/year	2 years	Pump cost based on pumping a static head of 208 m, 0.9 m diameter pipeline and a 3.15 km long pipeline. Electricity cost of R0.6/kwh Maintenance calculated at 0.25% of Capex

3. WATER BALANCE SITUATION IN MVOTI AND MDLOTI SYSTEMS

The water balance situation was investigated in the Mvoti and Mdloti River Systems for the following two scenarios:

- Scenario 1: Hazelmere Dam Raising followed by Lower Thukela BWSS Phase 2
- Scenario 2: Lower Thukela BWSS Phase 2 followed by Hazelmere Dam Raising

For both Scenarios, the Lower Thukela BWSS Phase 1 is assumed to be implemented and delivering water by 2015. The volume of water delivered and the costs of the Lower Thukela BWSS Phase 1 is therefore common to both scenarios.

3.1 Scenario 1 – Hazelmere Dam Raising followed by Lower Thukela BWSS Phase 2

The water balance situation in the Mvoti and Mdloti River Systems are shown in **Figure 1** and **Figure 2** respectively.

The water requirement projection illustrated in **Figure 1** was adopted from Water Reconciliation Strategy Study for the Kwa-Zulu Natal Coastal Metropolitan Areas (**DWA, 2008**) and was originally derived from the Water and Sanitation Master Plan for the iLembe District Municipality (**DWA, 2007**).

The indicated system yield of the Mvoti System represents the existing run-of-river abstraction which is currently the source of water for KwaDukuza. The figure also shows that the Mvoti System is in a deficit situation (water requirements exceed available yield) up to 2014, after which the system is supported by the Lower Thukela BWSS Phase 1. A maximum deficit of 14.7 million m^3/year occurs in this period. The Lower Thukela BWSS Phase 1 can supply 20 million m^3/year which will meet the Mvoti shortfall until 2030. The excess water from the Lower Thukela BWSS Phase 1 after the supply the Mvoti System is used to meet the water requirements in the Mdloti System.

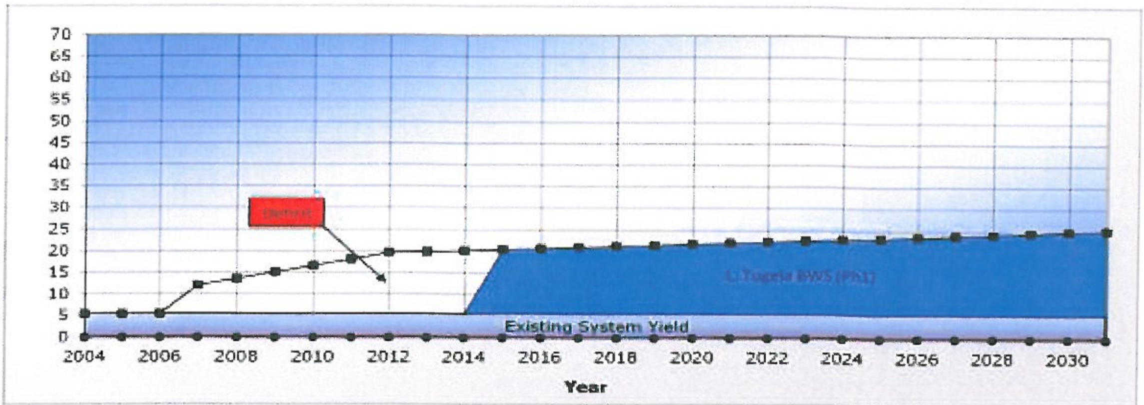

Figure 1: Water balance diagram for the Mvoti River System (Scenario 1)

The water balance diagram for the Mdloti System is shown in **Figure 2**. The water requirement projection in the figure is the Umgeni Water (UW) September 2011 projection (including irrigation), which is significantly lower than the UW 2007 projection (used in the KZN Recon Strategy) as illustrated.

From the figure it can be seen that the water requirements slightly exceed the available yield in 2014 as a result of Hazelmere Dam not being raised and with the Lower Thukela BWSS Phase 1 only delivering water in 2015. This deficit is however small (1.2 million m^3/year) and over a short period.

For Scenario 1, the Lower Thukela BWSS Phase 1 meets the water requirements above the existing system yield until 2016. The Hazelmere Dam must be raised by 2016 so that water from the dam can be delivered in 2017. The additional yield of 8.9 million m^3/year due to the raising of Hazelmere Dam is utilized by 2019. By 2019, the Lower Thukela BWSS Phase 2 must be constructed to start delivering water by 2020. The future augmentation scheme (Isithundu Dam, seawater desalination and/or re-use of treated sewage effluent) will be required to deliver water by 2026.

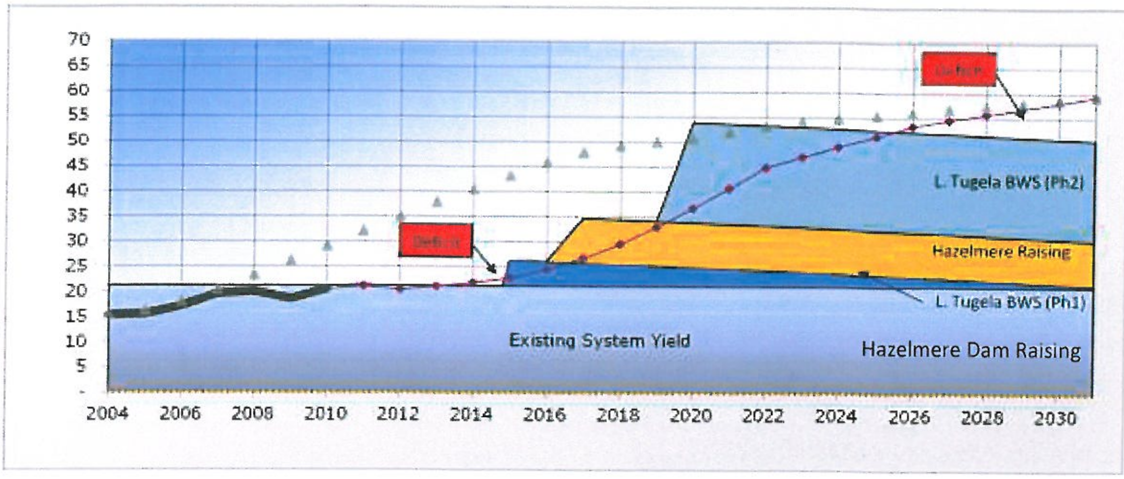

Figure 2: Water balance diagram for the Mdloti River System (Scenario 1)

3.2 Scenario 2 –Lower Thukela BWSS Phase 2 followed by Hazelmere Dam Raising

The water balance diagram for the Mvoti System for Scenario 2 is identical to the diagram presented in **Figure 1** (Scenario 1) and is thus not been presented again. The water balance diagram for the Mdloti System is illustrated in **Figure 3**.

The Lower Thukela BWSS Phase 1 supplies the Mdloti System as in Scenario 1. In Scenario 2, the Lower Thukela BWSS Phase 2 is implemented to deliver water in 2017 The Hazelmere Dam raising is required by 2021 so that water can be delivered in 2022. The date for the future augmentation scheme is 2026 which is the same as for Scenario 1.

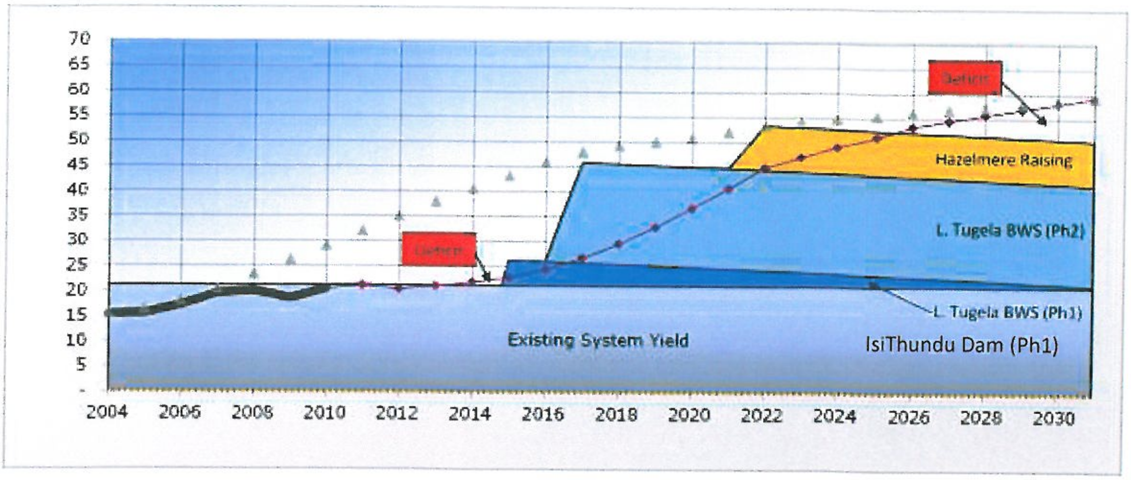

Figure 3: Water balance diagram for the Mdloti River System (Scenario 2)

3.3 Summary of augmentation dates

The summary of augmentation dates for the two scenarios are listed in Table 2.

Table 2: Summary of delivery dates for Scenarios

Scenario	Element	Delivery Date
1-Raised Hazelmere Dam raising followed by Lower Thukela BWSS P2	Lower Thukela BWSS Phase 1	2015
	Hazelmere Dam raising	2017
	Lower Thukela BWSS Phase 2	2020
	Future augmentation scheme	2026
2-Lower Thukela BWSS Phase 2 followed Hazelmere Dam raising	Lower Thukela BWSS Phase 1	2015
	Lower Thukela BWSS Phase 2	2017
	Hazelmere Dam raising	2022
	Future augmentation scheme	2026

The water balances highlight the following:

- The Lower Thukela BWSS Phase 1 is common to both scenarios in terms of timing, water delivered and costs. It is therefore not necessary to include Phase 1 in the economic analysis.
- The date of 2026 for the future augmentation scheme is common to both scenarios as the total volume of water delivered by the Hazelmere Dam raising and Lower Thukela BWSS Phase 2 are the same.
- The implementation of the Lower Thukela BWSS Phase 2 first (Scenario 2) postpones the need for the expenditure of further capital until 2022 as opposed to 2020 for Scenario 1. This is because Phase 2 of the Lower Thukela BWSS delivers a larger volume of water (20 million m^3/year) compared to the raising of Hazelmere Dam (8.9 million m^3/year).

4. DETERMINATION OF URV FOR SUPPLY SCENARIOS

4.1 Assumptions

The analysis of Scenario 1 and 2 are based on the following assumptions:-

- The base date for the analysis and costs is January 2012;
- The analysis period was45 years from January 2012 to December 2056;
- No allowance has been made in the analysis for increases in electricity costs over the analysis period;
- Inflation was not accounted for in the analysis. The URVs were calculated for the capex and opex cash flows using 6%, 8% and 10% interest rates.
- The Lower Thukela Phase 1 was not included in the analysis as it is common to both scenarios. The exclusion of Phase 1 will allow for a direct comparison of the economic advantages of the sequencing of the two schemes.

4.2 Analysis Results

The NPV of the total capex, total opex and the URV are presented in Table 3. The results show the following:-

- The URV s for the two scenarios are similar. The URVs for Scenario 2 are slightly lower than for Scenario 1
- The capital expenditure for the raising of Hazelmere Dam (R277 million) and Lower Thukela BWSS Phase 2 (R300 million) are similar. The NPV for the capex is higher for Scenario 1 than for Scenario 2 as the capital expenditure of the second scheme in the scenario is delayed by two years (2022 for Scenario 2 versus 2020 for Scenario 1).
- The NPV of the operating costs are higher for Scenario 2 than for Scenario 1 due to the higher treatment and pumping costs associated with the Lower Thukela BWSS Phase 2.
- The higher NPV for the operating cost is offset by the lower NPV for the capital costs for Scenario 2. This results in the NPV of the total costs being similar for the two Scenarios.

Table 3: Summary of NPV of Capital and operating costs and URV for scenario 1 and 2

Scenario	Discount Rate											
	6%				8%				10%			
	NPV Capex (R million)	NPV Opex (R million)	Total NPV (R million)	URV (R/m^3)	NPV Capex (R million)	NPV Opex (R million)	Total NPV (R million)	URV (R/m^3)	NPV Capex (R million)	NPV Opex (R million)	Total NPV (R million)	URV (R/m^3)
1– Hazelmere Dam	424.0	516.8	940.8	3.67	384.8	353.9	738.7	4.20	350.1	250.9	600.9	4.82
2– Lower Thukela BWSS P2	406.3	525.6	931.9	3.64	364.6	361.3	725.9	4.13	328.5	257.1	585.6	4.70

5. SUMMARY OF ADVANTAGES AND DISADVANTAGES OF LOWER THUKELA BWSS AND RAISING OF HAZELMERE DAM

The advantages and disadvantages of the two schemes are presented in Table 4 .These are based on discussions held at the extraordinary SSC meeting of 23rd May 2010.

Table 4: Summary of advantages and disadvantages of Lower Thukela BWSS and Hazelmere Dam

Hazelmere Dam Raising	
Advantages	**Disadvantages**
The detailed design process for Hazelmere Dam is complete and the risk of cost overruns is small.	
The regulatory approvals and designs are in place. The risk of time overruns are low	The full funding for the raising has not been secured
Hazelmere Dam can supply some users that are supplied from the Mgeni System. The Lower Thukela BWSS cannot supply these users. This will provide a more robust system although the area of overlap is relatively small	
Lower Thukela BWSS Phase 2	
Advantages	**Disadvantages**
	Flooding in the Thukela River will delay construction of the river abstraction works. The risk of delays is therefore greater than for the Hazelmere Dam raising. There is a risk that Phase 1 and 2 can be delayed
Design and regulatory approvals are well advanced.	Funding has not been secured for Phase 2

6. CONCLUSIONS

The economic shows that there is very little difference between the two scenarios. The URVs and the NPV of the total costs are very similar at the different discount rates. The percentage difference in the NPV of the total costs varies from 2.5% at the 10% discount rate to 0.9% at the 6% discount rate. The NPV of the total costs are the same at a discount rate of about 3%. The advantages and disadvantages of the two schemes listed in Table 4 indicate that the Hazelmere Dam raising has more advantages than the Lower Thukela BWSS Phase 2. Based on this assessment and the available information, the Scenario 1 with the raising of Hazelmere Dam as the first scheme to be implemented is the preferred scenario.

7. REFERENCES

DWA (2007) Department of Water Affairs, South Africa. **Water Sanitation Master Plan for the iLembe District Municipality Area.** Compiled by Jeffares & Green Consulting Engineers, June 2007.

DWA (2008) Department of Water Affairs, South Africa. **Water Reconciliation strategy Study for the KwaZulu-Natal Coastal Metropolitan Areas: Second Stage Reconciliation Strategy Report.** Compiled by WRP Consulting Engineers (Pty) Ltd. On behalf of the Directorate: National Water Resource Planning, 2008.

Signature for approval

26/07/2012

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