water affairs
Department:
Water Affairs
REPUBLIC OF SOUTH AFRICA

Feasibility Study
Mzimvubu Water Project

Newsletter 2/September 2013

Activities and Achievements to Date

A Detailed Feasibility Study is underway in the Eastern Cape to investigate a potential site for a multipurpose dam to supply new water capacity for irrigation development, domestic and industrial water requirements, and hydropower usage in the Mzimvubu River catchment.

As outlined in the first Newsletter of August 2012 the study, which began in January 2012, is divided into two distinct phases of which Phase 1 has been completed and Phase 2 is underway.

Phase 1 involved a screening process to investigate 19 potential dam development sites that were identified under previous studies, to select the three sites which showed the most promise in meeting the specific requirements (i.e. domestic water supply, irrigated agriculture and hydropower) in a viable, affordable, sustainable and environmentally acceptable manner.

After investigating these three options in some detail, and once all the relevant stakeholders had agreed upon the finally chosen single development option, this single dam option was to be taken forward for further more detailed investigation, in Phase 2 of the study.

Phase 1: Report back on the findings of preliminary studies on the three dam development options

The shortlisting process, undertaken in consultation with the Stakeholder Forum and members of the Project Steering Committee recommended the three dam development options as: Thabeng, Somabadi, and Ntabelanga sites which are located as shown in Figure 1.

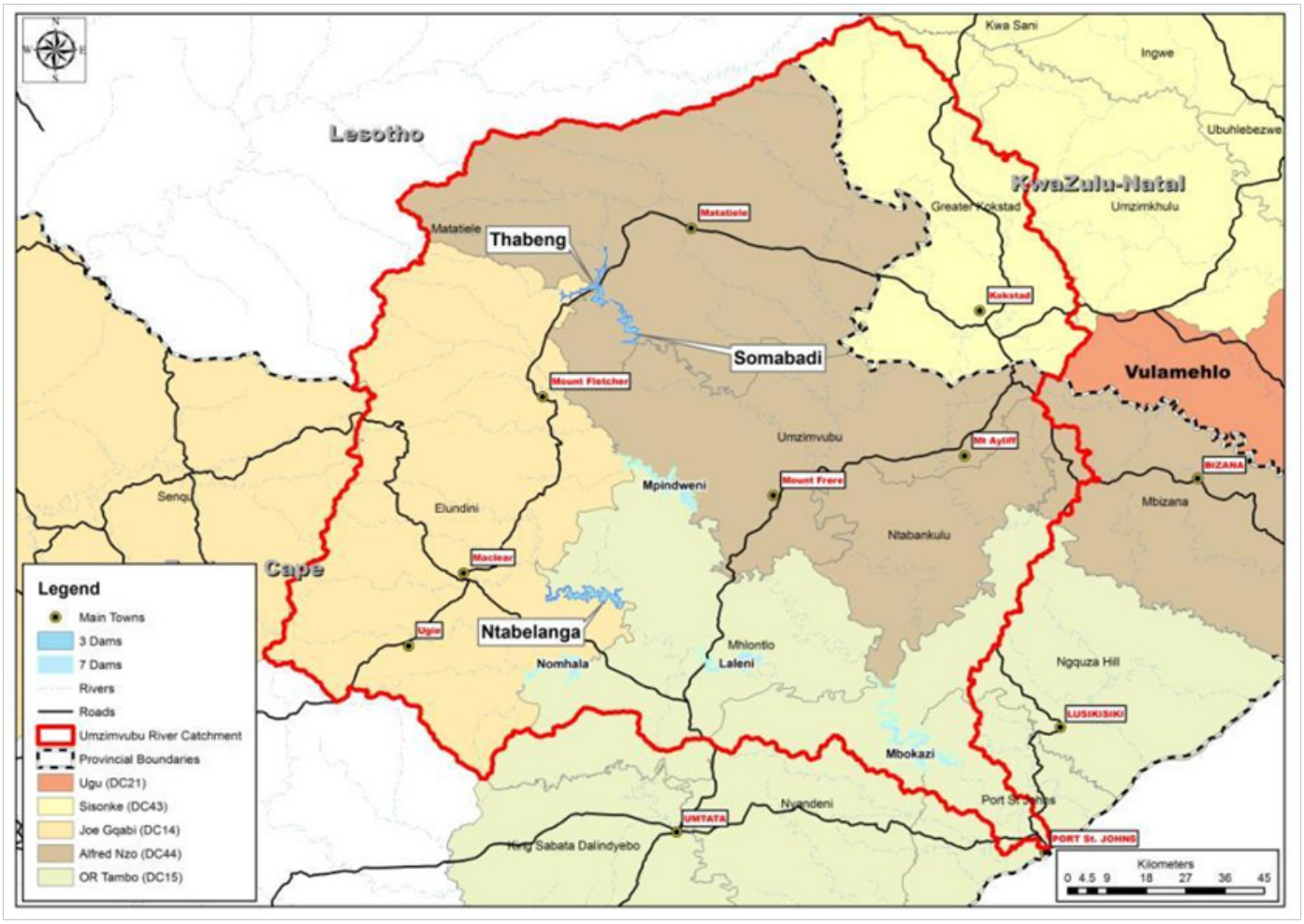

Figure 1: Three Dam Sites Selected for Further Investigation

The three sites were then rated comparatively to ascertain their viability as a development site. Economic and social aspects of each location were compared and additional detailed investigations included:

1. Hydrological investigation,
2. Topographical surveys,
3. Geotechnical investigations,
4. Investigations into water requirements (agriculture and domestic water supply),
5. Approximate dam sizing,
6. Hydropower potential assessment, and
7. Cost comparison.

1) Hydrological investigation

A detailed hydrological assessment including rainfall analysis, rainfall- runoff modelling, stochastic streamflow analysis and yield modelling of both the Kinira and Tsitsa Rivers was undertaken. This allowed accurate and reliable yield assessments to be produced for each of the three dams which aided in making the optimisation and economic comparison of the three options more robust. The outputs of the modelling exercise were used along with the topographical survey data to provide improved and accurate storage depth versus surface area versus volume figures for each dam.

Several scenarios were established as part of the yield modelling and these included a variety of dam sizes in order to establish the different yields that can be obtained for varying levels of assurance of supply at different dam sizes. The outcome of the analysis was that Ntabelanga generated the highest yield when viewing yield generated versus volume stored.

2) Topographical survey

Whereas, the original intention was to undertake detailed topographical surveys only in Phase 2, it was decided by the Study Management Committee to advance the initial topographical surveys into Phase 1 in order to enhance the accuracy of calculation of the area vs depth vs volume curves for the three dams, as well as the calculation of more accurate cost estimations for each dam, which improved the reliability of these Phase 1 analyses.

This approach was proven to be successful as it identified a large discrepancy between this new data and the data used in the pre-feasibility studies.

3) Geotechnical investigations

It was further decided by the Study Management Committee that the advancement of some of the geotechnical investigations into Phase 1 would provide important information regarding potential fatal flaws that might exist regarding the technical suitability of each dam site, as well as informing the decision-making on optimum dam type and materials usage. These investigations also provided useful information regarding the further investigations that are required in Phase 2 for the single dam site selected from Phase 1.

The conclusions were that the foundation conditions are reasonable at all three sites. Ntabelanga also appears to have adequate sources of rock, sand and clay (for core material), within the inundated basin upstream of the dam, whereas Thabeng's rock quarries lie more downstream, which could possibly have a higher environmental impact.

4) Water requirements

Domestic water supply

Meetings were held individually with each of the Water Services Departments from the Alfred Nzo, OR Tambo and Joe Gqabi District Municipalities (DM's) in order to obtain information on existing and planned water supply initiatives and to get an indication of the areas of need within each DM. Additional GIS analysis was undertaken utilizing the provided information in order to estimate the number of people that could potentially be supplied with water from each proposed dam site. These figures were used in the comparison of the three dam sites. The total demand, when compared to the Mean Annual Runoff (MAR) within the catchment, is low and the hydrological analysis combined with this information indicated that only a small storage would be required to meet the domestic water supply demand alone.

Irrigated agricultural land

Additional agricultural investigations were undertaken including ground truthing of the identified areas and a small amount of soil auguring on site. This process indicated that in some cases the actual area of land that would be suitable for irrigated agriculture was significantly less than those identified through desktop investigations. The outcomes were as follows:

- Ntabelanga – Desktop estimate 840ha
  Revised estimate 500ha
- Somabadi – Desktop estimate 1 327ha
  Revised estimate 1 000ha
- Thabeng – Desktop estimate 1621ha
  Revised estimate 1 000ha

Figure 2: Example of soil sample with a high potential for irrigated agriculture

5) Dam sizing based on requirements

The range of sizes of dams analysed were for capacities ranging from 33 million m^3 to 490 million m^3. Increasing dam volume above this higher figure produces less benefit. The water requirements were compared with the yields produced by this range of dam sizes. It was noted that the "minimum" sized dam produced sufficient reliable yield to supply all of the water demand projections if the water was only going to be used for domestic water supply and irrigated agriculture. A base case and a high demand scenario were developed with the base case being the proposed minimum water requirement for domestic water supply and irrigation (incl.

compulsory environmental releases) and the high demand scenario being the proposed maximum if supply areas were increased. The storage volumes required at each dam site are shown in **Table 1** below.

	GRAND TOTAL WATER DEMAND		98% Reliable Dam Yield	EWR	DAM SIZE (GROSS VOLUME INCLUDING SEDIMENT ALLOWANCE)		Dam FSL Water Depth	ESTIMATED CONT. HYDROPOWER	
	BASE	HIGH						BASE	HIGH
	Mm^3/a	Mm^3/a	Mm3/a	Mm3/a	MAR x	Mm3	m	MW	MW
NTABELANGA	7.83	21.97	26.80	52.82	0.10	33.00	31.00	0.27	0.27
THABENG	9.19	23.62	24.80	84.33	0.20	58.00	33.00	0.35	0.35
SOMABADI	8.59	21.47	21.32	104.98	0.15	54.15	44.53	0.40	0.40

Table 1: Dam sizes required to meet total water requirements

6) Hydropower potential assessment

A check was undertaken on each dam to ascertain the amount of reliable (continuous) hydropower that could be generated if a hydropower station were to be built at the dam. The figures shown in the table above indicate that, for the smallest dam sizes this output would range from 0.27 to 0.40 MW for the three dams. The requirements for a self-sufficient "hydro-powered" scheme cannot be met by these small dams.

An analysis was therefore also undertaken to see how much larger the three dams would need to be built to be able to generate the required power requirements and to provide the necessary domestic and irrigation water supply. The incremental cost of these larger dams and installing hydropower plant for this latter scenario was thus calculated and included in the analyses described below.

7) Cost comparison

For each of the options described above, capital cost estimates were prepared so that a discounted cash flow analysis could be undertaken to compare the cost of water produced by each of the three dams. Calculating capital costs for the three dams and for various dam sizes enabled a "costing curve" to be produced for the full ranges of dam sizes, as shown in **Figure 3** below.

Summary and conclusion of preliminary findings

Scenarios were firstly investigated for dams that supplied raw water to meet only the domestic and irrigation water demands, with no hydropower component. Other scenarios were then run which included larger dams with hydropower plant installed to both deliver the required quantity of raw water to meet the projected demands, as well as generating sufficient hydropower to meet the energy needs of the water supply systems in the supply area served by the dam. A summary of key outputs from the above analyses is given below for base case (low demand) scenario and the "with" and "without" hydropower options. The colour coding in **Tables 2 and 3** below shows the ranking of the various selection criteria between the three dams.

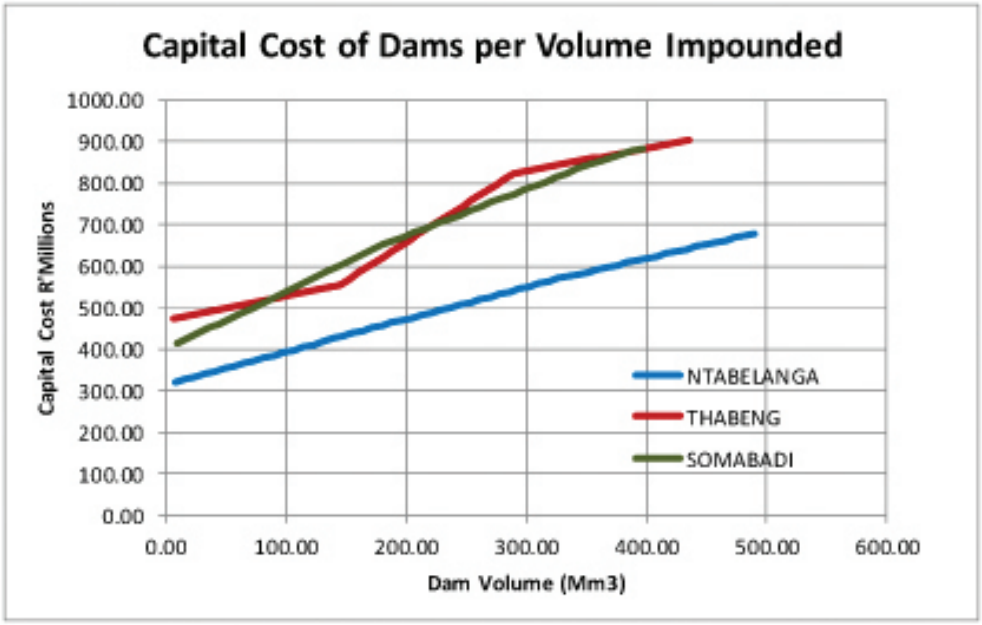

Figure 3: Cost comparison of three dams by volume impounded

Table 2: Comparison of dams by technical criteria – Base demand case

TECHNICAL CRITERIA	NTABELANGA	THABENG	SOMABADI
POPULATION SERVED FOR THIS SCENARIO	134,633	111,564	97,303
TOTAL POPULATION WITHIN 50 KM OF DAM	223,686	94,666	116,337
IRRIGATABLE AREAS WITHIN ECONOMIC LIMITS (ha)	504	1062	1062
COST OF DAM FOR RAW WATER SUPPLY ONLY (R million)	391	581	546
IS THE DAM SELF-SUFFICIENT FOR HYDROPOWER?	NO	NO	NO
INCREMENTAL COST OF LARGER DAM & HYDRO-PLANT (R million	194	287	141
DOES LARGER DAM MEET ALL SCHEME POWER REQUIREMENTS?	YES	YES	YES
TOTAL WATER AVAILABLE (Mm^3/a)	113.82	96.88	54.08
UNIT REFERENCE VALUE OF TOTAL WATER AVAILABLE (R/m^3)	0.27	0.48	0.68

Note: Unit reference values of water are average figures for the whole demand. More detailed analysis will be undertaken in Phase 2.

Other criteria have also been evaluated for each dam and ranked in a similar manner, which are listed below on **Table 3**.

Table 3: Comparison of dams by other criteria – Base demand case

OTHER CRITERIA	NTABELANGA	THABENG	SOMABADI
AREA OF LAND INUNDATED (km^2) - NO HYDROPOWER	7.5	7.8	5.8
AREA OF LAND INUNDATED (km^2) - WITH HYDROPOWER	20	16	7.3
IMPACTS EXISTING NATIONAL ROAD AND OTHER INFRASTRUCTURE?	LOWER	HIGH	MODERATE
OTHER REGIONAL SCHEMES AND SOURCES EXISTING/PLANNED?	YES	YES	YES
CAN SCHEME WORK CONJUNCTIVELY WITH OTHER MAJOR SCHEMES?	YES	NO	NO
ECOSYSTEM RISK ASSESSMENT RESULTS	LOWER	HIGHER	HIGHER
JOB CREATION (ESTIMATED NUMBERS)			
TEMPORARY DURING CONSTRUCTION	200 to 300	200 to 300	200 to 300
DURING FIRST SEVEN YEARS OF CATCHMENT IMPROVEMENTS	635	635	635
PERMANENT WATER SUPPLY	30 to 50	30 to 50	30 to 50
PERMANENT ON IRRIGATED AGRICULTURE SCHEMES	50	106	106
PERMANENT ON ANNUAL CATCHMENT MANAGEMENT	167	167	167

Can scheme work conjunctively with other major schemes?

This criteria is pertinent. This applies particularly to Ntabelanga, as this dam has the advantage that it can be used in tandem with a potential and significant hydropower scheme that was previously identified by ESKOM. This same dam could also be utilized to effect inter-basin transfer to the Orange River system, and could also potentially augment the Mthatha water supply via inter-basin transfer to the neighbouring catchment. The hydropower option is discussed further below, and whilst the two inter-basin transfer options have previously been discounted as being too expensive, they will be revisited again in Phase 2.

Conclusions

In terms of purely economic comparison of the three dam site options, Ntabelanga is clearly the highest ranked option, having the lowest capital cost and lowest URV of water produced for all configurations considered. It should be noted that the URV's of raw water produced by all three dams are high if only actual domestic and irrigation water usage is taken into consideration, rather than total water availability. Whilst the ranking is less clearly indicated when regarding the other impacts considered, the overall conclusion based upon the criteria considered is that the Ntabelanga Dam is the best single option to be taken forward into Phase 2 of this study.

The additional benefit that Ntabelanga has over the other two options is that it is well located so that it can be developed to work conjunctively and cost-beneficially with a potential large hydropower scheme on the same river, as well as having the potential to augment water supplies in other regions, if inter-basin transfers are deemed to be viable either now or in the future. If such additional uses can be realised, then the URV of water produced would reduce accordingly and the viability of the dam be assured.

Phase 2

The Department of Water Affairs is moving ahead with Phase 2 of the Mzimvubu Water Project with the Ntabelanga Dam site on the Tsitsa River as the preferred option as outlined above. The intention is to develop a conjunctive scheme where the Ntabelanga Dam is developed such that it will provide water releases to a hydropower scheme based at the proposed Laleni Dam site near to Tsitsa Falls. This process got underway in May 2013.

The Study Team is currently dealing with the Detailed Feasibility Study of the Ntabelanga Dam and the Department of Water Affairs is in the process of appointing an Environmental Consultant to undertake the legislated environmental process. The Study Team is finalising the detailed hydrology, undertaking geotechnical drilling and materials investigations, dam and spillway type analysis as well as detailed agricultural and domestic water supply planning investigations. Phase 2 is planned to be complete by April 2014.

Further information

Contact Persons:

Department of Water Affairs
Directorate: Options Analysis
Sedibeng Building
185 Frances Baard Street
Pretoria 0001
Tel: 012 336 6838; Fax: 012 336 7399

Contact: Mr M Mugumo
mugumom@dwa.gov.za

Professional Service Provider
Jeffares & Green (Pty) Ltd
P O Box 794
Hilton 3245
Tel: 033 343 6700; Fax: 033 343 6701

Contact: Mr A Pepperell
pepperella@jgi.co.za

Documentation and Reports:

This project will soon be available via the DWA Public Domain and Reports published as part of a website at: www.dwa.gov.za under “Projects and Programmes”.