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DEPARTMENT OF WATER AFFAIRS
AND FORESTRY

in association with

UMGENI WATER
Corporate Services Division

MKOMAZI/MOOI-MGENI TRANSFER SCHEME PRE-FEASIBILITY STUDY

MKOMAZI-MGENI TRANSFER SCHEME

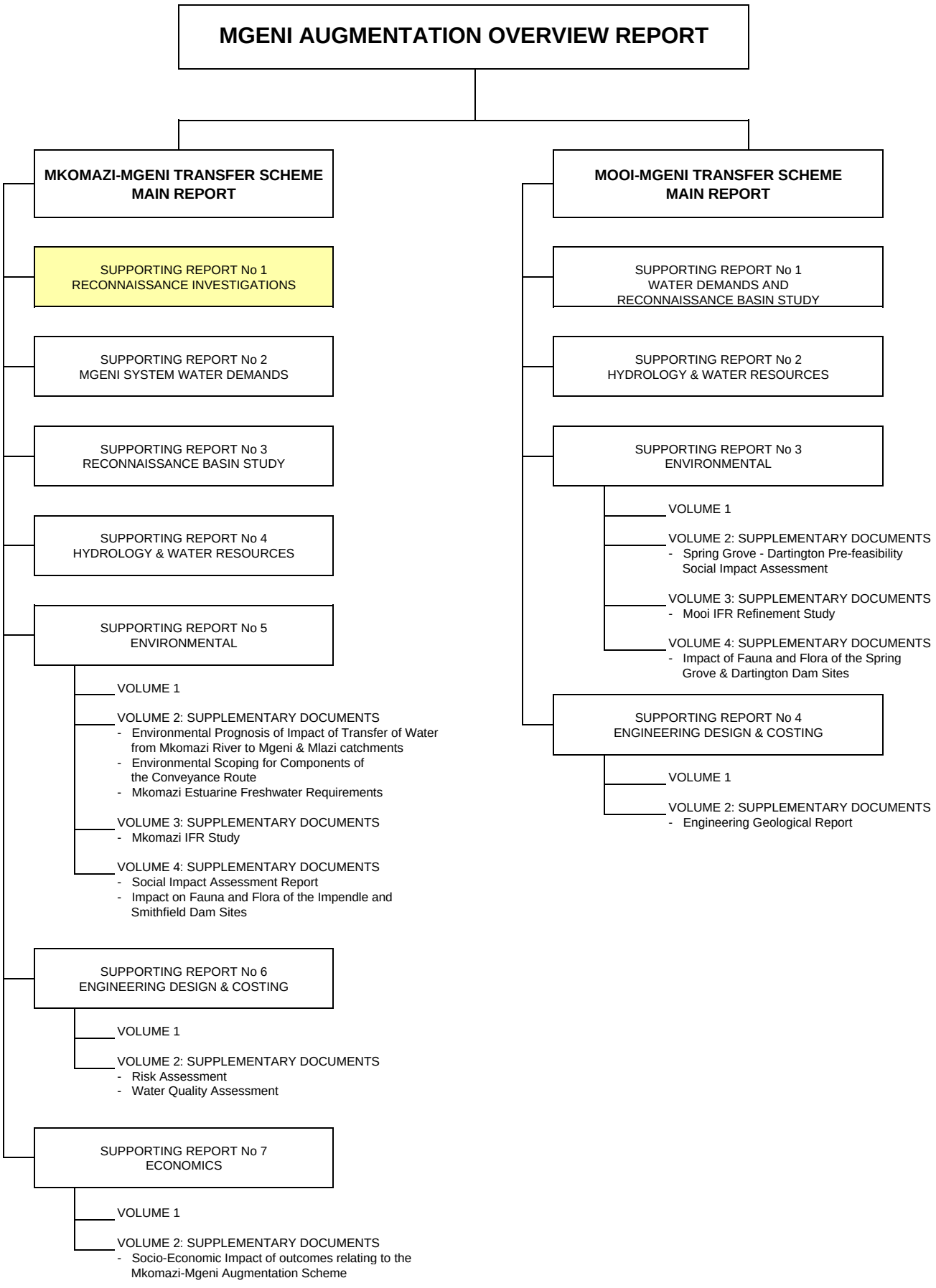
SUPPORTING REPORT No 1

RECONNAISSANCE INVESTIGATIONS

Report No 2787a/7856
May 1999

NINHAM SHAND
CONSULTING ENGINEERS

MKOMAZI/MOOI-MGENI TRANSFER SCHEME PRE-FEASIBILITY STUDY REPORT STRUCTURE



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MKOMAZI / MOOI-MGENI TRANSFER SCHEME PRE-FEASIBILITY STUDY

PREFACE

In January 1997, the Department of Water Affairs & Forestry: Directorate of Project Planning, in conjunction with Umgeni Water: Corporate Services Division, invited various firms of consulting engineers to submit proposals to undertake a Pre-Feasibility Study for a scheme to transfer water from the upper Mkomazi River to the Mgeni System. In July 1997, a multi-disciplinary team led by Ninham Shand was appointed.

This Study follows on from the Mgeni River System Analysis Study carried out between 1991 and 1994, in which the Mkomazi River was identified as a potentially viable source of water for augmentation of the Mgeni System, and the Mooi-Mgeni Transfer Feasibility Study carried out in 1995, in which the first phase scheme to augment the Mgeni System from the Mooi River was investigated in detail and possible second phase schemes were identified.

This Study comprises two distinct parts; a pre-feasibility investigation of augmentation schemes on the Mkomazi River preceded by scheme identification and reconnaissance investigations, and a pre-feasibility investigation of second phase transfer schemes from the Mooi River. A comparison of the two main augmentation options is made at the culmination of the Study. The report structure is given overleaf.

Sub-consultants employed by Ninham Shand to undertake various aspects of the Study included:

- IWR Environmental: Environmental studies and IEM co-ordination
- Scott Wilson: Social studies
- Keeve Steyn: Engineering aspects of tunnels and pumpstations, and involvement with Basin Studies
- Simmer Biggar and Associates: Infrastructure aspects.

As part of the Study Team, the following Client departments were involved:

- Council for Geoscience: Geological Survey
- Department of Water Affairs & Forestry: Project Planning (East)
- Department of Water Affairs & Forestry: Environment Studies
- Department of Water Affairs & Forestry: Hydrology
- Umgeni Water: Corporate Services Division: Water Resources Planning
- Umgeni Water: Scientific Services Division: Water Quality
- Umgeni Water: Scientific Services Division: Hydro-biology.

EXECUTIVE SUMMARY

The objective of this first phase of the Mkomazi-Mgeni Transfer Scheme Pre-Feasibility Study was to select the optimal transfer schemes for the Mkomazi by identifying and evaluating a number of potential schemes, all delivering clear water to Umlaas Road, eliminating those that clearly have little merit, and carrying out a reconnaissance investigation of the remaining schemes. This report deals with the review, identification and reconnaissance investigation of the various development options for the transfer of water to the Mgeni System. This phase will be followed by a pre-feasibility investigation of the selected scheme or schemes.

The first task was to determine present and projected future water demands in the portion of the Mgeni System which is to be supplied from the proposed transfer schemes. Data was obtained from BKS and Umgeni Water for the inland and coastal systems and average growth rates were selected to approximate the figures supplied, namely 3% for the coastal (Durban) system and 4% for the inland system. Net demands from the proposed transfer schemes were calculated by subtracting the Mgeni System yield, assuming the Midmar Dam is raised and Phase 1 of the Mooi-Mgeni Transfer Scheme is in place, from the total system demand.

Yield analyses for selected schemes were carried out by BKS, using the recently revised catchment hydrology. At this stage, historical firm yields of the individual schemes only were determined.

In the initial Scheme Identification phase, a total of eight schemes were identified. These included schemes previously identified by DWAF and Umgeni Water, by BKS in the Mgeni System Analysis Study, as well as several new schemes. Of these, three were considered unworthy of further investigation for various reasons, and were eliminated. An economic analysis of the remaining schemes yielded Unit Reference Values within a range of 12%, which was not considered large enough to justify the elimination of any of these schemes at this level of study detail.

The remaining schemes, which consisted of dams, waterworks, pumpstations and conveyances made up of tunnels, pipelines, canals and siphons in various combinations, were assessed in more detail in a Pre-Reconnaissance phase. In particular, phasing of schemes was considered and an initial environmental scoping exercise was carried out. One scheme (Clayborne) was eliminated mainly on environmental grounds and a second scheme (Ndonyane) was provisionally eliminated on economic and environmental grounds. The latter scheme was only to be reconsidered should the Reconnaissance phase yield results which render the remaining schemes less viable. These decisions were ratified by the Environmental Task Group (ETG) and Stakeholder Committee.

In the Reconnaissance phase, the remaining three schemes were reviewed. Their main characteristics are as follows:

Impendle Scheme: *A rockfill dam on the Mkomazi near Impendle, constructed in three phases, a gravity tunnel to a stream feeding Midmar Dam, an upgraded low lift pumpstation and pipeline to an extended Midmar waterworks, and a gravity pipeline along the Northern Feeder route to Umlaas Road. The existing Hilton tunnel and proposed Stuckenberg's Ledge tunnel would be utilised. The ultimate yield of the transfer scheme would be 340 million m^3/a.*

Smithfield-Richmond: *A first phase rockfill dam on the Mkomazi at Smithfield, followed by a second phase dam at Impendle, a pumpstation and gravity tunnel to a balancing dam on the Lovu River near Richmond, a waterworks and gravity pipeline to Umlaas Road. The ultimate yield of the transfer scheme would be 410 million m^3/a.*

Smithfield-Baynesfield: *Dams as for the Smithfield-Richmond scheme, a pumpstation and gravity tunnel to a balancing dam on the Mlazi River near Baynesfield, a waterworks and gravity pipeline to Umlaas Road. The ultimate yield of the transfer scheme would be 410 million m^3/a.*

In the Reconnaissance phase, Initial Environmental Assessments (ROIPs) were carried out by DWAF. It was found that the Smithfield schemes would have a greater ecological impact than Impendle, due to their effect on the downstream flow regime. The Impendle scheme would have relatively severe social impacts, which would also apply with the second phase of the Smithfield schemes. However, it was agreed that no fatal ecological or social flaws were apparent. In the case of the Ndonyane scheme, which was provisionally eliminated in the Pre-Reconnaissance phase, a habitat integrity assessment indicated that the dam would inundate a valuable and important resource base.

Economically, it was found that the Smithfield-Richmond scheme was least favourable. Technically, problems were encountered with the pipeline between Richmond and Umlaas Road which would necessitate deep cuts.

It was therefore proposed to and agreed by the ETG and Stakeholder Committee that only the Impendle and Smithfield-Baynesfield schemes should be investigated further at Pre-Feasibility level.

MKOMAZI-MGENI TRANSFER SCHEME

SUPPORTING REPORT NO 1: RECONNAISSANCE INVESTIGATIONS

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MKOMAZI-MGENI TRANSFER SCHEME

SUPPORTING REPORT NO 1: RECONNAISSANCE INVESTIGATIONS

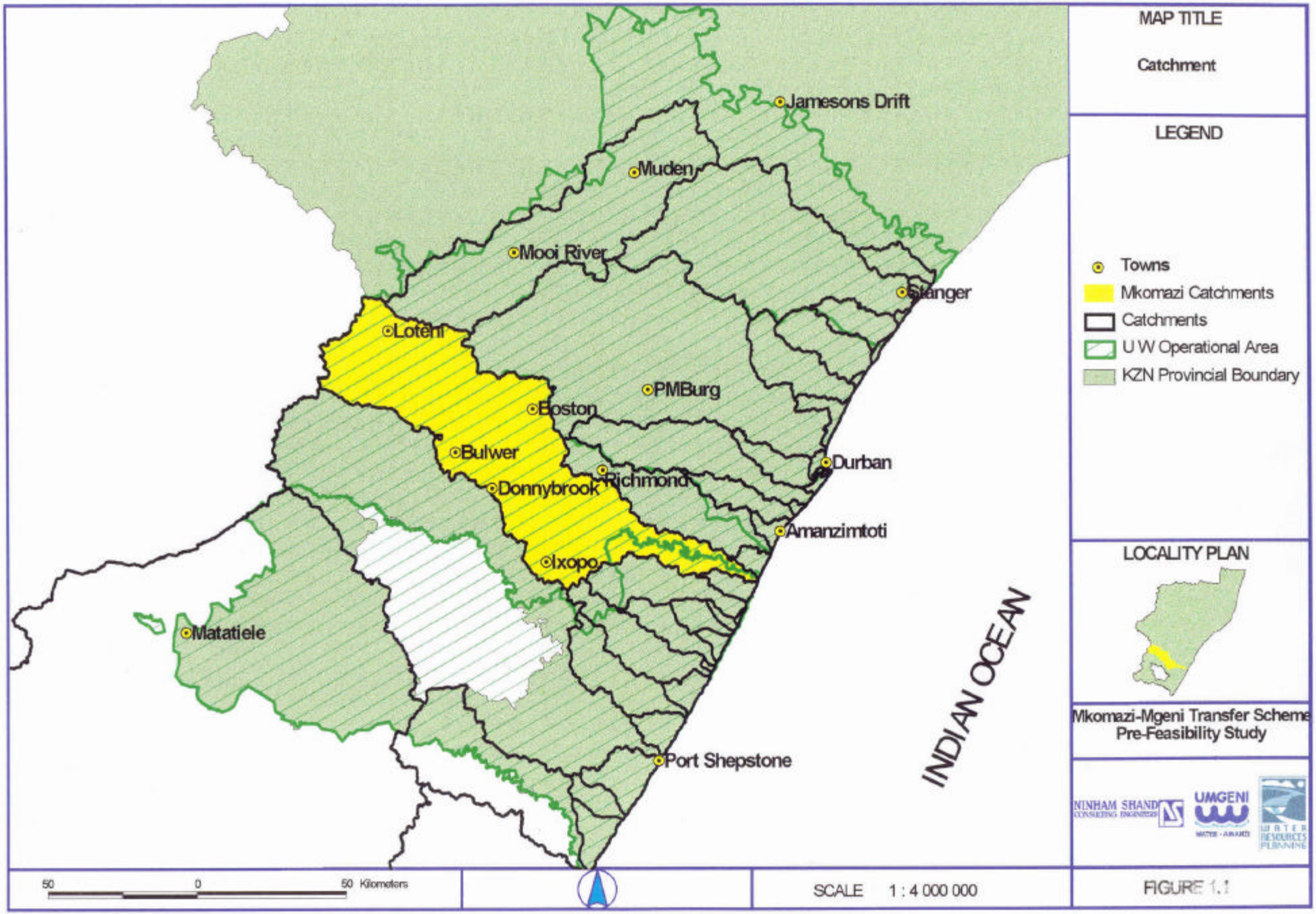
1. BACKGROUND AND OBJECTIVES

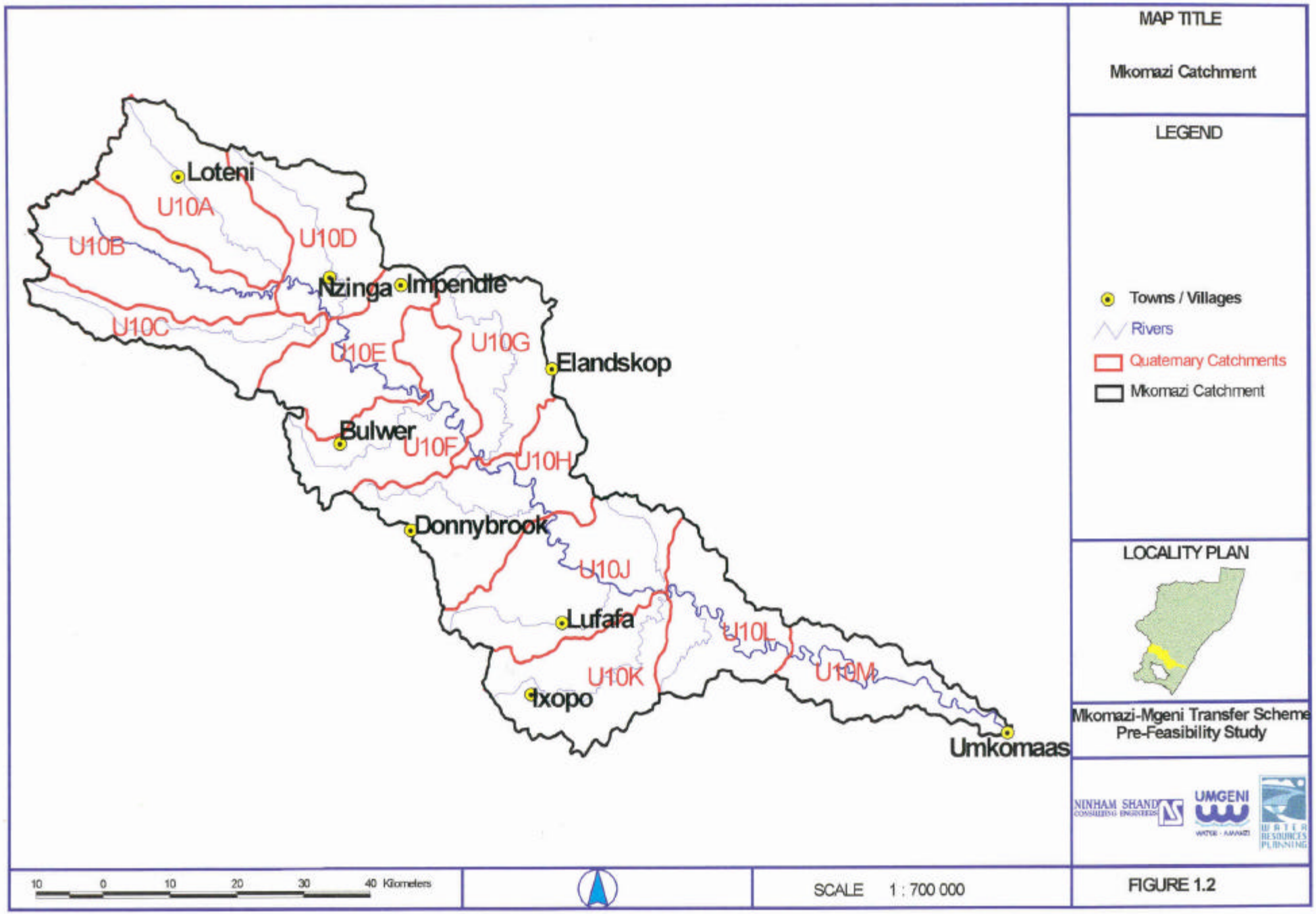
The water resources of the Mgeni River System, which is the main source of water for the Durban/Pietermaritzburg metropolitan area, the economic powerhouse of KwaZulu-Natal Province, are already fully utilised. Phase 1 of the Mooi-Mgeni Transfer Scheme and the raising of Midmar Dam will shortly proceed to the design phase, but additional augmentation will be required about seven years hence.

Water resources in South Africa are now regarded as a national asset and the goal of Government is to ensure that all South Africans have access to basic water supply and sanitation services. KwaZulu-Natal is considered to be a relatively water-rich Province, evidenced in the major interbasin transfers, both existing and planned, on the Province's major rivers. However, very sensitive management will be required at central and regional government level to avoid conflicts of interest between provincial strategies and the basic needs of the inhabitants of the affected river basins. Comprehensive and careful planning of the development of these water resources is therefore essential and it is with this in mind that the current planning initiative was commissioned by the Department of Water Affairs & Forestry (DWAF) and Umgeni Water.

The Mkomazi is one of the nine major rivers in the Province with a catchment area greater than 1 000 km^2 and is therefore an extremely important water resource in the region. Its potential is currently largely untapped, with approximately 85% of its virgin Mean Annual Runoff (MAR) of 1 070 million m^3/a flowing to the Indian Ocean. The locality of the catchment is shown in **Figure 1.1** and quaternary subcatchments are shown in **Figure 1.2**.

In the Umgeni River System Analysis (BKS, 1994a), transfer schemes from the Mooi and Mkomazi Rivers were identified as being the most feasible to augment the Mgeni System. A number of other alternatives were identified and evaluated, but were found to be too small and/or uneconomical to be viable. The Mooi-Mgeni Transfer Scheme was subsequently investigated in more detail (Keeve Steyn, 1995) and recommendations for development of a first phase scheme were made. Schemes on the other major rivers that could potentially be tapped, namely the Bushmans, Mzimkhulu and Mzimvubu, would all involve far greater capital and running costs than the Mkomazi, due to their distance from the demand node and their relative elevations.


MAP TITLE
Catchment
LEGEND
Towns
Mkomazi Catchments
Catchments
U W Operational Area
KZN Provincial Boundary
LOCALITY PLAN
Mkomazi-Mgeni Transfer Scheme
Pre-Feasibility Study
Jamesons Drift
Muden
Mooi River
Estanger
Lotent
PMBurg
Boston
Bulwer
Durban
Richmond
Donnybrook
Amanzimtoti
Ixopo
Matatiele
Port Shepstone
INDIAN OCEAN
50 0 50 Kilometers
SCALE 1 : 4 000 000
FIGURE 1.1


MAP TITLE
Mkomazi Catchment
LEGEND
Towns / Villages
Rivers
Quaternary Catchments
Mkomazi Catchment
LOCALITY PLAN
Mkomazi-Mgeni Transfer Scheme
Pre-Feasibility Study
NINHAM SHAND
UMGENI
WATER RESOURCES PLANNING
Loteni
Nzinga
Impendle
Elandskop
Bulwer
Donnybrook
Lufafa
Ixopo
Umkomaas
U10A
U10B
U10C
U10D
U10E
U10F
U10G
U10H
U10J
U10K
U10L
U10M
10 0 10 20 30 40 Kilometers
SCALE 1 : 700 000
FIGURE 1.2

The ultimate objective of this Study is to identify the next augmentation scheme for the Mgeni System after the first phase of the Mooi-Mgeni River Transfer Scheme is fully utilised. Such a scheme will be either on the Mooi or Mkomazi Rivers. The Mkomazi-Mgeni Transfer Scheme is to supply potable water to the distribution centre at Umlaas Road and its selection will be based on economics as well as engineering, hydrological, social and environmental considerations. A scheme which would allow the deferment of capital expenditure would be particularly attractive and phasing has therefore been considered.

In order to be in a position to make this selection on an equitable basis, the Study will bring the investigation of the Mkomazi River options to the same level of detail as the Mooi River scheme. Additional work will also be required on the Mooi River options to bring them to a level of detail where a realistic comparison can be made.

An initial component of the Study, which preceded the pre-feasibility level comparisons of the Mkomazi and Mooi River schemes, was to select the optimal schemes for the Mkomazi by identifying and evaluating a number of potential schemes, eliminating those which clearly have little merit and carrying out a reconnaissance level investigation of the remaining schemes. This report deals with the review, identification and reconnaissance investigation of the various development options for the transfer of water to the Mgeni System from the Mkomazi, at three distinct levels, namely Scheme Identification Phase (Section 3), Pre-reconnaissance Assessment (Section 4) and Reconnaissance Investigation (Section 5). Note that the Appendices containing supporting data are structured accordingly and data may differ between the various study phases.

2. BASE CONDITIONS AND WATER DEMANDS

The Mkomazi River has a catchment area of approximately 4 400 km^2 and a Mean Annual Precipitation (MAP) of 950 mm. The virgin MAR at the estuary is approximately 1 070 million m^3/a (BKS, 1997a) and the present day MAR approximately 920 million m^3/a (BKS, 1997b). Most of the activities affecting runoff, such as forestry and dry land sugar cane cultivation, as well as demands on riverflow, are concentrated in the catchment below the schemes under consideration. By far the single largest consumer of water in the catchment is SAPPI SAICCOR, with a permit allocation of 53 million m^3/a.

The virgin MAR in the reach of river where the schemes under consideration would be located ranges from approximately 570 to 750 million m^3/a.

The predicted system water demands given in **Table 2.1** were obtained from Umgeni Water for the inland system (Umgeni Water, 1997a) and from BKS for the Durban (Wiggins and Durban Heights) system (BKS, 1997c) at the commencement of the Study. After discussion with Umgeni Water personnel, it was decided to base the growth in water demands in the system on a growth rate of 3% p.a. for the Durban or coastal system and 4% p.a. for the inland system, commencing with the expected water demands in 1997 of 235 and 61 million m^3/a for Durban and the inland system respectively. This represents a low road scenario. It should be noted that the estimated water demand figures provided independently by BKS and Umgeni Water for the years 2010 and 2020 indicate water demands approximately 10% greater than those predicted using the above assumptions.

Water demand projections were under review by BKS for Umgeni Water at the time of this phase of the Study and revised figures were produced, approximately 4% higher than earlier projections (BKS, 1997d). However, it was determined that the impact on the economics of the schemes under consideration would be negligible and would not affect their ranking. The revised figures were therefore not adopted for this phase of the Study, but will be utilised in the Pre-Feasibility phase.

The net water demand to be met from the Mkomazi Transfer Schemes to the Umlaas Road demand node was derived by subtracting the estimated Mgeni System demand described above, from the estimated Mgeni System yield at Inanda, assuming Midmar Dam raised and augmentation from the Phase 1 of the Mooi-Mgeni Transfer Scheme, of 355 million m^3/a (BKS, 1997e).

Figure 2.1 shows the projected water demands in the Mgeni System supply area in graphical form. From this graph it can be seen that with the estimates of water demands in the Mgeni System assumed for this phase of the Study, the first phase of the proposed Mkomazi Transfer Scheme should be implemented by 2004. More recent investigations undertaken for Umgeni Water reportedly show that the effect of imposing strict demand management measures is limited to permitting only a short deferment of augmentation schemes. A more detailed assessment of demands will be carried out during the Pre-Feasibility Phase of the Study.

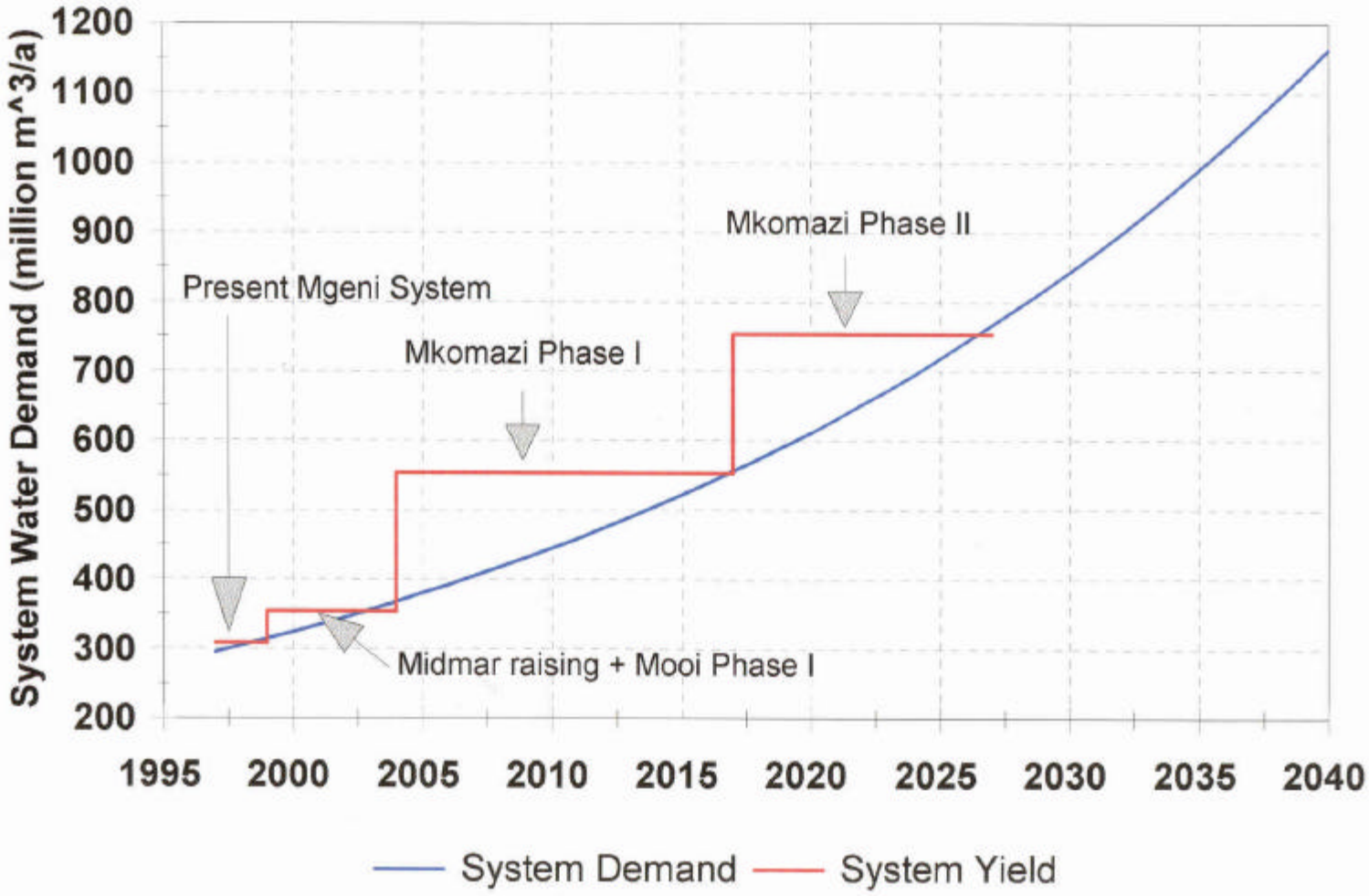
Preliminary indications are that the maximum practical yield which can be obtained from storage in the upper/middle Mkomazi is in the order of 400 million m^3/a. If a greater proportion of the Mkomazi's yield is to be utilised, additional storage would have to be provided on the lower Mkomazi. It is only practical to transfer water to Umlaas Road from the upper and middle Mkomazi and water from schemes on the lower Mkomazi would have to be delivered to a point lower down in the coastal system.

TABLE 2.1 ESTIMATE OF SYSTEM WATER DEMANDS

YEAR	DEMAND ASSESSMENTS BY OTHERS			DEMAND ASSESSMENTS FOR THIS STUDY			Net demand from Mkomazi Schemes
	Durban (ex BKS)	Inland (ex UW)	TOTAL	Estimated Durban at 3% growth	Estimated Inland at 4% growth	Estimated Total Mgeni system demands	
1997	235	61	296	235	61	296	(59)
2000	267	76	343	257	68	325	(30)
2005	322			298	83	381	26
2010	371	114	485	345	101	446	91
2015	426			400	123	523	168
2020	490	178	668	464	149	613	258
2025	572			538	182	720	364
2030				623	221	844	489
2035				723	269	992	637
2040				838	327	1 165	810

Notes:
1. All demands in million m^3/a
2. Existing system yield assumed to be 355 million m^3/a with Midmar raised and Mooi-Mgeni Phase I implemented.
3. Net demand in brackets indicate that the system yield still exceeds the demand

FIGURE 2.1
PROJECTED MGENI SYSTEM DEMAND



3. SCHEME IDENTIFICATION

*Note that all relevant supporting data for this phase of the Study is included in **Appendix A**.*

3.1 Scheme Descriptions

3.1.1 General

It became apparent after a preliminary review of previous studies that in view of the requirement that water from the proposed transfer scheme was to be delivered to the demand node at Umlaas Road, only one of the two Mkomazi schemes identified in the System Analysis Study (BKS, 1994b) would be feasible in the configuration proposed in that study. Taking this and subsequent discussions with Umgeni Water and DWAF on other alternatives into account, Ninham Shand were requested at the first Project Co-ordination Meeting to review all the development options that had been previously proposed for the Upper Mkomazi-Mgeni Transfer and to investigate any other development options that may be considered feasible. These were to be subjected to an initial screening process prior to proceeding to the next level of detail of investigation.

The previous reports by BKS and schemes proposed by Umgeni Water and DWAF were studied and evaluated, and other possible alternatives were identified. The layout of the schemes is shown in **Figure 3.1** and the main characteristics of the schemes which warranted further investigation are given in **Appendix A1**. The schemes are described briefly below. It should be noted that in this initial screening process, only first phase schemes with yields of 200 million m^3/a were considered. In the later phases of the Reconnaissance Study, phasing of schemes was evaluated.

3.1.2 Impendle Scheme (Scheme 1)

This scheme was originally identified by DWAF and is described in the Mgeni River System Analysis Study reports (BKS, 1994b). The scheme consisted of an initial 20 m high concrete gravity dam on the Mkomazi River near Impendle and a gravity tunnel to a stream feeding Midmar Dam, augmented later with a larger rollcrete gravity dam. A rockfill dam was also evaluated. From Midmar Dam, water would be pumped at a head of approximately 10 m to the Midmar Treatment Works and then transferred by gravity via the Hilton Tunnel and Northern Feeder pipeline to Umlaas Road.

For the purposes of this phase of the current Study, it was assumed that the scheme would consist of a rockfill dam with a capacity of 200 million m^3, with a side channel spillway and a yield of 200 million m^3/a. The conveyance system is as described above. This scheme would meet demands for approximately 13 years after commissioning.

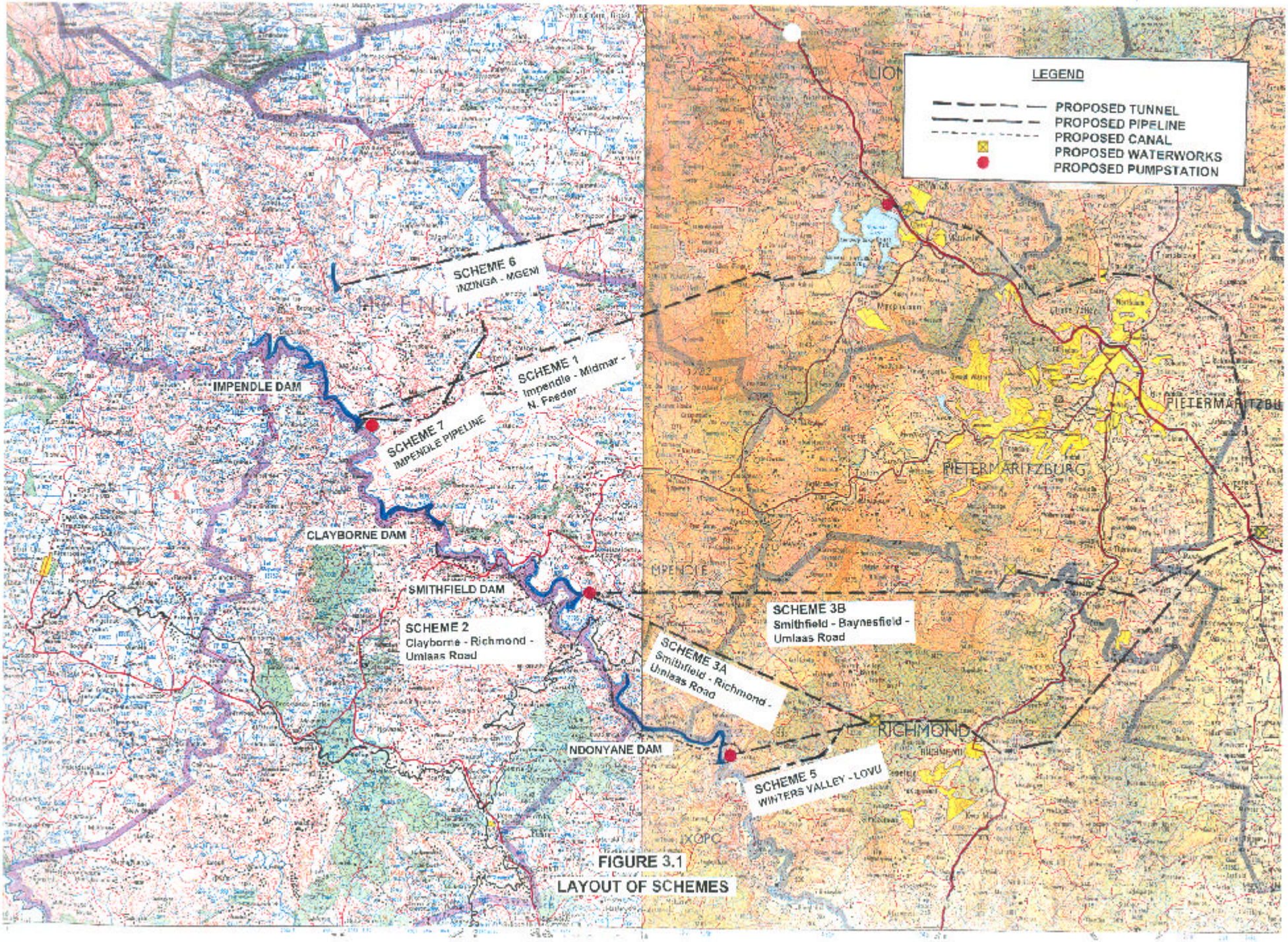


FIGURE 3.1

LAYOUT OF SCHEMES

3.1.3 Clayborne Scheme (Scheme 2)

This scheme was identified by Umgeni Water. The layout of the scheme was provided to Ninham Shand on marked up 1:50 000 plans and explained in personal communication (Umgeni Water, 1997b).

The proposed scheme consists of a dam (the possibility of an arch dam was mentioned) on the Mkomazi at Clayborne, 10 km downstream of the Impendle site, 66 km of canals and a total of 8 km of gravity tunnels to the Lovu River near Richmond. Here, water would be diverted to a waterworks from where clear water would be piped under gravity to the Mgeni System.

For the purposes of this Study, the scheme was evaluated as a rockfill dam with a 170 million m^3 capacity, with a side channel spillway and a 200 million m^3/a yield. The conveyance system would be largely as described above. However, it was found that the elevation of the specified delivery point at Umlaas Road was such that the scheme would not operate purely under gravity and that limited pumping, at a static head of 20 m, would be required.

3.1.4 Smithfield Schemes

The Smithfield Scheme was identified in the Mgeni River System Analysis Study (BKS, 1994b). Initially a dam would be built at Woody Glen on the Mlazi River, supplying the coastal region, augmented later with a dam on the Mkomazi at Smithfield and a gravity tunnel (the Deepdale tunnel) to the Mlazi River. Transferred water would then flow down the Mlazi River to the Woody Glen Dam.

As this scheme would not deliver water to the Umlaas Road demand centre, as required in terms of current planning, it was necessary to modify its configuration. In particular, it was necessary to provide storage on the Mkomazi River as part of the initial scheme, instead of on the Mlazi. Two alternative configurations were evaluated, as follows:

Smithfield-Richmond (Scheme 3A)

This scheme consists of a 170 million m^3 capacity rockfill dam with a side channel spillway and a 200 million m^3/a yield on the Mkomazi at Smithfield, an underground pumpstation delivering water at a head of 85 m via a shaft and 25 km long gravity tunnel to a waterworks near Richmond. From there, clear water would be conveyed by a 36 km long gravity pipeline to Umlaas Road.

Smithfield-Baynesfield (Scheme 3B)

This scheme consists of a dam, pumpstation and shaft as described in 3.3.1 above, a 32 km long gravity tunnel to a waterworks at Baynesfield and a 21 km long clear water gravity pipeline to Umlaas Road. The pumping head is significantly lower than Scheme 3A at 25 m.

3.1.5 Ndonyane Scheme (Scheme 4)

This scheme was not identified in previous studies. It consists of a 160 million m^3 capacity rockfill dam at Ndonyane with a side channel spillway and a yield of 200 million m^3/a. A pumpstation would deliver water at a head of 340 m via a shaft and gravity tunnel to a waterworks near Richmond. The clear water pipeline to Umlaas Road would be as per Scheme 3A.

3.1.6 Winters Valley-Lovu (Scheme 5)

The scheme, identified by Umgeni Water, consists of a weir on the Mkomazi River at Winters Valley near Hele Hele, a canal and multiple stage pumping to a similar head as the Ndonyane Scheme via a pipeline over the divide between the Mkomazi and the Lovu Rivers. A waterworks on the Lovu River near Richmond would supply clear water by a 36 km long gravity pipeline to Umlaas Road.

3.1.7 Inzinga-Mgeni (Scheme 6)

This scheme consists of a dam on the Inzinga River near Brooklyn, with a 24 km gravity tunnel to the upper reaches of the Mgeni River near Fort Nottingham. From this point water would flow to the Midmar Dam, from where the treatment and conveyances would be as per the Impendle Scheme.

3.1.8 Impendle Pipeline (Scheme 7)

As an alternative to the Impendle Scheme described above, DWAF suggested that a scheme consisting of a small dam at Impendle, a pumpstation, delivering water at a head of 600 m, and rising main across the watershed into the Mgeni catchment should be considered. From this point, water would flow via natural watercourses into Midmar Dam, from where it would be treated and conveyed as per the Impendle Scheme.

3.2 Initial Screening

Of the eight schemes identified, three were eliminated at an early stage, without the need for carrying out cost estimates or economic analyses. The reasons were as follows:

Winters Valley-Lovu (Scheme 5)

This scheme is based on the assumption that run-of-river would be sufficient to provide a significant yield throughout the year, as no significant storage is provided. An analysis of observed flows at the DWAF gauge no. U1H006 shows that the flows in late winter drop below 1 m^3/s under extreme conditions and exceed 3 m^3/s (an average of 100 million m^3/a) for approximately 80% of the time. With the likely IFR and EFR requirements, it is probable that little or no water could be abstracted during the dry winter months, particularly during droughts, and the proposed waterworks and other infrastructure would have to be duplicated elsewhere as low as exceedance flows. The required pumping head is also very high (500 to 600 m). This scheme therefore does not warrant any further consideration.

Inzinga-Mgeni (Scheme 6)

The MAR of the Inzinga River at the proposed site is estimated to be approximately 80 million m^3/a (Midgley *et al*, 1994) and it is unlikely that more than 50% of this would be available for transfer. When considering this small yield against the large capital cost associated with a 24 km tunnel and the fact that there would be no scope for further expansion of the scheme, it is clear that this scheme could not be viable. In addition, water would be discharged into the Mgeni Vlei, which would have negative environmental impacts.

Impendle Pipeline (Scheme 7)

This scheme is not considered feasible due to the extremely high pumping head of 600 m, with associated technical problems and extremely high running costs. In addition, water would be discharged into sensitive vlei areas in the headwaters of an Mgeni River tributary, with associated significant negative environmental impacts.

The possibility of a compromise scheme, with a tunnel at a higher elevation and less pumping, was also investigated superficially. However, the nature of the topography is such that to shorten the tunnel significantly, pumping heads in the order of 400 m will be required and similar problems with the receiving stream to those of the pipeline scheme will be experienced.

3.3 Hydrology and Yield Analyses

At the time of this phase of the Study, BKS were in the process of finalising a revision of the hydrology of the Mkomazi River, taking into account the latest available land use and abstraction data (BKS, 1997a). Sub-catchment boundaries had been selected to match the dam sites proposed in the System Analysis Study (BKS, 1994b), namely Impendle and Smithfield, and it was therefore a relatively simple matter to set up a model to determine the historical firm yield for the two dams. This was carried out for Ninham Shand by BKS, assuming compensation releases of 11,4 and 9,5 million m^3/a for Smithfield and Impendle respectively, as per the System Analysis. No allowance was made for IFR at this stage, as the impact of this on the yield of the dams was anticipated to be sufficiently similar, considering the level of detail of this phase of the study. Depth-area-capacity relationships determined for the System Analysis Study using 1:50 000 mapping, were used. The results of this analysis are given in **Figure 3.2**.

For the Clayborne and Ndonyane schemes, the yields determined for Smithfield and Impendle Dams were adjusted to match the estimated MAR's at these two sites.

3.4 Engineering, Costing and Economics

3.4.1 Engineering

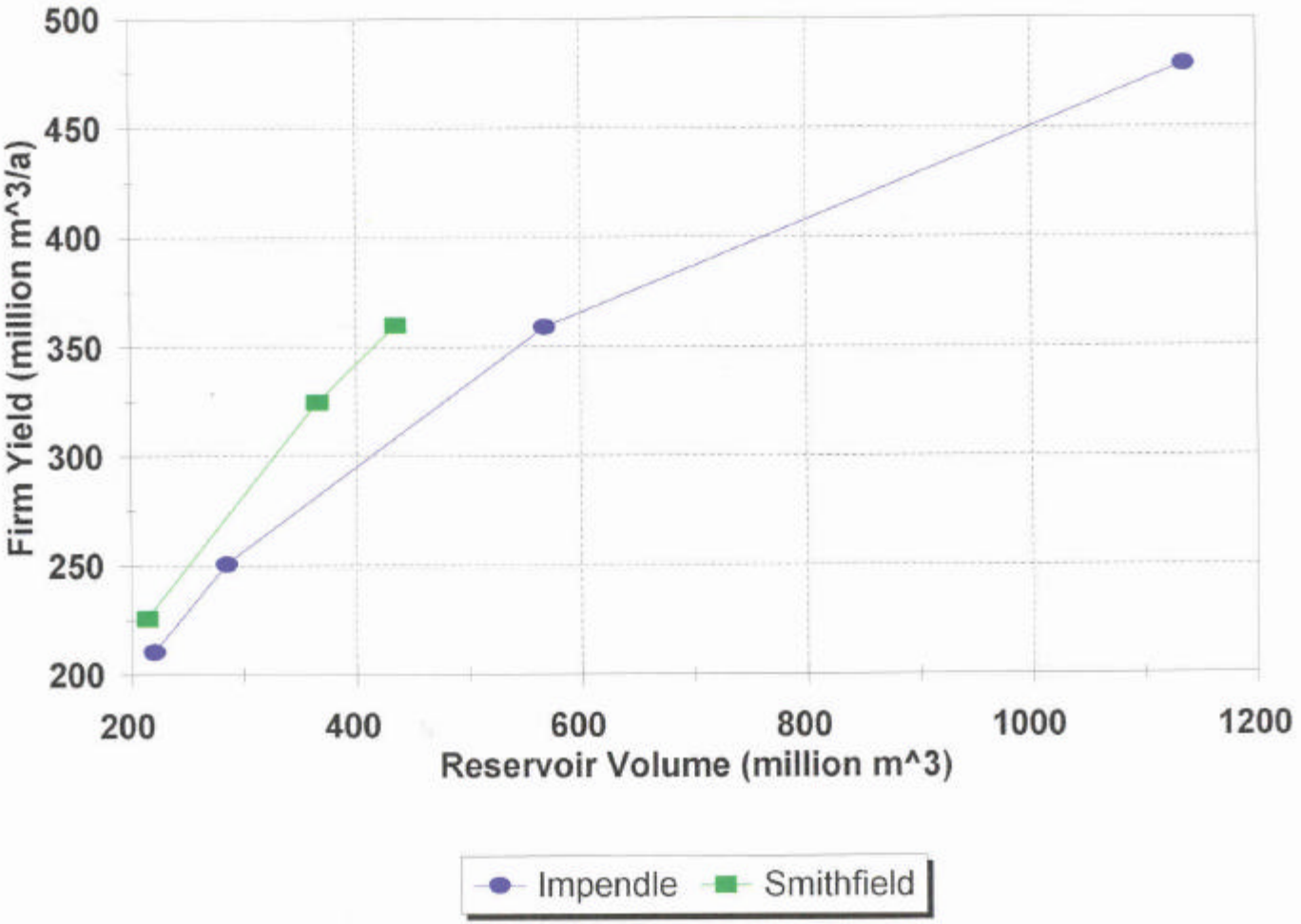
Schemes 1 to 4 described above were considered worthy of more detailed investigation, for reasons set out below.

The level of detail and methods used for the preliminary design and cost estimates of the above five schemes were in accordance with current DWAF (VAPS) Guidelines (DWAF, 1994) for scheme identification stage.

For the dams, a study of available information and a visit to the sites indicated that concrete dams would probably not be appropriate, as flood magnitudes are not particularly large and reasonable spillway sites are present on the flanks. In the case of the Smithfield site, a neck spillway on the left flank would be feasible. Spillways were sized to pass the Regional Maximum Flood (RMF) assuming a k-value of the adjacent catchment numerically one step higher than that of the relevant dam site.

In all cases, it was assumed that rockfill dams with central clay cores would be feasible. Slopes of 1:1,75 and 1:1,6 were assumed for the upstream and downstream shells respectively and a crest width of 12 m was assumed. Multi-level draw-off facilities and reinforced concrete outlet conduits were allowed for. The conduits would be used for river diversion during construction.

FIGURE 3.2: HISTORICAL FIRM YIELD



Tunnel routes were selected on the basis of 1:250 000 mapping. All tunnels were designed as gravity tunnels with a free water surface. All but short tunnels and adits were assumed to be bored, 3,5 m in diameter, fully concrete lined with a waterproof membrane over 50% of their length. Drill and blast tunnels were assumed to also have a 3,5 m nominal diameter and be fully lined. Multi-level intake structures were provided in the dams.

Pipeline routes were selected on the basis of 1:50 000 mapping and pipelines were assumed to be cement mortar lined steel.

Canals were assumed to be trapezoidal, with a 2,5 m base width and 1:1,5 side slopes. A 100 mm thick concrete lining was provided. Average crossfalls of 25% were assumed.

Pumpstation designs were based on the DWAF (VAPS) Guidelines.

3.4.2 Costing and economics

Cost estimates for dams, tunnels, canals and pumpstations were based on VAPS cost models, escalated by 1,3 to August 1997 prices. Pipeline and treatment works costs were based on information provided by Umgeni Water, which, in turn, was based on experience with similar works and forms the basis for their infrastructure planning. A nominal R5 million was allowed for social and environmental costs. In the case of the waterworks for the Impendle Scheme, a 20% reduction was allowed for to account for the existing infrastructure and facilities at Midmar. Provision was made for an additional 6 km of pipeline to allow for conveyance infrastructure upgrades between Midmar Dam and the Midmar Tunnel. The costs of the Midmar pumpstation upgrade were considered insignificant for this level of evaluation and were ignored. Cost estimates of the various components are included in **Appendix A2** and are summarised in **Table 3.1**.

Economic analyses for the period up to 2053 were carried out on Schemes 1 to 4, assuming commissioning in 2004. The Net Present Value (NPV) of costs and Unit Reference Value (URV) of each scheme was determined for discount rates of 6, 8 and 10%. The URV is calculated as the NPV of all costs for the analysis period divided by the NPV of water delivered during the same period.

Construction periods of 4 years were assumed. Annual maintenance costs were calculated in accordance with the DWAF guidelines, except that a higher annual maintenance cost of 0,75% of capital cost was assumed for the canal, in view of the difficult terrain which the canal traverses.

Treatment costs were assumed to be the same for all schemes and were therefore not considered in the economic analyses, as the quality of water being treated is not expected to differ significantly between schemes.

Results of the analyses are included in **Appendix A3** and are summarised in **Table 3.2**.

TABLE 3.1: COST BREAKDOWNS: SCHEME IDENTIFICATION PHASE

SCHEME	COMPONENT	CAPITAL COST (R000)
1: Impendle	Dam (FSL 1 160 masl)	175 200
	Tunnel	858 245
	Waterworks	193 200
	Pipelines	247 250
	TOTAL	**1 473 895**
2: Clayborne	Dam (FSL 1 040 masl)	248 800
	Tunnel	349 600
	Canals/syphons	395 600
	Pumpstation	11 370
	Waterworks	241 500
	Pipelines	210 450
	TOTAL	**1 457 320**
3A: Smithfield-Richmond	Dam (FSL 907 masl)	235 000
	Tunnel	566 950
	Pumpstation	17 020
	Waterworks	241 500
	Pipelines	210 450
	TOTAL	**1 270 920**
3B: Smithfield-Baynesfield	Dam (FSL 907 masl)	235 000
	Tunnel	711 850
	Pumpstation	11 500
	Waterworks	241 500
	Pipelines	120 750
	TOTAL	**1 320 600**
4: Ndonyane	Dam (FSL 680 masl)	543 200
	Tunnel	315 100
	Pumpstation	74 060
	Waterworks	241 500
	Pipelines	210 450
	TOTAL	**1 384 310**

Note: 1. Costs are based on an August 1997 base date.
2. Costs include engineering fees (15%) but exclude VAT.
3. Dam costs include R5 million for social and environmental costs.
4. All schemes are designed for a yield of 200 million m^3/a.
5. Costs are as used in the economic analysis and may differ slightly from those in Appendix A2 due to rounding-off.

TABLE 3.2: COSTS AND ECONOMICS: SCHEME IDENTIFICATION PHASE

SCHEME	CAPITAL COST (R000)	RUNNING COSTS (R000/a)	NET PRESENT VALUE OF COSTS (R000) @ DISCOUNT RATES			UNIT REFERENCE VALUE (c/m^3) @ DISCOUNT RATES		
			6%	8%	10%	6%	8%	10%
1. Impendle	1 474 000	7 856	1 238 822	1 122 980	1 026 473	82,3	118,3	163,6
2. Clayborne	1 457 000	13 273	1 242 658	1 105 020	994 446	82,6	116,4	158,5
3A. Smithfield-Richmond	1 271 000	23 541	1 172 608	1 020 829	906 386	77,9	107,6	144,5
3B. Smithfield-Baynesfield	1 321 000	10 918	1 120 631	1 001 808	905 774	74,5	105,5	144,4
4. Ndonyane	1 384 000	26 268	1 276 359	1 107 357	980 162	84,8	116,7	156,2

Note: 1. All costs are based on an August 1997 base date.
2. Costs exclude VAT.
3. Analysis period of 50 years from commissioning date of schemes (2004).
4. Unit Reference Value = (Net Present Value)÷(Net Present Value of water delivered).

3.5 Secondary Screening

The five schemes remaining after the initial screening all appear to be viable at this level of investigation and their relative merits are discussed below. Positive and negative aspects of all 8 schemes are summarised in **Table 3.3**.

3.5.1 Impendle Scheme (Scheme 1)

The Impendle Scheme has the highest capital cost, due mainly to the relatively long tunnel. At a discount rate of 8%, it also has the highest URV. As it is the most upstream dam of those evaluated, it has the smallest MAR and consequently a limited yield, when considering long term future demands.

From a technical perspective, there appear to be no obvious difficulties with the dam or conveyances and, with the exception of a low lift pumpstation at Midmar, it is a gravity scheme. It would also be feasible to phase the dam, waterworks and pipeline, although the benefit of this is limited by the fact that the tunnel, which cannot be phased, dominates the capital cost.

The scheme would allow for more centralised operation than the other alternatives, with a single waterworks and pipeline route. However, this also makes the system more vulnerable to possible failure of a major component, such as the clear water conveyance, than would be the case with the other schemes.

3.5.2 Clayborne Scheme (Scheme 2)

The Clayborne Scheme has the second highest capital cost and the third highest URV at an 8% discount rate. It would have a slightly larger utilisable yield than Impendle. However, the scope for phasing would be limited by practical difficulties in increasing the canal capacity.

The scheme requires only limited pumping and there may be scope to supply future irrigators from the canal.

Technically, the scheme is feasible, although there are signs of possible instability on the left flank of the dam site. Also, the canal traverses steep terrain, and will almost certainly encounter stability problems along its route.

The major disadvantage of the scheme is the major ecological and social impacts of a large, long canal, particularly in such steep terrain. The total bench width will be at least 12 m, including the service road. The risk to livestock and human lives in a rural area

such as that which the canal traverses would be significant, as it is unlikely that fencing could be adequately maintained. Extensive maintenance problems could also be anticipated, with significant cost implications and which would require large balancing storage to be provided at the waterworks to ensure continuity of supply. As the scheme would be supplying a very significant proportion of the overall demand, the consequences of loss of supply due to a slope failure along the canal route would be disastrous.

3.5.3 Smithfield-Richmond (Scheme 3A)

The Smithfield-Richmond Scheme has the lowest capital cost, due mainly to its relatively short tunnel (25 km), and the second lowest URV at an 8% discount rate. It would have a larger yield than Impendle, due to the greater MAR, but the topography of the dam site limits the feasible size of the dam. Additional storage would therefore have to be provided elsewhere for future phases.

The scheme has a relatively high pumping head, with associated high running costs. There appear to be no particular technical problems associated with the dam or conveyances.

3.5.4 Smithfield-Baynesfield (Scheme 3B)

This scheme has the second lowest capital cost and the lowest URV at an 8% discount rate. The characteristics of the dam are the same as Scheme 3A, but the pipeline is significantly shorter, with a consequent reduction in environmental impact. Technically, it is very similar to Scheme 3A.

Although the tunnel is significantly longer than Scheme 3A (32 km), with a consequent impact on capital cost, it has a lower pumping head and consequent lower running cost.

3.5.5 Ndonyane Scheme (Scheme 4)

The Ndonyane Scheme has the third highest capital cost and the second highest URV at an 8% discount rate. It would have the largest yield of the five schemes considered.

The main disadvantage of the scheme is the very high pumping head and associated high running cost. This would also make the scheme technically somewhat more complex than the others.

Initial indications are that the Ndonyane dam basin is in a more pristine state than the other three under consideration and its environmental impact will therefore be greater.

3.5.6 Conclusions

Of the eight schemes initially identified, five were found to be viable, representing a relatively diverse range of conveyance configurations. The Net Present Values of costs and Unit Reference Values of the selected schemes are within a 12% range, which is considered small at this level of comparison. It was therefore not considered appropriate to eliminate any of these schemes on the grounds of economics at this stage, but rather to investigate them further, with cognisance being taken of possible phasing.

Of the other factors affecting the viability of the schemes, the most significant was considered to be the social and environmental impacts of the Clayborne Scheme canal. However, it was decided that a decision in this regard should be left to the Environmental Task Group (ETG) nominated for the Study.

TABLE 3.3: SCHEME COMPARISON: SCHEME IDENTIFICATION PHASE

SCHEME	ADVANTAGES	DISADVANTAGES
1: Impendle	C Very limited pumping C Probably least impact on estuary C Least impact of conveyance and waterworks C Centralised system simplifies operation	C Highest capital cost and Unit Reference Value C Yield limited by MAR C Centralised system entails greater risks
2: Clayborne	C Limited pumping C Scope for supplying irrigation along canal route	C Second highest capital cost and third highest URV C Limited scope for phasing of canal C High social and environmental impacts of canal C High maintenance costs of canal
3A: Smithfield-Richmond	C Lowest capital cost and second lowest URV C Greater yield than Impendle	C Relatively high pumping head C Maximum size limited by topography C Second dam required for future phases
3B: Smithfield-Baynesfield	C Second lowest capital cost and lowest URV C Greater yield than Impendle C Low pumping head	C Maximum size limited by topography C Second dam required for future phases
4: Ndonyane	C Potentially highest yield of schemes evaluated	C Very high pumping head C Relatively high capital cost and second highest URV C Dam basin relatively pristine
5: Winters Valley-Lovu	C Low capital cost	C Very high pumping head C Inadequate assurance of supply for scheme to be viable
6: Inzinga-Mgeni		C Inadequate yield vs. capital cost for scheme to be viable
7: Impendle Pipeline	C Low capital cost	C Unacceptably high pumping head C Unacceptable negative impact on receiving stream C Low yield

Note: 1. Shading indicates schemes which were eliminated from further investigation and points considered critical are underlined.

4. PRE-RECONNAISSANCE ASSESSMENT

*Note that all relevant supporting data for this phase of the Study is included in **Appendix B**.*

4.1 Review of Schemes

4.1.1 General

This phase of the Study concentrated on refining the five schemes selected in the Scheme Identification phase, with particular emphasis on phasing of schemes. During the Scheme Identification phase it became clear that the tunnel costs dominated three of the five schemes. Emphasis was therefore also placed on the review of tunnel alignments and unit rates for tunnels in this phase.

The revised scheme particulars are given in **Appendix B1** and are summarised in Sections 4.1.3 to 4.1.7 below.

4.1.2 Hydrology and Yield Analyses

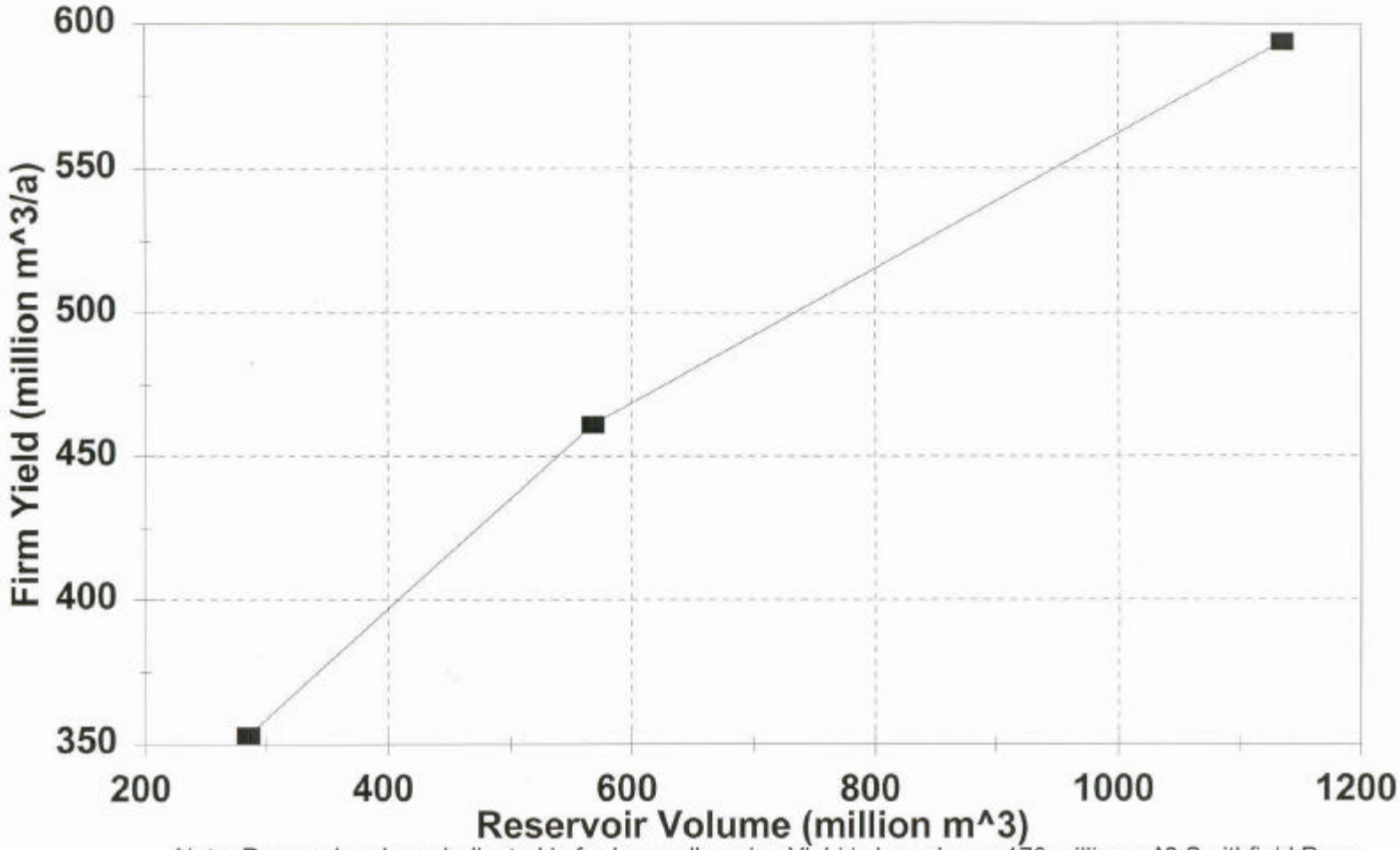
The same hydrology and catchment characteristics used in the Scheme Identification phase were utilised in this phase. However, with the phased Smithfield schemes, it was necessary to determine the yield for a combination of dams in addition to the yield of the individual dams, as previously determined. BKS were requested to carry out the analysis, assuming a first phase dam at Smithfield, from which all transfers would take place, augmented by a second dam at Impendle, from where water would be released down river to Smithfield. The results of the analysis are shown in **Figure 4.1**.

4.1.3 Impendle Scheme (Scheme 1)

The revised Impendle Scheme consists of a rockfill dam with a clay core and side channel spillway, implemented in three phases by raising with capacities of 58, 200 and 680 million m^3, yielding 115, 200 and 380 million m^3/a respectively. It was assumed that 40 million m^3/a of the third phase yield would be released for Instream Flow Requirements (IFR).

The waterworks and pumpstation would also be implemented in three phases, but the pipeline would be implemented in only two phases, due mainly to space constraints along the Northern Feeder route.

FIGURE 4.1: HISTORICAL FIRM YIELD
Smithfield & Impendle combined



Note: Reservoir volume indicated is for Impendle only. Yield is based on a 170 million m^3 Smithfield Dam plus Impendle

The tunnel alignment was reviewed, using 1:50 000 scale mapping and more accurate inlet and outlet levels. This allowed the tunnel to be shortened by approximately 3,7 km.

4.1.4 Clayborne Scheme (Scheme 2)

Potential fatal environmental and social flaws with the Clayborne Scheme were identified at Scheme Identification Phase. In addition, the practicality of phasing the canal was doubtful and the potential stability problems on the left flank of the dam site were of concern, particularly for a larger dam. There was also little scope for revising the tunnel route. It was therefore not considered worthwhile reviewing this scheme, but rather to accept the layout as determined in the first phase of the Study.

4.1.5 Smithfield-Richmond (Scheme 3A)

Due to the presence of a neck to the north of the proposed Smithfield Dam site, the maximum practical capacity that can be attained at the site is limited to approximately 170 million m^3. Consequently, for further phasing, additional storage has to be provided at some point upstream of Smithfield and Impendle was identified as the preferred site.

The revised scheme therefore consists of a 170 million m^3 capacity first phase dam at Smithfield, with a 560 million m^3 second phase dam at Impendle, with total yields of 200 and 460 million m^3/a. It was assumed that 50 million m^3/a of the second phase yield would be released for the IFR. Both dams would be clay cored rockfill with side channel spillways. In the second phase, water would be released down river from Impendle.

The conveyance routes and waterworks would be as described in Section 3.1.3. The pumpstation, waterworks and pipelines would be constructed in two phases to match the scheme yields. No significant revisions of the conveyance routes were possible and the tunnel length remained unchanged.

4.1.6 Smithfield-Baynesfield (Scheme 3B)

The configuration of the dams for this scheme is identical to Scheme 3A. As with Scheme 3A, no significant revisions of the conveyance routes were possible and the tunnel length remains unchanged. The pumpstation, waterworks and pipelines would be constructed in two phases to match the scheme yields.

4.1.7 Ndonyane (Scheme 4)

The revised Ndonyane Scheme consists of a rockfill dam with a clay core and side channel spillway, implemented in two phases, with a capacity of 160 million m^3 initially, raised to provide 560 million m^3 ultimately, yielding 200 and 460 million m^3/a respectively. It was assumed that 50 million m^3/a of the second phase yield would be released for the IFR. The conveyance routes remain unchanged, but the pumpstation, waterworks and pipelines would be constructed in two phases to match the scheme yields.

4.2 Scheme Comparison

4.2.1 Engineering, costing and economics

Cost estimates for the various scheme components are given in **Appendix B2** and are summarised in **Table 4.1** and results of the economic analysis are given in **Appendix B3** and summarised in **Table 4.2**. The basis for the cost estimates was generally the same as in the Scheme Identification phase. However, tunnel costs were re-calculated using escalated unit rates from the Mooi-Mgeni Transfer Scheme study, which were based on Midmar Tunnel tendered rates. Assumptions for the economic analyses were the same as for the Scheme Identification phase, but analyses were carried out with the original water demands both for all phases of the schemes and for the first phase schemes only. In addition, the schemes were evaluated assuming a lower (2,5% p.a.) growth in demand. As can be seen from **Table 4.2**, the relative ranking of the schemes in terms of URV's remains unaffected. The schemes are discussed individually below:

<u>Impendle</u>

The engineering characteristics of the scheme are largely the same as described under the Scheme Identification Phase, as are its advantages and disadvantages. The only potential technical difficulty which could be anticipated would be the raising of the dam twice. This will be addressed in more detail in the Pre-Feasibility phase of the Study, but it should be noted that the incremental cost of constructing the dam to its Phase 2 height in the first phase amounts to less than 5% of the total capital cost of Phase 1 and would have a minimal effect on the Unit Reference Value of the scheme.

In the cost estimates, it was assumed that the spillway would be replaced in its entirety with each of the raisings and that the outlet conduit would be constructed to its full length as part of the first phase.

The Impendle Scheme has the second lowest capital cost of the phased schemes, but the third lowest URV at an 8% discount rate, due to its lower yield.

Clayborne

As indicated in Section 3.4.2. the Clayborne Scheme has a number of technical and, in particular, environmental drawbacks, the latter being discussed in detail in Section 4.2.2 below. Technically, the canal is problematic, as the terrain which the route traverses is far from ideal for a canal. The side slopes are generally steep, and with a bench width of approximately 12 m, high cuts will be required. An inspection of sections of the route indicated that the stability of such cuts is likely to be a problem and it should be noted that any significant slope failure would render the scheme unserviceable for several days at least, with a loss of supply to the Mgeni system of 550 Ml/day. The only means of reducing this risk would be to provide a large volume of storage at the downstream end of the canal, which would make the scheme even less economically attractive.

The capital cost of the scheme is the lowest, as it only has one phase, but its URV is the highest of all the schemes considered.

Smithfield - Richmond

The engineering characteristics of the individual components of the scheme are as in the Scheme Identification Phase, with the obvious difference being the second phase dam at Impendle. There are no obvious technical difficulties, but the environmental impact of two dams will obviously be greater than would be the case with a single dam.

The basis for the cost estimates was unchanged, except for the tunnel, where rates as for the Impendle tunnel were used.

The Smithfield-Richmond Scheme has the third lowest capital cost of the phased schemes, but the second lowest URV at an 8% discount rate, due to its higher yield.

Smithfield-Baynesfield

Technically this scheme is very similar to the Smithfield-Richmond Scheme and cost estimates were calculated on the same basis.

The Smithfield-Baynesfield Scheme has the lowest total capital cost and URV for all phases of the phased schemes.

Ndonyane

The engineering characteristics of the scheme are largely the same as described under the Scheme Identification Phase, as are its advantages and disadvantages. The main potential technical difficulties which could be anticipated would be the raising of the dam and hydraulic problems associated with the very high pumping head. A preliminary site inspection by G Davis (see **Supporting Report No 6: Engineering Design & Costing**)

indicated that geological conditions are less favourable than the Impendle and Smithfield sites.

As with the Impendle Scheme, it was assumed in the cost estimates that the spillway would be replaced in its entirety with the raising and that the outlet conduit would be constructed to its full length as part of the first phase. Revised tunnel rates were also used.

The capital cost of the scheme is the highest, 13% more than the next highest. The URV at an 8% discount rate is also the highest of the phased schemes.

TABLE 4.1: COST ESTIMATES: PRE-RECONNAISSANCE PHASE

SCHEME	COMPONENT	CAPITAL COST ® 000)			RUNNING COSTS ® 000)
		Phase 1	Phase 2	Phase 3	
1: Impendle		**(2004)**	**(2012)**	**(2018)**	
	Dam	111 950	121 150	293 650	
	Tunnel	635 950	-	-	
	Pumpstation	5 290	5 290	6 900	
	Waterworks	135 700	88 550	177 100	
	Pipelines	225 400	293 250	-	
	TOTAL	**1 114 290**	**508 240**	**477 650**	**629 180**
2: Clayborne		**(2004)**			
	Dam	248 800			
	Canal	395 600			
	Pumpstation	11 370			
	Tunnels	349 600			
	Waterworks	241 500			
	Pipelines	210 450			
	TOTAL	**1 457 320**			**664 430**
3A: Smithfield-Richmond		**(2004)**	**(2018)**		
	Dam	205 100	321 250		
	Tunnel	440 450	-		
	Pumpstation	53 360	53 360		
	Waterworks	241 500	241 500		
	Pipelines	250 700	250 700		
	TOTAL	**1 191 110**	**866 810**		**1 603 740**
3B: Smithfield-Baynesfield		**(2004)**	**(2018)**		
	Dam	205 100	321 250		
	Tunnel	512 900	-		
	Pumpstation	37 950	37 950		
	Waterworks	241 500	241 500		
	Pipelines	144 900	144 900		
	TOTAL	**1 142 350**	**745 600**		**829 699**
4: Ndonyane		**(2004)**	**(2018)**		
	Dam	488 000	430 500		
	Tunnel	264 500	-		
	Pumpstation	74 060	74 060		
	Waterworks	241 500	241 500		
	Pipelines	250 700	250 700		
	TOTAL	**1 318 760**	**996 760**		**2 551 060**

Note:
1. Costs are based on an August 1997 base date.
2. Costs include engineering fees (15%) but exclude VAT.
3. Dam costs include R5 million for social and environmental costs.
4. Running costs given are for full evaluation period for all phases.
5. Numbers in brackets indicate year of commissioning.
6. Costs are as used in the economic analysis and may differ slightly from those in Appendix B2 due to rounding-off.

TABLE 4.2: ECONOMIC COMPARISON: PRE-RECONNAISSANCE PHASE

SCHEME	WATER TRANSFER (ALL PHASES) $m^3 \times 10^6/a$	URV (ALL PHASES) @ DISCOUNT RATE (c/m^3)			WATER TRANSFER (1ST PHASE) $m^3 \times 10^6/a$	URV (1ST PHASE) @ DISCOUNT RATE			URV (WATER DEMAND GROWTH = 2,5%) @ DISCOUNT RATE		
		6%	8%	10%		6%	8%	10%	6%	8%	10%
1: Impendle	340	67,2	94,4	128,4	115	96,9	133,3	176,7	90,2	132,6	188,6
2: Clayborne	200	82,6	116,4	158,5	200	82,6	116,4	158,5	-	-	-
3A: Smithfield-Richmond	411	65,6	90,6	122,7	200	72,1	100,1	134,9	85,8	125,0	177,7
3B: Smithfield-Baynesfield	411	57,2	81,2	112,3	200	64,9	92,0	125,9	76,1	113,7	164,5
4: Ndonyane	414	78,0	105,5	140,7	200	84,5	115,1	153,1	100,4	143,6	201,4

Note: 1. All costs are based on an August 1997 base date.
2. Costs exclude VAT.
3. Water transfer figures are based on scheme yields.
4. Analysis period of 50 years from commissioning date of schemes (2004).
5. Unit Reference Value = (Net Present Value)÷(Net Present Value of water delivered).

4.2.2 Environmental

The pre-reconnaissance environmental assessment comprised a site visit and an initial scoping exercise.

During the site visit the initial environmental status of each dam basin was assessed. The basic characteristics of the dam options were noted and the feasibility assessed in terms of the topography, initial environmental status assessment and visible social aspects. Findings of the site visit were conveyed to the scoping exercise.

The scoping exercise involved the convening of an Environmental Task Group (ETG) attended by affected parties capable of providing technical input and having sufficient experience to review environmental reports and recommend the scope of environmental work required.

The ETG was presented with appropriate background information on the engineering aspects of the project and technical and environmental characteristics of the schemes. A comparison of the five schemes was undertaken on the basis of a number of characteristics as follows:

- area to be inundated (using worst case inundation scenarios),
- impacts on basin and riverine biota,
- conceptual impacts on downstream river system and environment,
- conceptual impacts of associated infrastructure,
- basic functioning of schemes,
- cumulative impacts of scheme phasing.

The Task Group concluded that:

- The Clayborne scheme should not proceed due to the extent of the impact on the environment of the local area, its biota and human population. This was largely due to the extensive reliance of the scheme on open canals to convey water. It was agreed that due to the generally steep topography of the area, the canals would have a significant and unacceptable impact on the movement and migration of humans and natural fauna in the area, as well as significant negative aesthetic impacts.

- The Ndonyane Dam may result in the inundation of a valuable and important resource base, being important rapids for river rafters and canoeists, valuable and unique flora and fauna and aesthetic value.

It was clearly stated, however, that the value of the resource base would need to be investigated further through a Habitat Integrity Assessment. This assessment would need to be undertaken before the Task Group would be in the position to recommend the rejection of the scheme.

4.3 Selection of Schemes for Reconnaissance Investigation

The advantages and disadvantages of the various schemes are listed in **Table 4.3**. On the basis of the Pre-Reconnaissance investigations, the Clayborne Scheme was eliminated from further investigation, for environmental and economic reasons. There were no aspects of this scheme identified which, with more detailed investigation, were likely to render it more attractive than the Impendle and Smithfield Schemes.

In the case of the Ndonyane Scheme, the scheme was found to be the least economical of the phased schemes and concern was expressed about the probable negative environmental impact of the dam. However, a final decision on its elimination was to be dependent on a Habitat Integrity Assessment to be carried out in the Reconnaissance phase of the study.

The following schemes were therefore selected for further investigation at reconnaissance level, as ratified by the ETG and Stakeholder Committee:

- Impendle Scheme
- Smithfield-Richmond Scheme
- Smithfield-Baynesfield Scheme
- Ndonyane Scheme (Habitat Integrity Assessment only, except if the technical or economic viability of the other schemes change significantly)

TABLE 4.3: SCHEME COMPARISON: PRE-RECONNAISSANCE ASSESSMENT PHASE

SCHEME	ADVANTAGES	DISADVANTAGES
1: Impendle	C Very limited pumping C Probably least impact on estuary C Least environmental impact of conveyance and waterworks C Centralised system simplifies operation	C Third highest URV C Yield limited by MAR C Centralised system entails greater risks
2: Clayborne	C Limited pumping C Scope for supplying irrigation along canal route	C Highest URV C Limited scope for phasing of canal C Unacceptably high social and environmental impacts of canal C High maintenance costs of canal and risk of interruption of supply due to instability C Possible instability on dam site
3A: Smithfield-Richmond	C Second lowest URV C Greater yield than Impendle	C Relatively high pumping head C Maximum size limited by topography C Second dam required for future phases
3B: Smithfield-Baynesfield	C Lowest URV C Greater yield than Impendle C Low pumping head	C Maximum size limited by topography C Second dam required for future phases
4: Ndonyane	C Potentially highest yield of schemes evaluated	C Very high pumping head C Highest capital cost and second highest URV C Dam probably has greatest environmental impact

Note: 1. Shading indicates schemes which were eliminated from further investigation and points considered critical are underlined.

5. RECONNAISSANCE INVESTIGATION

*Note that all relevant supporting data for this phase of the Study is included in **Appendix C**.*

5.1 Water Demands and Water Resources

During the course of the earlier phases of this Study, a review of water demands in the Mgeni System for various scenarios was carried out by Umgeni Water as part of their Infrastructure Bulk Services Masterplan. The revised figures were reviewed and found to be slightly higher than those assumed for the Study, but the differences were small and would not affect the relative economics of the selected schemes. However, the revised figures will be utilised in the Pre-Feasibility Phase.

The yield analyses carried out for the Scheme Identification and Pre-Reconnaissance phases were considered adequate for this phase of the Study and no further analysis was carried out.

5.2 Engineering and Geotechnical Aspects

A number of modifications were made to the selected schemes in this phase of the Study and various aspects were investigated in more detail. The revised scheme details are provided in **Appendix C1** and the layouts are shown in **Figure 5.1** at the end of this section.

Initially, Umgeni Water indicated that their preferred point for delivery of clear water at Umlaas Road was near the existing reservoir at an elevation of approximately 840 masl. After studying topographical maps of the area, it was found that water would gravitate to the Durban system from a significantly lower elevation and a reservoir site on the southern side of the N3 freeway at an elevation of 804 masl was identified. Umgeni Water indicated that they had no objection to this revised site after consultation and approval from Durban Metro.

In the initial phases of this Study, it was assumed that clear water would be delivered at a constant rate to Umlaas Road, and all scheme components were sized accordingly. However, considering the significant proportion of the total Mgeni System demand which the proposed schemes will supply, it was considered appropriate to make allowance for a peak demand factor of 25%. In the case of all schemes this has an impact on the sizing of the pumpstations, waterworks and pipelines. In the case of the Impendle Scheme, the peak raw water demand is balanced by Midmar Dam and the tunnel would not be

subjected to peaks, but in the case of the Smithfield Schemes, the capacity of the raw water tunnels had to be checked for the peak flows.

To facilitate the operation of the schemes, raw water balancing storage is required. In the case of the Smithfield-Richmond Scheme, an embankment dam with a capacity of 0,5 million m^3 was provided on the Lovu River, at a position to match the tunnel portal elevation. Similarly, with the Smithfield-Baynesfield Scheme, balancing storage of 0,5 million m^3 is provided on the Mlazi River. The positions of the Richmond and Baynesfield waterworks were also revised to suit the locations and elevations of the balancing dams. The topography in the Richmond area is generally relatively steep and a substantial quantity of earthworks will be required for the waterworks.

With the revision of the waterworks positions and elevations, the revised delivery point elevation and the higher peak flows, it was necessary to significantly revise the designs of the pipelines for the Smithfield schemes. Using 1:50 000 mapping, augmented by 1:10 000 orthophotos in problem areas, the pipeline routes were reviewed. In the case of the Richmond-Umlaas Road pipeline, a problem area was identified where deep excavations will be required. In both cases, 1 900 mm diameter pipelines will be required for each phase, which will be laid parallel. The available head for the Midmar-Umlaas Road pipeline component of the Impendle Scheme is such that no revisions to the route were required. The required first phase pipe diameter is 1 400 mm and the second phase 1 900 mm. The latter also services the third phase, i.e. only two pipelines are required. Note that these pipelines will be in addition to the planned 1 400 mm diameter Northern Feeder pipeline.

No significant changes were required to the Impendle Dam. However, a preferred site approximately 1,5 km upstream of the original Smithfield site was identified. This site allows a reduction of approximately 50% in fill volume and a chute spillway can be provided on the left flank. A preliminary design was carried out for this site and geotechnical investigations were also concentrated on this alignment.

The impact of the schemes on existing infrastructure was also evaluated. Two roads are affected by Impendle Dam, one of which will have to be relocated to a higher elevation and another, which crosses the basin, will have to relocated, possibly across the dam wall. Only local telephone and power lines to affected properties are affected. In the case of Smithfield Dam, one road would have to relocated and the embankment of the main road between Pietermaritzburg and Bulwer at Lundy's Hill will be partially inundated and will require protection. In addition, telephone lines and a power line will have to be relocated. The estimated cost of the relocation of this infrastructure is approximately R8 million in both cases. Ponts may also have to be provided to allow additional crossing points across the reservoirs.

The costs for the provision of access roads, electricity and related infrastructure for construction are likely to be similar for the two schemes.

A preliminary assessment of possible spin-off development in the form of water supply to and electrification of rural communities in the vicinity of the dams indicates that a larger population could be served from the Impendle Scheme. This aspect will be considered in more detail in the Pre-Feasibility phase.

A reconnaissance level geotechnical investigation was carried out by the Council for Geoscience on the dam sites and tunnel routes, using previous reports, regional geological data and aerial photography, augmented by information gathered during site visits. The findings are summarised as follows:

Impendle

The dam site is also roughly symmetrical; the river section is approximately 40 m wide and the flanks moderately steep. An unweathered dolerite sill, with a minimum thickness of 35 m, outcrops within the river section. The flanks are essentially underlain by sedimentary strata. On the left flank, weathering of the siltstones extends to depths of 7,5 - 11 m. The right flank is mainly covered with dolerite talus with a thickness up to 9 m, while the underlying siltstones are weathered to depths from 16 m to more than 30 m.

With the exception of the approaches to the outlet portal which will be within strata of the Volksrust Formation, the 35 km long transfer tunnel will be driven within the younger rocks of the Estcourt Formation; predominantly comprising siltstones, although interbedded mudstone and sandstone horizons also occur. Intrusive dolerites are expected to comprise 11% of the tunnel alignment.

Smithfield

The dam site is roughly symmetrical, comprising a 60 m wide river section with flanks rising steeply to a level approximately 25 - 30 m above river level, above which the slopes are gently sloping. The river section is underlain by sedimentary strata of the Volksrust Formation, predominantly comprising siltstones, which are visible at surface. The steeper flanks are underlain by a dolerite sill, while the gently sloping upper slopes are again underlain by siltstones. Depths of weathering on the flanks are expected to be moderate.

Indications are that there would be sufficient suitable material (dolerite) present upstream of the dam on the left flank for rockfill and concrete aggregate. The presence of suitable material for a clay core will have to be confirmed.

The 32 km long Smithfield-Baynesfield transfer tunnel is expected to mainly be driven within rocks of the Volksrust Formation (69%), which almost exclusively comprises mudrocks (predominantly siltstone), but will also intersect strata of the older Vryheid Formation (14%) which comprises sandstone with interbedded siltstone, and the Pietermaritzburg Formation (17%), a relatively homogeneous unit comprising siltstone with interbedded mica-rich horizons. These sedimentary strata have all been intruded by dolerites, in the form of dykes and sills.

Similarly, the shorter 25 km Smithfield-Richmond transfer tunnel will predominantly be driven within the Volksrust Formation (60%), and the Vryheid Formation (40%). These sedimentary strata have also been intruded by younger dolerites.

5.3 Environmental and Social Aspects

The Reconnaissance Investigation comprised the compilation of an Initial Environmental Assessment (ROIP) for each of the dams, a Habitat Integrity Assessment and a further scoping exercise. Details are provided in **Supporting Report No 5: Environmental**.

5.3.1 Initial Environmental Assessment (ROIP)

Separate Initial Environmental Assessments (ROIPs) were undertaken by the DWAF Sub-Directorate Environment Studies for the Impendle and Smithfield Schemes (DWAF, 1997a and 1997b). These were based on a number of visits to the sites, available literature and findings from the scoping exercise carried out during the first meeting of the Environmental Task Group. A separate and superficial scoping exercise compared the conveyance routes and related infrastructure, and the findings were that the impacts could be relatively easily mitigated.

The prominent findings of the ROIPs are as follows:

Smithfield Schemes

Both Smithfield Schemes involve the same basin and area of inundation, the differences between the two schemes being their conveyance routes to Umlaas Road. It was therefore appropriate to group these together.

A number of potential red flags were raised for the social aspects, particularly with regard to potential land restitution claims, the loss of important resources and 200 hectares of arable land, the inundation of five dwellings, the disruption of existing access routes and the potential loss of some archaeological sites. The introduction of water borne diseases which may accompany changes in the flow regime of the river was also identified. An overall socio-economic assessment of the Smithfield schemes rated them as generally problematic.

The major ecological issue raised was that of the change in the downstream flow regime due to the impoundment of the river and the future functioning of the river during further phases of the scheme. The loss of some evidently rare and threatened species within the dam basin also appears likely.

Nine social and ecological recommendations were listed for the Pre-Feasibility investigations. These would need to be addressed to determine the acceptability of the scheme.

Impendle Scheme

The social aspects of this scheme are particularly significant. The anticipated resource loss to the social community is considerable: The anticipated loss of 1 070 hectares of arable land could affect some 3 000 people and the inundation of the entire Rockleigh Lodge settlement area, which would require the relocation of 400 to 500 people. Other aspects are the loss of archaeological sites and the loss of important recreational areas for river rafting and canoeing. An overall socio-economic assessment rated the potential impacts of this scheme as severe.

Ecological aspects listed were those of the extent of modification of runoff in the catchment from a state which is currently relatively undeveloped, the impacts on the downstream environment and the loss of sensitive habitats for flora and fauna of conservation significance.

Eleven social and ecological recommendations were listed for Pre-Feasibility investigations and five for the feasibility phase.

Overall assessment

The overall assessment is that the social impacts of the Impendle Scheme dominate and are severe. Mitigation may be problematic, but feasible. While the Smithfield schemes are also socially problematic, these impacts could be successfully mitigated.

The Smithfield Scheme appears to be the more problematic from an ecological perspective due to the potentially larger impacts on the downstream environment as a consequence of the operation of the scheme and the inundation of a second basin during the further phase.

5.3.2 Ndonyane Habitat Integrity Assessment

The Habitat Integrity Assessment was conducted by means of a low-level helicopter survey and an assessment of the status of habitats in the Ndonyane basin available to fauna and flora. A continuous video of the dam basin was also taken during the helicopter survey, which was presented to the second meeting of the Environmental Task Group as part of the further scoping exercise.

The Habitat Integrity Assessment confirmed that the Ndonyane Dam basin has a valuable and important resource base which exceeds that of the other schemes. The dam basin contains large quantities of indigenous flora (unlike the other dam sites which are largely infested with exotic species) and extensive challenging and important river rafting rapids and channels. It is also an area of exceptional scenic and aesthetic value.

5.3.3 Further scoping

During the second meeting of the Environmental Task Group, the findings of the ROIPs and the Habitat Integrity Assessment were presented. Recommendations were made regarding the elimination of the Ndonyane and Smithfield-Richmond Schemes and a number of specific requirements for further study during the Pre-Feasibility Phase were identified.

5.4 Costing and Economic Analyses

Revised cost estimates were carried out for the schemes. Much of the approach was the same as in the previous phase of the Study, with tunnel and dam costs remaining unchanged. The basis for the calculation of pumpstation capital and running costs was also unchanged, but the capacities were increased to meet peak demands.

Of the various scheme components, changes to pipeline costs had the greatest impact on overall costs for this phase of the Study. This was brought about firstly by the larger pipe diameters required to meet peak demands and secondly, the revised unit rates which were used. These rates were based on average all-in rates derived from actual contracts and a number of other studies undertaken recently.

Detailed cost estimates are given in **Appendix C2** and are summarised in **Table 5.1**.

Economic analyses were carried out on the three schemes in the same manner as in the earlier phases of the Study and the results are given in **Appendix C3** and summarised in **Table 5.2**.

TABLE 5.1: COST BREAKDOWNS: RECONNAISSANCE PHASE

SCHEME	COMPONENT	CAPITAL COST ® 000)		
		Phase 1	Phase 2	Phase 3
1: Impendle		**(2004)**	**(2012)**	**(2018)**
	Dam	111 950	121 150	293 650
	Tunnel	633 650	-	-
	Pumpstation	5 750	5 750	8 625
	Waterworks	169 625	125 350	207 000
	Pipelines	225 400	377 200	-
	TOTAL	**1 146 375**	**629 450**	**509 275**
3A: Smithfield-Richmond		**(2004)**	**(2012)**	
	Dam	131 500	321 250	
	Tunnel	432 400	-	
	Pumpstation	100 050	100 050	
	Waterworks	297 850	297 850	
	Balancing Dam	11 500	-	
	Pipelines	350 750	350 750	
	TOTAL	**1 324 050**	**1 069 900**	
3B: Smithfield-Baynesfield		**(2004)**	**(2012)**	
	Dam	131 500	321 250	
	Tunnel	546 250	-	
	Pumpstation	48 185	48 185	
	Waterworks	297 850	297 850	
	Balancing Dam	403	-	
	Pipelines	221 950	221 950	
	TOTAL	**1 246 138**	**889 235**	

Note: 1. Costs are based on an August 1997 base date.
2. Costs include engineering fees (15%) but exclude VAT.
3. Dam costs include R5 million for social and environmental costs.
4. Numbers in brackets indicate year of commissioning.
5. Costs are as used in the economic analysis and may differ slightly from those in Appendix A2 due to rounding-off.

TABLE 5.2: ECONOMIC COMPARISON: RECONNAISSANCE PHASE

SCHEME	COMMISSIONING DATE			CAPITAL COST (All phases) (R000)	RUNNING COST (All phases) (R000)	NET PRESENT VALUE OF COSTS (R000) @ DISCOUNT RATES			UNIT REFERENCE VALUE (c/m^3) @ DISCOUNT RATES		
	Ph 1	Ph 2	Ph 3			6%	8%	10%	6%	8%	10%
1. Impendle	2004	2012	2018	2 285 000	712 000	1 463 000	1 234 000	1 062 000	72,3	101,0	136,7
3A. Smithfield-Richmond	2004	2018	-	2 394 000	1 954 000	1 660 000	1 352 000	1 136 000	75,4	103,2	138,6
3B. Smithfield-Baynesfield	2004	2018	-	2 135 000	1 200 000	1 440 000	1 201 000	1 029 000	65,4	91,7	125,5

Note: 1. All costs are based on an August 1997 base date.
2. Costs exclude VAT.
3. Costs, NPV's and URV's are for all phases of schemes.
4. Analysis period of 50 years from commissioning date of schemes (2004).
5. Unit Reference Value = (Net Present Value)÷(Net Present Value of water delivered).

5.5 Recommendations for Pre-Feasibility Study

The main advantages and disadvantages of the schemes are summarised in **Table 5.3**.

The Reconnaissance Study confirmed that all three schemes selected in the pre-reconnaissance phase are technically feasible, although the Smithfield-Richmond Scheme has some drawbacks in the form of deep excavations on the pipeline route, a steep waterworks site and a relatively high pumping head.

From an environmental perspective, the Impendle Dam has a greater social impact than Smithfield, but a lesser ecological impact. The main ecological impact of both dams would be on the ecology of the river downstream of the dams caused by changes in the flow regime. Neither of these dams are deemed to have fatal environmental flaws, although some red flags were raised. Clearly, the Smithfield Schemes would have a greater impact, as they would require both dams to be built. These issues will be addressed in more detail during the Pre-feasibility Phase of the Study.

The Habitat Integrity Assessment carried out on the Ndonyane Dam, which was provisionally eliminated from further investigation pending the outcome of this assessment, indicated that the dam basin has a valuable resource base which would be destroyed. Taking these environmental factors into account, along with the scheme's technical problems and its poor economic ranking, the elimination of the scheme from further study was confirmed.

The impact of the conveyances and waterworks of the Smithfield schemes would be greater than the Impendle Scheme, as they affect more greenfield areas, but these could be mitigated relatively easily.

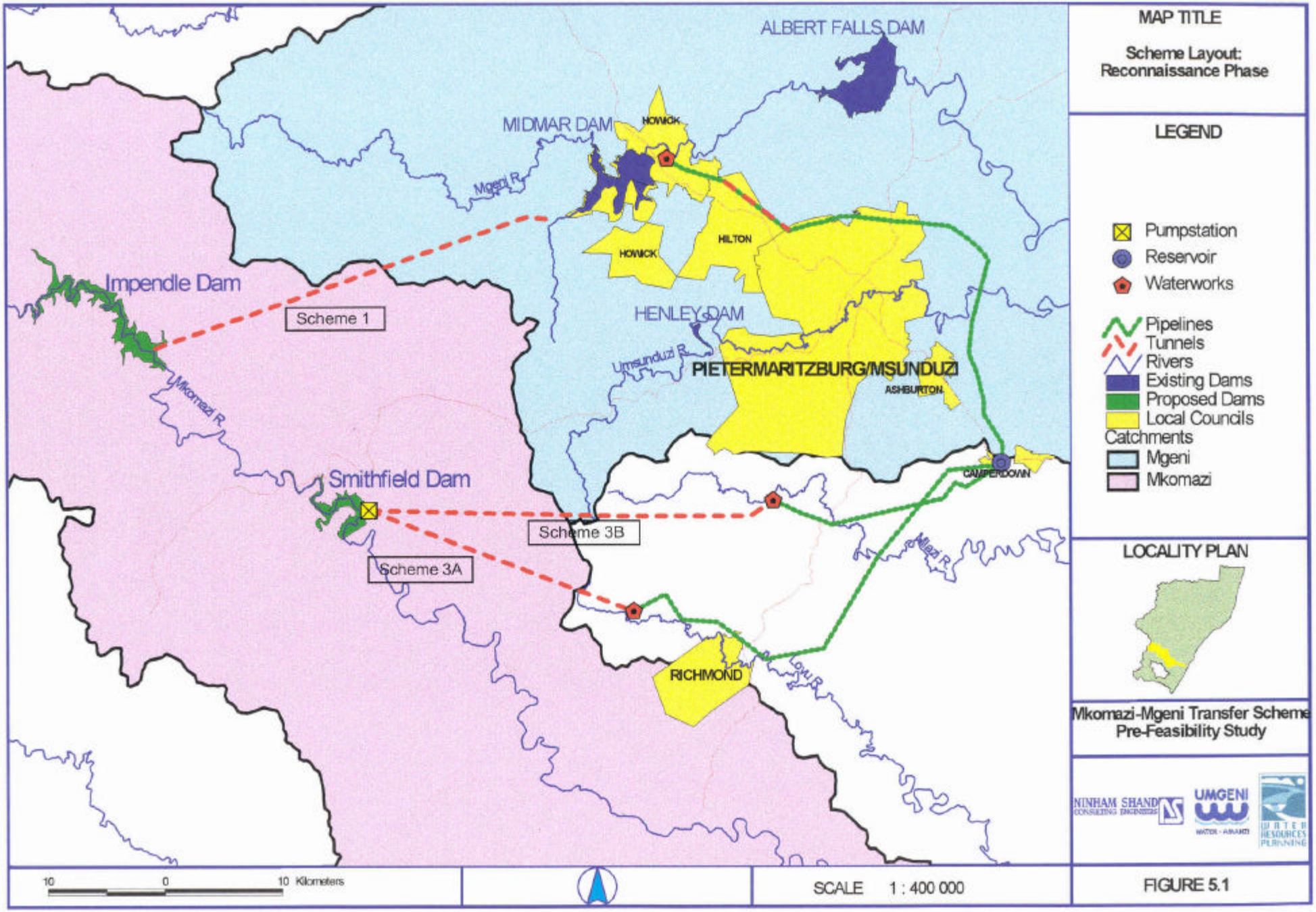
The NPVs and URVs of the three schemes were found to be within a small range, and the Impendle Scheme moves from third to second most economical, albeit by a small margin. It is unlikely that the Smithfield-Richmond Scheme would become more attractive economically, in view of its technical problems, which were not taken into account in the cost estimates.

In view of the above, it was recommended that the Impendle and Smithfield-Baynesfield Schemes should be investigated in the Pre-Feasibility phase of the Study. There was insufficient difference between these two schemes to be in a position to select one or the other at this level of study detail. This decision was ratified by the ETG and the Stakeholder Committee.

TABLE 5.3: SCHEME COMPARISON: RECONNAISSANCE PHASE

SCHEME	ADVANTAGES	DISADVANTAGES
1: Impendle	C Very limited pumping C Low running costs C Impact of waterworks and conveyance system minimised by using Midmar site and northern feeder C Infrastructure is centralised: Ease of operation C More scope for spin-off development of rural areas C Second lowest Unit Reference Value (URV)	C Yield limited by Mean Annual Runoff C Probable technical difficulties in raising dam C Relatively high initial capital cost C Vulnerability of centralised infrastructure
3A: Smithfield-Richmond	C Larger yield than Impendle Scheme C Would create more permanent employment than Impendle Scheme	C Requires two dams: Greater environmental impact C Requires major excavation at high point on pipeline route C Waterworks site not ideal topographically C Relatively high pumping head C Highest URV
3B: Smithfield-Baynesfield	C Larger yield than Impendle C Relatively low pumping head and running costs C Pipeline route and waterworks site not problematic C Lowest URV C Would create more permanent employment than Impendle Scheme	C Requires two dams: Greater environmental impact

Note: 1. Shading indicates schemes which were eliminated from further investigation.


ALBERT FALLS DAM
MIDMAR DAM
HOWICK
Mgeni R.
HILTON
HOWICK
Impendle Dam
Scheme 1
HENLEY DAM
Umsunduzi R.
PIETERMARITZBURG/MSUNDUZI
ASHBURTON
Mkomazi R.
CAMPERDOWN
Smithfield Dam
Scheme 3B
Scheme 3A
Mlazi R.
RICHMOND
Lovu R.
10 0 10 Kilometers
SCALE 1 : 400 000
MAP TITLE
Scheme Layout:
Reconnaissance Phase
LEGEND
Pumpstation
Reservoir
Waterworks
Pipelines
Tunnels
Rivers
Existing Dams
Proposed Dams
Local Councils
Catchments
Mgeni
Mkomazi
LOCALITY PLAN
Mkomazi-Mgeni Transfer Scheme
Pre-Feasibility Study
NINHAM SHAND
UMGENI
WATER RESOURCES PLANNING
FIGURE 5.1

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A P P E N D I C E S

APPENDIX A1

SCHEME DETAILS:
SCHEME IDENTIFICATION PHASE

SCHEME IDENTIFICATION PHASE

SCHEME 1: IMPENDLE - MIDMAR - NORTHERN FEEDER

DAM - IMPENDLE

Minimum Operating Level:	=	1 123 masl
Full Supply Level:	=	1 160 masl
Height:	=	73 m
Scheme Yield	=	200 million m^3/a
Area Flooded at FSL:	=	1 000 ha
Max. Volume of Storage:	=	200 million m^3
Type:		Earth cored rockfill dam with side channel spillway

RAW WATER TRANSFER BY:

Tunnel

From: Impendle Dam at Impendle
To: Midmar Dam
Length: 38,5 km

Canal None

Pumping

From: Midmar Dam
To: Midmar Water Treatment Works } not costed

WATERWORKS

Upgrade of existing Midmar Treatment Waterworks.

CLEAR WATER TRANSFER

Via existing 251 pipeline and Midmar Tunnel to Ferncliffe and then via upgraded Northern Feeder to Umlaas Road.

Length: 35 km (for upgrade of Northern Feeder)

Additional upgrade of 251 Pipeline at Stuckenberg's Ledge will be required.

FEATURES

Gravity scheme making maximum use of existing facilities at Midmar and proposed Northern Feeder.

Impendle Dam is located on dolerite dyke. Existing geological data indicates deep excavation for dam foundation may be required. To be consistent with other schemes and as detailed geological reports are not available at this stage, the deep excavation was not allowed for in preliminary costing.

SCHEME IDENTIFICATION PHASE

SCHEME 2: CLAYBORNE - RICHMOND - UMLAAS ROAD

DAM - CLAYBORNE

Minimum Operating Level:	=	990 masl
Full Supply Level:	=	1 040 masl
Height:	=	84 m
Scheme Yield	=	200 million m^3/a
Area Flooded at FSL:	=	300 ha
Max. Volume of Storage:	=	170 million m^3
Type:		Earth cored rockfill dam with side channel spillway

RAW WATER TRANSFER BY:

Canal

From: Clayborne
To: Lovu River near Richmond
Length: 65 km

Includes two tunnels of 7,5 and 0,5 km and 16 siphons totalling 10,4 km.

Pumping 20 m average static head

WATERWORKS

New Greenfield Waterworks at Riverdale near Richmond.

Approximate elevation of Water Treatment Works is 960 masl.

CLEAR WATER PIPELINE

Richmond Waterworks to Umlaas Road 1 600 dia. gravity pipeline.

Length: 36,5 km

FEATURES

Gravity scheme requiring totally new construction. Anticipate maintenance and operation difficulties for long canal system and geotechnical stability problems for Clayborne dam site, dam basin and canal route. Additional cost due to possible instability not costed.

Small balancing dam required at Riverdale near Richmond.

SCHEME IDENTIFICATION PHASE

SCHEME 3A: SMITHFIELD - RICHMOND - UMLAAS ROAD

DAM - SMITHFIELD

Minimum Operating Level:	=	875 masl
Full Supply Level:	=	907 masl
Height:	=	60 m
Scheme Yield	=	200 million m^3/a
Area Flooded at FSL:	=	650 ha
Max. Volume of Storage:	=	150 million m^3
Type:		Earth cored rockfill dam with side chute spillway in saddle

RAW WATER TRANSFER BY:

Tunnel

From:	Smithfield Dam
To:	Lovu River near Richmond
Length:	25,4 km

Pumping

Maximum Static Head:	85 m
Average Static Head:	65 m

WATERWORKS

New Greenfield Waterworks at Riverdale near Richmond.

Approximate elevation of Water Treatment Works is 960 masl.

CLEAR WATER PIPELINE

Richmond Waterworks to Umlaas Road 1 600 dia. gravity pipeline.

Length: 36,5 km

FEATURES

Smithfield Dam built to maximum available topography and avoids flooding to road to Bulwer at Lundys Hill. Pumping of raw water at Smithfield required.

No obvious stability problems identified.

SCHEME IDENTIFICATION PHASE

SCHEME 3B: SMITHFIELD - BAYNESFIELD - UMLAAS ROAD

DAM - IMPENDLE

Minimum Operating Level:	=	875 masl
Full Supply Level:	=	907 masl
Height:	=	60 m
Scheme Yield	=	200 million m^3/a
Area Flooded at FSL:	=	650 ha
Max. Volume of Storage:	=	150 million m^3
Type:		Earth cored rockfill dam with side chute spillway in saddle

RAW WATER TRANSFER BY:

Tunnel

From:	Smithfield Dam
To:	Umlazi River near Baynesfield
Length:	32 km

Pumping

Maximum Static Head:	25 m
Average Static Head:	5 m

WATERWORKS

New Greenfield Waterworks near Baynesfield.

Approximate elevation of Water Treatment Works is 900 masl.

CLEAR WATER PIPELINE

Baynesfield Waterworks to Umlaas Road 1 600 dia. gravity pipeline.

Length: 21 km

FEATURES

Smithfield Dam built to maximum available topography and avoids flooding of road to Bulwer at Lundys Hill. Pumping of raw water at Smithfield required.

No obvious stability problems identified.

SCHEME IDENTIFICATION PHASE

SCHEME 4: NDONYANE - RICHMOND - UMLAAS ROAD

DAM - NDONYANE

Minimum Operating Level:	=	620 masl
Full Supply Level:	=	680 masl
Height:	=	110 m
Scheme Yield	=	200 million m^3/a
Area Flooded at FSL:	=	400 ha
Max. Volume of Storage:	=	170 million m^3
Type:		Earth cored rockfill dam with side channel spillway

RAW WATER TRANSFER BY:

Tunnel

From:	Ndonyane Dam
To:	Lovu River near Richmond
Length:	14 km
Raise bored shaft:	250 m

Pumping

From:	Ndonyane Dam
To:	Tunnel
Max. Static Head:	340 m
Ave. Static Head:	300 m

WATERWORKS

New Greenfield Waterworks at Riverdale near Richmond.

Approximate elevation of Water Treatment Works is 960 masl.

CLEAR WATER PIPELINE

Richmond Waterworks to Umlaas Road 1 600 dia. gravity pipeline.

Length: 36,5 km

FEATURES

Large high head pumping scheme required at Ndonyane. Raising main (350 m) via raised bored shaft with possible two stage pumping required.

The site of Ndonyane Dam has not been inspected on the ground.

No obvious stability problems identified.

APPENDIX A2

COST ESTIMATES:
SCHEME IDENTIFICATION PHASE

SCHEME IDENTIFICATION PHASE

IMPENDLE DAM (FSL = 1 160)

No	Description	Unit	Rate	Quantity	Amount
1.	Excavation	m3	R 15	400 000	6 000 000
3.	Embankment	m3	R 35	1 798 000	62 930 000
4.	Spillway	Sum			13 000 000
5.	Outlet Works	Sum			21 000 000
	Subtotal A (carried forward)				102 930 000
14.	Miscellaneous Preliminary and General works (% of Subtotal A)	%	15% 25%		15 439 500 25 732 500
	Subtotal B				144 102 000
15.	Contingencies (% of Subtotal B)	%	15%		3 859 875
	Subtotal C				147 961 875
20	Planning design & supervision, fees, time cost & transport (% of Subtotal C)	%	15%		22 194 281
	Subtotal D				**170 156 156**
21.	VAT (% of Subtotal D)	%	14%		23 821 862
	TOTAL PROJECT COST				**193 978 018**

August 1997 Base Date

SCHEME IDENTIFICATION PHASE

NDONYANE DAM (FSL = 680)

No	Description	Unit	Rate	Quantity	Amount
1.	Excavation	m3	R 15	650 000	9 750 000
3.	Embankment	m3	R 35	7 595 000	265 825 000
4.	Spillway	Sum			18 000 000
5.	Outlet Works	Sum			32 000 000
	Subtotal A (carried forward)				325 575 000
14.	Miscellaneous Preliminary and General works (% of Subtotal A)	%	15% 25%		48 836 250 81 393 750
	Subtotal B				455 805 000
15.	Contingencies (% of Subtotal B)	%	15%		12 209 063
	Subtotal C				468 014 063
20	Planning design & supervision, fees, time cost & transport (% of Subtotal C)	%	15%		70 202 109
	Subtotal D				**538 216 172**
21.	VAT (% of Subtotal D)	%	14%		75 350 264
	TOTAL PROJECT COST				**613 566 436**

August 1997 Base Date

SCHEME IDENTIFICATION PHASE

SMITHFIELD DAM (FSL = 907)

No	Description	Unit	Rate	Quantity	Amount
1.	Excavation	m3	R 15	330 000	4 950 000
3.	Embankment	m3	R 35	2 805 000	98 175 000
4.	Spillway	Sum			15 000 000
5.	Outlet Works	Sum			21 000 000
	Subtotal A (carried forward)				139 125 000
14.	Miscellaneous Preliminary and General works (% of Subtotal A)	%	15% 25%		20 868 750 34 781 250
	Subtotal B				194 775 000
15.	Contingencies (% of Subtotal B)	%	15%		5 217 188
	Subtotal C				199 992 188
20	Planning design & supervision, fees, time cost & transport (% of Subtotal C)	%	15%		29 998 828
	Subtotal D				**229 991 016**
21.	VAT (% of Subtotal D)	%	14%		32 198 742
	TOTAL PROJECT COST				**262 189 758**

August 1997 Base Date

SCHEME IDENTIFICATION PHASE

CLAYBORNE DAM (FSL = 1 040)

No	Description	Unit	Rate	Quantity	Amount
1.	Excavation	m3	R 15	400 000	6 000 000
3.	Embankment	m3	R 35	2 843 000	99 505 000
4.	Spillway	Sum			16 000 000
5.	Outlet Works	Sum			26 000 000
	Subtotal A (carried forward)				147 505 000
14.	Miscellaneous Preliminary and General works (% of Subtotal A)	% %	15% 25%		22 125 750 36 876 250
	Subtotal B				206 507 000
15.	Contingencies (% of Subtotal B)	%	15%		5 531 438
	Subtotal C				212 038 438
20	Planning design & supervision, fees, time cost & transport (% of Subtotal C)	%	15%		31 805 766
	Subtotal D				**243 844 203**
21.	VAT (% of Subtotal D)	%	14%		34 138 188
	TOTAL PROJECT COST				**277 982 392**

August 1997 Base Date

TUNNEL COSTS
(Scheme Identification Phase)

Impendle

Item	Unit	Quantity	Rate(R)	Amount (R)
TBM driven tunnel	m	38 560	20 600	794 336 000
Drill & blast access adit	m	3 000	15 000	45 000 000
E/O for downgrade drive	m	12 050	1 030	12 411 500
Inlet and outlet structures	Sum			6 500 000
Sub-total				**858 247 500**
VAT @ 14%				120 154 650
TOTAL				**978 402 150**

Clayborne

Item	Unit	Quantity	Rate(R)	Amount (R)
TBM driven tunnel	m	7 500	20 600	154 500 000
Drill & blast tunnel	m	500	25 000	12 500 000
Transitions	Sum			10 800 000
Portal structures	No	3	500 000	1 500 000
Inlet and outlet structures	Sum			5 000 000
Reinforced concrete siphon	m	10 460	15 800	165 268 000
Sub-total				**349 568 000**
VAT @ 14%				48 939 520
TOTAL				**398 507 520**

Smithfield-Richmond

Item	Unit	Quantity	Rate(R)	Amount (R)
TBM driven tunnel	m	25 360	20 600	522 416 000
Drill & blast access adit	m	2 970	15 000	44 550 000
Inlet and outlet structures	Sum			6 500
Sub-total				**566 972 500**
VAT @ 14%				79 376 150
TOTAL				**646 348 650**

Smithfield-Baynesfield

Item	Unit	Quantity	Rate(R)	Amount (R)
TBM driven tunnel	m	32 180	20 600	662 908 000
Drill & blast access adit	m	2 830	15 000	42 450 000
Inlet and outlet structures	Sum			6 500 000
Sub-total				**711 858 000**
VAT @ 14%				99 660 120
TOTAL				**811 518 120**

Ndonyane

Item	Unit	Quantity	Rate(R)	Amount (R)
TBM driven tunnel	m	14 250	20 600	293 550 000
Drill & blast access adit	m	1 000	15 000	15 000 000
Inlet and outlet structures	Sum			6 500 000
Sub-total				**315 050 000**
VAT @ 14%				44 107 000
TOTAL				**359 157 000**

CANAL COSTS

Clayborne

Item	Unit	Quantity	Rate(R)	Amount (R)
Concrete lined canal (6,3m3/s)	m	65 930	6 000	**395 580 000**
VAT @ 14%				55 381 200
TOTAL				**450 961 200**

August 1997 Base Date

PIPELINE COSTS
(Scheme Identification Phase)

Impendle

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1600 dia)	5 000	41	205 000
E/O for connecting to existing			10 000
Sub-total			215 000
Engineering fees @ 15 %			32 250
Sub-total			**247 250**
VAT @ 14%			34 615
TOTAL			**281 865**

Richmond-Umlaas Rd
(Clayborne, Smithfield-Richmond & Ndonyane Schemes)

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1600 dia)	5 000	37	183 000
Engineering fees @ 15 %			27 450
Sub-total			**210 450**
VAT @ 14%			29 463
TOTAL			**239 913**

Baynesfield-Umlaas Rd (Smithfield-Baynesfield Scheme)

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1600 dia)	5 000	21	105 000
Engineering fees @ 15 %			15 750
Sub-total			**120 750**
VAT @ 14%			16 905
TOTAL			**137 655**

WATERWORKS COSTS

Based on Umgeni Water all-in unit rate of R375 000 /Ml,(excl VAT and engineering fees)

August 1997 Base Date

APPENDIX A3

ECONOMICS:
SCHEME IDENTIFICATION PHASE

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 1: IMPENDLE	**Date**	01-Aug-97
Base Year	1997	**Component Life**	50

Phase	1	**Commission Year**	2004	**Output (m3/s)**	6.41

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Mpendle	3.5	38,6km	726300	20000		2000	2003	4	20.0%	290520.0	8000.0	145260.0	4000.0
				Cap											
Treatment Works		Midmar		200	126000	42000		2002	2003	2	20.0%	75600.0	25200.0	50400.0	16800.0
Treatment Works											20.0%				
			Dia.	**Length**											
Pipeline		Northern feeder	1600	41km	185000	30000		2002	2003	2	20.0%	111000.0	18000.0	74000.0	12000.0
			FSL	**h**											
Dam	Rockfill	Mpendle	1160	73	128000	20000		2000	2002	3	20.0%	59733.3	9333.3	34133.3	5333.3
Dam															
			No.	**m3**											
Pump Station															
Infrastructure			N/A	N/A				1998	1997						
Infrastructure			N/A	N/A											
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					1165300	112000									
					1473895										

Year	Cost Factors	
	Social & Environ.	Admin.
1998		
1999		
2000	0.3000	
2001	0.4000	
2002	0.3000	
2003		
2004		
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.50%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.50%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Other	0.25%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 1: IMPENDLE

YEAR	PHASE 1			PHASE 2									TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
1998	31 300.50	0.00	0.00	0.00	0.00	0.00							31 300.50	0.00	0.00
1999	31 300.50	0.00	0.00	0.00	0.00	0.00							31 300.50	0.00	0.00
2000	411 898.60	0.00	0.00	0.00	0.00	0.00							411 898.60	0.00	0.00
2001	219 229.80	0.00	0.00	0.00	0.00	0.00							219 229.80	0.00	0.00
2002	453 508.80	0.00	0.00	0.00	0.00	0.00							453 508.80	0.00	0.00
2003	326 656.80	1 120.00	0.00	0.00	0.00	0.00							326 656.80	1 120.00	0.00
2004	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2005	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2006	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2007	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2008	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2009	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2010	0.00	14 155.75	0.00	0.00	0.00	0.00							0.00	14 155.75	0.00
2011	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2012	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2013	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2014	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2015	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2016	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2017	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2018	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2019	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2020	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2021	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2022	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2023	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2024	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2025	0.00	14 155.75	0.00	0.00	0.00	0.00							0.00	14 155.75	0.00
2026	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2027	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2028	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2029	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2030	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2031	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2032	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2033	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2034	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2035	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2036	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2037	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2038	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2039	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2040	0.00	14 155.75	0.00	0.00	0.00	0.00							0.00	14 155.75	0.00
2041	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2042	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2043	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2044	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2045	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2046	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2047	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2048	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2049	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2050	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2051	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2052	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
2053	0.00	7 855.75	0.00	0.00	0.00	0.00							0.00	7 855.75	0.00
TOTAL	**1 473 895**	**412 808**	**0**	**0**	**0**	**0**							**1 473 895**	**412 808**	**0**
Commission date		2004			0			0			0				
Transfer capacity (m3/s)		6.41			0.00			0.00			0.00				

(CONTINUED.....)

Check	R 1 473 895	R 0	R 0	R 0

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 1: IMPENDLE

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	29 529	0	0	28 982	0	0	28 455	0	0
1999	27 857	0	0	26 835	0	0	25 868	0	0
2000	345 838	0	0	326 978	0	0	309 466	0	0
2001	173 651	0	0	161 140	0	0	149 737	0	0
2002	338 888	0	0	308 650	0	0	281 593	0	0
2003	230 280	790	0	205 849	706	0	184 389	632	0
2004	0	5 225	0	0	4 584	0	0	4 031	0
2005	0	4 929	0	0	4 244	0	0	3 665	0
2006	0	4 650	0	0	3 930	0	0	3 332	0
2007	0	4 387	0	0	3 639	0	0	3 029	0
2008	0	4 138	0	0	3 369	0	0	2 753	0
2009	0	3 904	0	0	3 120	0	0	2 503	0
2010	0	6 637	0	0	5 205	0	0	4 100	0
2011	0	3 475	0	0	2 675	0	0	2 069	0
2012	0	3 278	0	0	2 476	0	0	1 881	0
2013	0	3 092	0	0	2 293	0	0	1 710	0
2014	0	2 917	0	0	2 123	0	0	1 554	0
2015	0	2 752	0	0	1 966	0	0	1 413	0
2016	0	2 596	0	0	1 820	0	0	1 284	0
2017	0	2 449	0	0	1 685	0	0	1 168	0
2018	0	2 311	0	0	1 561	0	0	1 062	0
2019	0	2 180	0	0	1 445	0	0	965	0
2020	0	2 057	0	0	1 338	0	0	877	0
2021	0	1 940	0	0	1 239	0	0	798	0
2022	0	1 830	0	0	1 147	0	0	725	0
2023	0	1 727	0	0	1 062	0	0	659	0
2024	0	1 629	0	0	983	0	0	599	0
2025	0	2 769	0	0	1 641	0	0	982	0
2026	0	1 450	0	0	843	0	0	495	0
2027	0	1 368	0	0	781	0	0	450	0
2028	0	1 290	0	0	723	0	0	409	0
2029	0	1 217	0	0	669	0	0	372	0
2030	0	1 148	0	0	620	0	0	338	0
2031	0	1 083	0	0	574	0	0	307	0
2032	0	1 022	0	0	531	0	0	280	0
2033	0	964	0	0	492	0	0	254	0
2034	0	910	0	0	456	0	0	231	0
2035	0	858	0	0	422	0	0	210	0
2036	0	810	0	0	391	0	0	191	0
2037	0	764	0	0	362	0	0	174	0
2038	0	721	0	0	335	0	0	158	0
2039	0	680	0	0	310	0	0	143	0
2040	0	1 156	0	0	517	0	0	235	0
2041	0	605	0	0	266	0	0	119	0
2042	0	571	0	0	246	0	0	108	0
2043	0	538	0	0	228	0	0	98	0
2044	0	508	0	0	211	0	0	89	0
2045	0	479	0	0	195	0	0	81	0
2046	0	452	0	0	181	0	0	74	0
2047	0	426	0	0	167	0	0	67	0
2048	0	402	0	0	155	0	0	61	0
2049	0	380	0	0	144	0	0	55	0
2050	0	358	0	0	133	0	0	50	0
2051	0	338	0	0	123	0	0	46	0
2052	0	319	0	0	114	0	0	42	0
RES+2050	0	301	0	0	106	0	0	38	0
TOTAL	**1 146 043**	**92 779**	**0**	**1 058 436**	**64 544**	**0**	**979 508**	**46 964**	**0**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 238 822**	**1 505**	**82.32**
8%	**R 1 122 980**	**949**	**118.31**
10%	**R 1 026 473**	**627**	**163.59**

"

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 2: CLAYBORNE	**Date**	01-Aug-97
Base Year	1997	**Component Life**	50

Phase	1	**Commission Year**	2004	**Output (m3/s)**	6.41

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Various	3.5	8000	294000	10000		2000	2003	4		73500.0	2500.0	73500.0	2500.0
				Cap											
Treatment Works		Richmond		550	157000	53000		2002	2003	2	20.0%	94200.0	31800.0	62800.0	21200.0
Treatment Works											20.0%				
			Dia.	**Length**											
Pipeline			1600	36.5	153000	30000		2002	2003	2	20.0%	91800.0	18000.0	61200.0	12000.0
			FSL	**h**											
Dam	Rockfill	Clayborne	1040	84	192000	20000		2001	2003	3	20.0%	89600.0	9333.3	51200.0	5333.3
Dam															
			No.	**m3**											
Pump Station				6.5	6865	3022	3533	2003	2003	1		6865.0	3022.0	6865.0	3022.0
			Cap	**Length**				2000	1999						
Canals		Main		66000	340000	4000		2001	2003	3	20.0%	158666.7	1866.7	90666.7	1066.7
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					1142865	120022	3533								
					1457320.05										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.50%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Other	0.75%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 2: CLAYBORNE

YEAR	PHASE 1			PHASE 2									TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
1998	10 640.00	0.00	0.00	0.00	0.00	0.00							10 640.00	0.00	0.00
1999	18 060.00	0.00	0.00	0.00	0.00	0.00							18 060.00	0.00	0.00
2000	127 335.00	0.00	0.00	0.00	0.00	0.00							127 335.00	0.00	0.00
2001	376 405.05	0.00	0.00	0.00	0.00	0.00							376 405.05	0.00	0.00
2002	498 718.05	0.00	0.00	0.00	0.00	0.00							498 718.05	0.00	0.00
2003	424 661.96	0.00	44.12	0.00	0.00	0.00							424 661.96	0.00	44.12
2004	1 500.00	9 740.54	245.84	0.00	0.00	0.00							1 500.00	9 740.54	245.84
2005	0.00	9 740.54	454.07	0.00	0.00	0.00							0.00	9 740.54	454.07
2006	0.00	9 740.54	667.03	0.00	0.00	0.00							0.00	9 740.54	667.03
2007	0.00	9 740.54	886.80	0.00	0.00	0.00							0.00	9 740.54	886.80
2008	0.00	9 740.54	1 113.61	0.00	0.00	0.00							0.00	9 740.54	1 113.61
2009	0.00	9 740.54	1 347.68	0.00	0.00	0.00							0.00	9 740.54	1 347.68
2010	0.00	9 740.54	1 589.24	0.00	0.00	0.00							0.00	9 740.54	1 589.24
2011	0.00	9 740.54	1 841.33	0.00	0.00	0.00							0.00	9 740.54	1 841.33
2012	0.00	9 740.54	2 101.58	0.00	0.00	0.00							0.00	9 740.54	2 101.58
2013	0.00	9 740.54	2 370.26	0.00	0.00	0.00							0.00	9 740.54	2 370.26
2014	0.00	9 740.54	2 647.63	0.00	0.00	0.00							0.00	9 740.54	2 647.63
2015	0.00	9 740.54	2 933.98	0.00	0.00	0.00							0.00	9 740.54	2 933.98
2016	0.00	9 740.54	3 228.69	0.00	0.00	0.00							0.00	9 740.54	3 228.69
2017	0.00	9 740.54	3 532.91	0.00	0.00	0.00							0.00	9 740.54	3 532.91
2018	0.00	18 143.84	3 533.00	0.00	0.00	0.00							0.00	18 143.84	3 533.00
2019	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2020	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2021	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2022	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2023	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2024	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2025	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2026	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2027	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2028	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2029	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2030	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2031	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2032	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2033	0.00	18 143.84	3 533.00	0.00	0.00	0.00							0.00	18 143.84	3 533.00
2034	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2035	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2036	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2037	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2038	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2039	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2040	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2041	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2042	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2043	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2044	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2045	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2046	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2047	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2048	0.00	18 143.84	3 533.00	0.00	0.00	0.00							0.00	18 143.84	3 533.00
2049	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2050	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2051	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2052	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
2053	0.00	9 740.54	3 533.00	0.00	0.00	0.00							0.00	9 740.54	3 533.00
TOTAL	**1 457 320**	**512 237**	**152 193**	**0**	**0**	**0**							**1 457 320**	**512 237**	**152 193**
Commission date		2004			0			0			0				
Transfer capacity (m3/s)		6.41			0.00			0.00			0.00				

(CONTINUED.....)

Check	**R 1 457 320**	**R 0**	**R 0**	**R 0**

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 2: CLAYBORNE

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	10 038	0	0	9 852	0	0	9 673	0	0
1999	16 073	0	0	15 484	0	0	14 926	0	0
2000	106 913	0	0	101 083	0	0	95 669	0	0
2001	298 148	0	0	276 669	0	0	257 090	0	0
2002	372 671	0	0	339 419	0	0	309 665	0	0
2003	299 370	0	31	267 609	0	28	239 711	0	25
2004	998	6 478	163	875	5 684	143	770	4 998	126
2005	0	6 111	285	0	5 263	245	0	4 544	212
2006	0	5 765	395	0	4 873	334	0	4 131	283
2007	0	5 439	495	0	4 512	411	0	3 755	342
2008	0	5 131	587	0	4 178	478	0	3 414	390
2009	0	4 841	670	0	3 868	535	0	3 104	429
2010	0	4 567	745	0	3 582	584	0	2 821	460
2011	0	4 308	814	0	3 316	627	0	2 565	485
2012	0	4 064	877	0	3 071	663	0	2 332	503
2013	0	3 834	933	0	2 843	692	0	2 120	516
2014	0	3 617	983	0	2 633	716	0	1 927	524
2015	0	3 413	1 028	0	2 438	734	0	1 752	528
2016	0	3 219	1 067	0	2 257	748	0	1 593	528
2017	0	3 037	1 102	0	2 090	758	0	1 448	525
2018	0	5 337	1 039	0	3 604	702	0	2 452	477
2019	0	2 703	980	0	1 792	650	0	1 197	434
2020	0	2 550	925	0	1 659	602	0	1 088	395
2021	0	2 406	873	0	1 536	557	0	989	359
2022	0	2 270	823	0	1 422	516	0	899	326
2023	0	2 141	777	0	1 317	478	0	817	296
2024	0	2 020	733	0	1 219	442	0	743	269
2025	0	1 906	691	0	1 129	410	0	675	245
2026	0	1 798	652	0	1 045	379	0	614	223
2027	0	1 696	615	0	968	351	0	558	202
2028	0	1 600	580	0	896	325	0	507	184
2029	0	1 509	547	0	830	301	0	461	167
2030	0	1 424	516	0	768	279	0	419	152
2031	0	1 343	487	0	712	258	0	381	138
2032	0	1 267	460	0	659	239	0	347	126
2033	0	2 227	434	0	1 136	221	0	587	114
2034	0	1 128	409	0	565	205	0	286	104
2035	0	1 064	386	0	523	190	0	260	94
2036	0	1 004	364	0	484	176	0	237	86
2037	0	947	343	0	448	163	0	215	78
2038	0	893	324	0	415	151	0	196	71
2039	0	843	306	0	384	139	0	178	65
2040	0	795	288	0	356	129	0	162	59
2041	0	750	272	0	330	120	0	147	53
2042	0	708	257	0	305	111	0	134	48
2043	0	668	242	0	283	102	0	121	44
2044	0	630	228	0	262	95	0	110	40
2045	0	594	216	0	242	88	0	100	36
2046	0	561	203	0	224	81	0	91	33
2047	0	529	192	0	208	75	0	83	30
2048	0	929	181	0	358	70	0	141	27
2049	0	471	171	0	178	65	0	69	25
2050	0	444	161	0	165	60	0	62	23
2051	0	419	152	0	153	55	0	57	21
2052	0	395	143	0	141	51	0	52	19
RES+2050	0	373	135	0	131	47	0	47	17
TOTAL	**1 104 211**	**112 166**	**26 282**	**1 010 990**	**77 453**	**16 577**	**927 502**	**55 987**	**10 958**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 242 658**	**1 505**	**82.57**
8%	**R 1 105 020**	**949**	**116.42**
10%	**R 994 446**	**627**	**158.49**

"

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 3A: SMITHFIELD-RICHMOND	**Date**	01-Aug-97
Base Year	1997	**Component Life**	50

Phase	1	**Commission Year**	2004	**Output (m3/s)**	6.41

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Smithfield-Lovu	3.5	25.4	483000	10000		2000	2003	4		120750.0	2500.0	120750.0	2500.0
				Cap											
Treatment Works		Richmond		550	157000	53000		2002	2003	2	20.0%	94200.0	31800.0	62800.0	21200.0
Treatment Works											20.0%				
			Dia.	**Length**											
Pipeline		Richmond-Umlaas Rd	1600	36.5	153000	30000		2002	2003	2	20.0%	91800.0	18000.0	61200.0	12000.0
			FSL	**h**											
Dam	Rockfill	Smithfield	907	60	180000	20000		2001	2003	3	20.0%	84000.0	9333.3	48000.0	5333.3
Dam															
			No.	**m3**											
Pump Station				6.5	10300	4500	16000	2003	2003	1		10300.0	4500.0	10300.0	4500.0
			Cap	**Length**				2000	1999						
Canals											20.0%				
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					983300	117500	16000								
					1270920										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.50%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Other	0.75%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3A: SMITHFIELD-RICHMOND

YEAR	PHASE 1			PHASE 2									TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
1998	17 255.00	0.00	0.00	0.00	0.00	0.00							17 255.00	0.00	0.00
1999	24 255.00	0.00	0.00	0.00	0.00	0.00							24 255.00	0.00	0.00
2000	153 865.00	0.00	0.00	0.00	0.00	0.00							153 865.00	0.00	0.00
2001	248 183.00	0.00	0.00	0.00	0.00	0.00							248 183.00	0.00	0.00
2002	447 392.00	0.00	0.00	0.00	0.00	0.00							447 392.00	0.00	0.00
2003	378 470.00	0.00	199.83	0.00	0.00	0.00							378 470.00	0.00	199.83
2004	1 500.00	7 540.75	1 113.33	0.00	0.00	0.00							1 500.00	7 540.75	1 113.33
2005	0.00	7 540.75	2 056.35	0.00	0.00	0.00							0.00	7 540.75	2 056.35
2006	0.00	7 540.75	3 020.79	0.00	0.00	0.00							0.00	7 540.75	3 020.79
2007	0.00	7 540.75	4 016.09	0.00	0.00	0.00							0.00	7 540.75	4 016.09
2008	0.00	7 540.75	5 043.24	0.00	0.00	0.00							0.00	7 540.75	5 043.24
2009	0.00	7 540.75	6 103.27	0.00	0.00	0.00							0.00	7 540.75	6 103.27
2010	0.00	7 540.75	7 197.23	0.00	0.00	0.00							0.00	7 540.75	7 197.23
2011	0.00	7 540.75	8 338.89	0.00	0.00	0.00							0.00	7 540.75	8 338.89
2012	0.00	7 540.75	9 517.51	0.00	0.00	0.00							0.00	7 540.75	9 517.51
2013	0.00	7 540.75	10 734.26	0.00	0.00	0.00							0.00	7 540.75	10 734.26
2014	0.00	7 540.75	11 990.40	0.00	0.00	0.00							0.00	7 540.75	11 990.40
2015	0.00	7 540.75	13 287.20	0.00	0.00	0.00							0.00	7 540.75	13 287.20
2016	0.00	7 540.75	14 621.87	0.00	0.00	0.00							0.00	7 540.75	14 621.87
2017	0.00	7 540.75	15 999.61	0.00	0.00	0.00							0.00	7 540.75	15 999.61
2018	0.00	16 165.75	16 000.00	0.00	0.00	0.00							0.00	16 165.75	16 000.00
2019	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2020	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2021	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2022	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2023	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2024	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2025	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2026	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2027	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2028	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2029	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2030	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2031	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2032	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2033	0.00	16 165.75	16 000.00	0.00	0.00	0.00							0.00	16 165.75	16 000.00
2034	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2035	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2036	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2037	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2038	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2039	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2040	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2041	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2042	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2043	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2044	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2045	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2046	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2047	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2048	0.00	16 165.75	16 000.00	0.00	0.00	0.00							0.00	16 165.75	16 000.00
2049	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2050	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2051	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2052	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
2053	0.00	7 540.75	16 000.00	0.00	0.00	0.00							0.00	7 540.75	16 000.00
TOTAL	**1 270 920**	**402 913**	**689 240**	**0**	**0**	**0**							**1 270 920**	**402 913**	**689 240**
Commission date		2004			0			0			0				
Transfer capacity (m3/s)		6.41			0.00			0.00			0.00				

(CONTINUED.....)

Check	R 1 270 920	R 0	R 0	R 0

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3A: SMITHFIELD-RICHMOND

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	16 278	0	0	15 977	0	0	15 686	0	0
1999	21 587	0	0	20 795	0	0	20 045	0	0
2000	129 188	0	0	122 143	0	0	115 601	0	0
2001	196 584	0	0	182 422	0	0	169 512	0	0
2002	334 317	0	0	304 487	0	0	277 795	0	0
2003	266 806	0	141	238 500	0	126	213 636	0	113
2004	998	5 015	740	875	4 400	650	770	3 870	571
2005	0	4 731	1 290	0	4 074	1 111	0	3 518	959
2006	0	4 463	1 788	0	3 772	1 511	0	3 198	1 281
2007	0	4 211	2 243	0	3 493	1 860	0	2 907	1 548
2008	0	3 972	2 657	0	3 234	2 163	0	2 643	1 768
2009	0	3 748	3 033	0	2 995	2 424	0	2 403	1 945
2010	0	3 535	3 374	0	2 773	2 646	0	2 184	2 085
2011	0	3 335	3 688	0	2 567	2 839	0	1 986	2 196
2012	0	3 146	3 971	0	2 377	3 000	0	1 805	2 278
2013	0	2 968	4 226	0	2 201	3 133	0	1 641	2 336
2014	0	2 800	4 453	0	2 038	3 241	0	1 492	2 372
2015	0	2 642	4 655	0	1 887	3 325	0	1 356	2 390
2016	0	2 492	4 833	0	1 747	3 388	0	1 233	2 391
2017	0	2 351	4 989	0	1 618	3 433	0	1 121	2 378
2018	0	4 755	4 706	0	3 211	3 178	0	2 184	2 162
2019	0	2 093	4 440	0	1 387	2 943	0	926	1 966
2020	0	1 974	4 189	0	1 284	2 725	0	842	1 787
2021	0	1 862	3 952	0	1 189	2 523	0	766	1 624
2022	0	1 757	3 728	0	1 101	2 336	0	696	1 477
2023	0	1 658	3 517	0	1 020	2 163	0	633	1 342
2024	0	1 564	3 318	0	944	2 003	0	575	1 220
2025	0	1 475	3 130	0	874	1 855	0	523	1 109
2026	0	1 392	2 953	0	809	1 717	0	475	1 009
2027	0	1 313	2 786	0	749	1 590	0	432	917
2028	0	1 239	2 628	0	694	1 472	0	393	834
2029	0	1 168	2 479	0	642	1 363	0	357	758
2030	0	1 102	2 339	0	595	1 262	0	325	689
2031	0	1 040	2 207	0	551	1 169	0	295	626
2032	0	981	2 082	0	510	1 082	0	268	569
2033	0	1 984	1 964	0	1 012	1 002	0	523	518
2034	0	873	1 853	0	437	928	0	222	471
2035	0	824	1 748	0	405	859	0	202	428
2036	0	777	1 649	0	375	795	0	183	389
2037	0	733	1 556	0	347	736	0	167	354
2038	0	692	1 468	0	321	682	0	151	321
2039	0	652	1 384	0	298	631	0	138	292
2040	0	616	1 306	0	276	585	0	125	266
2041	0	581	1 232	0	255	541	0	114	241
2042	0	548	1 162	0	236	501	0	103	220
2043	0	517	1 097	0	219	464	0	94	200
2044	0	488	1 035	0	203	430	0	85	181
2045	0	460	976	0	188	398	0	78	165
2046	0	434	921	0	174	368	0	71	150
2047	0	409	869	0	161	341	0	64	136
2048	0	828	819	0	319	316	0	125	124
2049	0	364	773	0	138	292	0	53	113
2050	0	344	729	0	128	271	0	48	102
2051	0	324	688	0	118	251	0	44	93
2052	0	306	649	0	109	232	0	40	85
RES+2050	0	289	612	0	101	215	0	36	77
TOTAL	**965 759**	**87 826**	**119 023**	**885 200**	**60 557**	**75 073**	**813 047**	**43 714**	**49 625**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 172 608**	**1 505**	**77.92**
8%	**R 1 020 829**	**949**	**107.55**
10%	**R 906 386**	**627**	**144.46**

"

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 3B: SMITHFIELD-BAYNESFIELD	**Date**	01-Aug-97
Base Year	1997	**Component Life**	50

Phase	1	**Commission Year**	2004	**Output (m3/s)**	6.41

Element	Type	Name	Characteristics		Capital Costs		Electricity	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.	Costs per year	Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Smithfield-Baynesfield	3.5	32	599000	20000		2000	2003	4		149750.0	5000.0	149750.0	5000.0
				Cap											
Treatment Works		Baynesfield		550	157000	53000		2002	2003	2	20.0%	94200.0	31800.0	62800.0	21200.0
Treatment Works											20.0%				
			Dia.	**Length**											
Pipeline		Baynesfield-Umlaas Rd	1600	21	90000	15000		2002	2003	2	20.0%	54000.0	9000.0	36000.0	6000.0
			FSL	**h**											
Dam	Rockfill	Smithfield	907	60	180000	20000		2001	2003	3	20.0%	84000.0	9333.3	48000.0	5333.3
Dam															
			No.	**m3**											
Pump Station				6.5	7000	3000	3670	2003	2003	1		7000.0	3000.0	7000.0	3000.0
			Cap	**Length**				2000	1999						
Canals											20.0%				
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					1033000	111000	3670								
					1320600										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.50%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Other	0.75%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3B: SMITHFIELD-BAYNESFIELD

YEAR	PHASE 1			PHASE 2									TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
1998	21 665.00	0.00	0.00	0.00	0.00	0.00							21 665.00	0.00	0.00
1999	28 665.00	0.00	0.00	0.00	0.00	0.00							28 665.00	0.00	0.00
2000	185 155.00	0.00	0.00	0.00	0.00	0.00							185 155.00	0.00	0.00
2001	279 305.00	0.00	0.00	0.00	0.00	0.00							279 305.00	0.00	0.00
2002	430 700.00	0.00	0.00	0.00	0.00	0.00							430 700.00	0.00	0.00
2003	373 610.00	0.00	45.84	0.00	0.00	0.00							373 610.00	0.00	45.84
2004	1 500.00	7 247.50	255.37	0.00	0.00	0.00							1 500.00	7 247.50	255.37
2005	0.00	7 247.50	471.68	0.00	0.00	0.00							0.00	7 247.50	471.68
2006	0.00	7 247.50	692.89	0.00	0.00	0.00							0.00	7 247.50	692.89
2007	0.00	7 247.50	921.19	0.00	0.00	0.00							0.00	7 247.50	921.19
2008	0.00	7 247.50	1 156.79	0.00	0.00	0.00							0.00	7 247.50	1 156.79
2009	0.00	7 247.50	1 399.94	0.00	0.00	0.00							0.00	7 247.50	1 399.94
2010	0.00	7 247.50	1 650.87	0.00	0.00	0.00							0.00	7 247.50	1 650.87
2011	0.00	7 247.50	1 912.73	0.00	0.00	0.00							0.00	7 247.50	1 912.73
2012	0.00	7 247.50	2 183.08	0.00	0.00	0.00							0.00	7 247.50	2 183.08
2013	0.00	7 247.50	2 462.17	0.00	0.00	0.00							0.00	7 247.50	2 462.17
2014	0.00	7 247.50	2 750.30	0.00	0.00	0.00							0.00	7 247.50	2 750.30
2015	0.00	7 247.50	3 047.75	0.00	0.00	0.00							0.00	7 247.50	3 047.75
2016	0.00	7 247.50	3 353.89	0.00	0.00	0.00							0.00	7 247.50	3 353.89
2017	0.00	7 247.50	3 669.91	0.00	0.00	0.00							0.00	7 247.50	3 669.91
2018	0.00	15 647.50	3 670.00	0.00	0.00	0.00							0.00	15 647.50	3 670.00
2019	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2020	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2021	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2022	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2023	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2024	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2025	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2026	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2027	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2028	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2029	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2030	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2031	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2032	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2033	0.00	15 647.50	3 670.00	0.00	0.00	0.00							0.00	15 647.50	3 670.00
2034	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2035	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2036	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2037	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2038	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2039	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2040	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2041	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2042	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2043	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2044	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2045	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2046	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2047	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2048	0.00	15 647.50	3 670.00	0.00	0.00	0.00							0.00	15 647.50	3 670.00
2049	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2050	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2051	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2052	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
2053	0.00	7 247.50	3 670.00	0.00	0.00	0.00							0.00	7 247.50	3 670.00
TOTAL	**1 320 600**	**387 575**	**158 094**	**0**	**0**	**0**							**1 320 600**	**387 575**	**158 094**
Commission date		2004			0			0			0				
Transfer capacity (m3/s)		6.41			0.00			0.00			0.00				

(CONTINUED.....)

Check	R 1 320 600	R 0	R 0	R 0

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3B: SMITHFIELD-BAYNESFIELD

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	20 439	0	0	20 060	0	0	19 695	0	0
1999	25 512	0	0	24 576	0	0	23 690	0	0
2000	155 460	0	0	146 982	0	0	139 110	0	0
2001	221 236	0	0	205 298	0	0	190 769	0	0
2002	321 844	0	0	293 127	0	0	267 431	0	0
2003	263 380	0	32	235 438	0	29	210 893	0	26
2004	998	4 820	170	875	4 229	149	770	3 719	131
2005	0	4 547	296	0	3 916	255	0	3 381	220
2006	0	4 290	410	0	3 626	347	0	3 074	294
2007	0	4 047	514	0	3 357	427	0	2 794	355
2008	0	3 818	609	0	3 108	496	0	2 540	405
2009	0	3 602	696	0	2 878	556	0	2 309	446
2010	0	3 398	774	0	2 665	607	0	2 099	478
2011	0	3 206	846	0	2 467	651	0	1 908	504
2012	0	3 024	911	0	2 285	688	0	1 735	523
2013	0	2 853	969	0	2 115	719	0	1 577	536
2014	0	2 691	1 021	0	1 959	743	0	1 434	544
2015	0	2 539	1 068	0	1 814	763	0	1 304	548
2016	0	2 395	1 109	0	1 679	777	0	1 185	548
2017	0	2 260	1 144	0	1 555	787	0	1 077	546
2018	0	4 603	1 080	0	3 108	729	0	2 114	496
2019	0	2 011	1 018	0	1 333	675	0	890	451
2020	0	1 897	961	0	1 234	625	0	809	410
2021	0	1 790	906	0	1 143	579	0	736	373
2022	0	1 689	855	0	1 058	536	0	669	339
2023	0	1 593	807	0	980	496	0	608	308
2024	0	1 503	761	0	907	459	0	553	280
2025	0	1 418	718	0	840	425	0	503	254
2026	0	1 338	677	0	778	394	0	457	231
2027	0	1 262	639	0	720	365	0	415	210
2028	0	1 190	603	0	667	338	0	378	191
2029	0	1 123	569	0	617	313	0	343	174
2030	0	1 059	537	0	572	290	0	312	158
2031	0	1 000	506	0	529	268	0	284	144
2032	0	943	477	0	490	248	0	258	131
2033	0	1 921	450	0	980	230	0	506	119
2034	0	839	425	0	420	213	0	213	108
2035	0	792	401	0	389	197	0	194	98
2036	0	747	378	0	360	182	0	176	89
2037	0	705	357	0	334	169	0	160	81
2038	0	665	337	0	309	156	0	146	74
2039	0	627	318	0	286	145	0	132	67
2040	0	592	300	0	265	134	0	120	61
2041	0	558	283	0	245	124	0	109	55
2042	0	527	267	0	227	115	0	99	50
2043	0	497	252	0	210	106	0	90	46
2044	0	469	237	0	195	99	0	82	42
2045	0	442	224	0	180	91	0	75	38
2046	0	417	211	0	167	85	0	68	34
2047	0	393	199	0	155	78	0	62	31
2048	0	801	188	0	309	72	0	121	28
2049	0	350	177	0	132	67	0	51	26
2050	0	330	167	0	123	62	0	46	23
2051	0	312	158	0	114	58	0	42	21
2052	0	294	149	0	105	53	0	38	19
RES+2050	0	277	140	0	97	49	0	35	18
TOTAL	**1 008 868**	**84 463**	**27 301**	**926 355**	**58 233**	**17 220**	**852 358**	**42 034**	**11 383**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 120 631**	**1 505**	**74.47**
8%	**R 1 001 808**	**949**	**105.54**
10%	**R 905 774**	**627**	**144.36**

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Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 4: NDONYANE	**Date**	01-Aug-97
Base Year	1997	**Component Life**	50

Phase	1	**Commission Year**	2004	**Output (m3/s)**	6.41

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Ndonyane-Lovu	3.5	14	264000	10000		2000	2003	4		66000.0	2500.0	66000.0	2500.0
				Cap											
Treatment Works		Richmond		550	157000	53000		2002	2003	2	20.0%	94200.0	31800.0	62800.0	21200.0
Treatment Works											20.0%				
			Dia.	**Length**											
Pipeline		Richmond-Umlaas Rd	1600	36.5	153000	30000		2002	2003	2	20.0%	91800.0	18000.0	61200.0	12000.0
			FSL	**h**											
Dam	Rockfill	Ndonyane	680	110	448000	20000		2001	2003	3	20.0%	209066.7	9333.3	119466.7	5333.3
Dam															
			No.	**m3**											
Pump Station				6.5	44400	20000	17900	2003	2003	1		44400.0	20000.0	44400.0	20000.0
			Cap	**Length**				2000	1999						
Canals											20.0%				
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					1066400	133000	17900								
					1384310										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.50%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Other	0.75%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 4: NDONYANE

YEAR	PHASE 1			PHASE 2									TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
1998	9 590.00	0.00	0.00	0.00	0.00	0.00							9 590.00	0.00	0.00
1999	25 970.00	0.00	0.00	0.00	0.00	0.00							25 970.00	0.00	0.00
2000	104 115.00	0.00	0.00	0.00	0.00	0.00							104 115.00	0.00	0.00
2001	325 861.00	0.00	0.00	0.00	0.00	0.00							325 861.00	0.00	0.00
2002	467 182.00	0.00	0.00	0.00	0.00	0.00							467 182.00	0.00	0.00
2003	450 092.00	0.00	223.56	0.00	0.00	0.00							450 092.00	0.00	223.56
2004	1 500.00	8 368.50	1 245.54	0.00	0.00	0.00							1 500.00	8 368.50	1 245.54
2005	0.00	8 368.50	2 300.54	0.00	0.00	0.00							0.00	8 368.50	2 300.54
2006	0.00	8 368.50	3 379.50	0.00	0.00	0.00							0.00	8 368.50	3 379.50
2007	0.00	8 368.50	4 493.00	0.00	0.00	0.00							0.00	8 368.50	4 493.00
2008	0.00	8 368.50	5 642.13	0.00	0.00	0.00							0.00	8 368.50	5 642.13
2009	0.00	8 368.50	6 828.04	0.00	0.00	0.00							0.00	8 368.50	6 828.04
2010	0.00	8 368.50	8 051.90	0.00	0.00	0.00							0.00	8 368.50	8 051.90
2011	0.00	8 368.50	9 329.14	0.00	0.00	0.00							0.00	8 368.50	9 329.14
2012	0.00	8 368.50	10 647.71	0.00	0.00	0.00							0.00	8 368.50	10 647.71
2013	0.00	8 368.50	12 008.96	0.00	0.00	0.00							0.00	8 368.50	12 008.96
2014	0.00	8 368.50	13 414.26	0.00	0.00	0.00							0.00	8 368.50	13 414.26
2015	0.00	8 368.50	14 865.05	0.00	0.00	0.00							0.00	8 368.50	14 865.05
2016	0.00	8 368.50	16 358.22	0.00	0.00	0.00							0.00	8 368.50	16 358.22
2017	0.00	8 368.50	17 899.56	0.00	0.00	0.00							0.00	8 368.50	17 899.56
2018	0.00	19 318.50	17 900.00	0.00	0.00	0.00							0.00	19 318.50	17 900.00
2019	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2020	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2021	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2022	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2023	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2024	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2025	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2026	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2027	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2028	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2029	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2030	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2031	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2032	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2033	0.00	19 318.50	17 900.00	0.00	0.00	0.00							0.00	19 318.50	17 900.00
2034	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2035	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2036	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2037	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2038	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2039	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2040	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2041	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2042	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2043	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2044	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2045	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2046	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2047	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2048	0.00	19 318.50	17 900.00	0.00	0.00	0.00							0.00	19 318.50	17 900.00
2049	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2050	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2051	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2052	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
2053	0.00	8 368.50	17 900.00	0.00	0.00	0.00							0.00	8 368.50	17 900.00
TOTAL	**1 384 310**	**451 275**	**771 087**	**0**	**0**	**0**							**1 384 310**	**451 275**	**771 087**
Commission date		2004			0			0			0				
Transfer capacity (m3/s)		6.41			0.00			0.00			0.00				

(CONTINUED.....)

Check	**R 1 384 310**	**R 0**	**R 0**	**R 0**

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 4: NDONYANE

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	9 047	0	0	8 880	0	0	8 718	0	0
1999	23 113	0	0	22 265	0	0	21 463	0	0
2000	87 417	0	0	82 650	0	0	78 223	0	0
2001	258 112	0	0	239 518	0	0	222 567	0	0
2002	349 106	0	0	317 956	0	0	290 083	0	0
2003	317 297	0	158	283 634	0	141	254 065	0	126
2004	998	5 566	828	875	4 883	727	770	4 294	639
2005	0	5 251	1 443	0	4 521	1 243	0	3 904	1 073
2006	0	4 953	2 000	0	4 186	1 691	0	3 549	1 433
2007	0	4 673	2 509	0	3 876	2 081	0	3 226	1 732
2008	0	4 408	2 972	0	3 589	2 420	0	2 933	1 978
2009	0	4 159	3 393	0	3 323	2 712	0	2 666	2 176
2010	0	3 923	3 775	0	3 077	2 961	0	2 424	2 332
2011	0	3 701	4 126	0	2 849	3 176	0	2 204	2 457
2012	0	3 492	4 443	0	2 638	3 357	0	2 003	2 549
2013	0	3 294	4 727	0	2 443	3 505	0	1 821	2 613
2014	0	3 108	4 982	0	2 262	3 625	0	1 656	2 654
2015	0	2 932	5 208	0	2 094	3 720	0	1 505	2 674
2016	0	2 766	5 407	0	1 939	3 790	0	1 368	2 675
2017	0	2 609	5 581	0	1 795	3 840	0	1 244	2 661
2018	0	5 683	5 265	0	3 838	3 556	0	2 611	2 419
2019	0	2 322	4 967	0	1 539	3 293	0	1 028	2 199
2020	0	2 191	4 686	0	1 425	3 049	0	935	1 999
2021	0	2 067	4 421	0	1 320	2 823	0	850	1 817
2022	0	1 950	4 171	0	1 222	2 614	0	772	1 652
2023	0	1 839	3 935	0	1 131	2 420	0	702	1 502
2024	0	1 735	3 712	0	1 048	2 241	0	638	1 365
2025	0	1 637	3 502	0	970	2 075	0	580	1 241
2026	0	1 544	3 304	0	898	1 921	0	528	1 128
2027	0	1 457	3 117	0	832	1 779	0	480	1 026
2028	0	1 375	2 940	0	770	1 647	0	436	933
2029	0	1 297	2 774	0	713	1 525	0	396	848
2030	0	1 223	2 617	0	660	1 412	0	360	771
2031	0	1 154	2 469	0	611	1 308	0	328	701
2032	0	1 089	2 329	0	566	1 211	0	298	637
2033	0	2 371	2 197	0	1 210	1 121	0	625	579
2034	0	969	2 073	0	485	1 038	0	246	526
2035	0	914	1 955	0	449	961	0	224	479
2036	0	862	1 845	0	416	890	0	203	435
2037	0	814	1 740	0	385	824	0	185	395
2038	0	768	1 642	0	357	763	0	168	360
2039	0	724	1 549	0	330	706	0	153	327
2040	0	683	1 461	0	306	654	0	139	297
2041	0	644	1 378	0	283	606	0	126	270
2042	0	608	1 300	0	262	561	0	115	246
2043	0	574	1 227	0	243	519	0	104	223
2044	0	541	1 157	0	225	481	0	95	203
2045	0	510	1 092	0	208	445	0	86	185
2046	0	482	1 030	0	193	412	0	78	168
2047	0	454	972	0	178	382	0	71	152
2048	0	989	917	0	381	353	0	150	139
2049	0	404	865	0	153	327	0	59	126
2050	0	381	816	0	142	303	0	54	115
2051	0	360	770	0	131	281	0	49	104
2052	0	339	726	0	121	260	0	44	95
RES+2050	0	320	685	0	112	241	0	40	86
TOTAL	**1 045 090**	**98 112**	**133 157**	**955 778**	**67 591**	**83 987**	**875 890**	**48 754**	**55 518**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 276 359**	**1 505**	**84.81**
8%	**R 1 107 357**	**949**	**116.66**
10%	**R 980 162**	**627**	**156.21**

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APPENDIX B1

SCHEME DETAILS:
PRE-RECONNAISSANCE PHASE

PRE-RECONNAISSANCE PHASE
SCHEME 1
IMPENDLE - MIDMAR - NORTHERN FEEDER

		Phase 1	Phase 2	Phase 3
Transfer Capacity		3,6 m^3/s (115 million m^3/a)	Total 6,3 m^3/s (200 million m^3/a)	Total 10,8 m^3/s (340 million m^3/a)
Transfer Route and Description		Impendle Dam-gravity tunnel-uGqishi River-Midmar Dam-pumpstation-Midmar Waterworks-gravity pipeline/tunnel-Midmar Tunnel-gravity pipeline (Northern Feeder)-Umlaas Road reservoir		
Dam:	Name	Impendle	Impendle raised	Impendle raised
	Type	Rockfill with clay core	Rockfill with clay core	Rockfill with clay core
	Spillway	Side channel	Side channel	Side channel
	Crest Level; **FSL**; River Bed Level	1 153 masl; **1 145 masl**; 1 095 masl 1 123 masl	1 168 masl; **1 160 masl**; 1 095 masl 1 123 masl	1 198 masl; **1 190 masl**; 1095 masl 1 123 masl
	Minimum operating level	58 m	73 m	90 m
	Height of wall	500 ha	1 000 ha	2 250 ha
	Surface area at FSL	58 million m^3 (10% MAR)	200 million m^3 (35% MAR)	680 million m^3
	Storage capacity at FSL	115 million m^3/a	200 million m^3/a	380 million m^3/a
	Historical firm yield			
Tunnel:	Route	From Impendle Dam to uGqishi River immediately upstream of Midmar Dam		
	Length	35,5 km		
	Diameter	3,5 m bored (3,0 m lined)		
	Description	Bored tunnel, fully concrete lined with membrane for 25% of its length. Free surface flow.		
	Typical rock formation	Sandstones and mudstones, with dolerite intrusions		
	Average gradient	1 in 1 000		
	Inlet invert level	1 115 masl		
	Outlet invert level	1 080 masl		
	Intake works	Multi-level intake structure		
Pumpstation:	Location	Midmar	Midmar (upgrade)	Midmar (upgrade)
	Capacity	4 m^3/s	7 m^3/s total	11 m^3/s total
	Average head	10 m	10 m	10 m
Pipelines:	Route	Raw water: Rising main from Midmar Dam to Midmar Water Treatment Works; Clear water: Gravity main to proposed Howick Tunnel, gravity link to existing Midmar Tunnel, gravity main from portal to reservoir at Umlaas Road, along route of proposed Northern Feeder		
	General	All pipelines are buried. Proposed Northern Feeder and existing pipelines will not be utilised.		
	Diameter	1 400 mm	1 800 mm	–
	Length (total)	41 km	41 km	
Waterworks:	Description	Upgrade of existing Midmar Waterworks	Upgrade of existing Midmar Waterworks	Upgrade of existing Midmar Waterworks
	Capacity prior to upgrade	370 Ml/d	690 Ml/d	920 Ml/d
	Upgraded capacity	690 Ml/d	920 Ml/d	1330 Ml/d
Features:		Gravity scheme making maximum use of existing facilities at Midmar and proposed Northern Feeder. Impendle Dam is located on a dolerite dyke. Existing geological data indicates deep excavation for dam foundation may be required. To be consistent with other schemes and as detailed geological reports not available at this stage, the deep excavation not allowed for in preliminary costing.		
Capital Costs:	Dam	R112 million	R121 million	R294 million
(Aug '97 prices):	Tunnel	R636 million		
	Pumpstation	R5 million	R5 million	R7 million
	Waterworks	R136 million	R89 million	R177 million
	Pipelines	R225 million	R293 million	
	TOTAL	**R1 114 million**	**R508 million**	**R478 million**
Running Costs:	Pumping	R0,3 million/a	R0,3 million/a	R0,5 million/a
(Aug '97 prices):	Operation & Maint.	R5,0 million/a	R3,6 million/a	R4,1 million/a
	TOTAL	**R5,3 million/a**	**R3,9 million/a**	**R4,6 million/a**
Net Present Value @ 8% (period to 2053)		R1 154 million		
Unit Reference Value @ 8% (period to 2053)		R0,94		

Note: Costs for Phases 2 and 3 represent incremental costs only

PRE-RECONNAISSANCE PHASE
SCHEME 2
CLAYBORNE - RICHMOND - UMLAAS RD

		Phase 1	Phase 2: Not practical
Transfer Capacity		6,3 m³/s (200 million m³/a)	
Transfer Route and Description		Clayborne Dam-canal-Ndonyane-pumpstation-rising main-short tunnels and pipelines to Lovu River-new waterworks near Richmond-gravity pipeline-Umlaas Road reservoir	
Dam:	Name	Clayborne	
	Type	Rockfill with clay core	
	Spillway	Side channel	
	Crest Level; **FSL**; River Bed Level	1 048 masl; **1 040 masl**; 964 masl	
	Minimum operating level	990 masl	
	Height of wall	84 m	
	Surface area at FSL	600 ha	
	Storage capacity at FSL	170 million m³(25% MAR)	
	Historical firm yield	200 million m³/a	
Canal:	Route	Along right bank of Mkomazi River, crossing near Ndonyane. Includes 16 siphons.	
	Type	Trapezoidal, concrete lined	
	Capacity	7,5 m³/s	
	Width of servitude	15 m	
	Phasing	Not feasible	
Tunnels:	Route	Under high ground between Mkomazi and Lovu watersheds	
	Length	7,5 and 0,5 km	
	Diameter	3,5 m bored/excavated (3,0 m lined)	
	Description	Bored tunnel, short tunnel drill and blast, both fully concrete lined. Free surface flow.	
	Typical rock formation	Sandstones and mudstones, with dolerite intrusions	
	Average gradients	1 in 1 000	
Pumpstation:	Location	Near Ndonyane Dam site	
	Capacity	6,3 m³/s	
	Average head	20 m	
Pipelines:	Route	Raw water: Rising main from Ndonyane pumpstation to first tunnel, link to second tunnel. Clear water: Gravity main from proposed Richmond waterworks to reservoir at Umlaas Road (new route)	
	General	All pipelines are buried	
	Diameter	1 600 mm	
	Length (total)	36,5 km	
Waterworks	Description	New waterworks near Richmond	
	Capacity	550 Ml/d	
Features		Largely a gravity scheme, with a low-lift pumpstation. Steep topography will require deep cuts for the canal, with associated stability and maintenance problems. Environmentally and socially also unattractive. Dam site may have stability problems on left flank.	
Capital Cost:	Dam	R249 million	
(Aug '97 prices)	Tunnel	R396 million	
	Pumpstation	R11 million	
	Waterworks	R350 million	
	Pipelines	R241 million	
	Canal	R210 million	
	TOTAL	**R1 457 million**	
Running Costs:	Pumping	R3,5 million/a	
(Aug '97 prices)	Operation & Maint.	R9,7 million/a	
	TOTAL	**R13,2 million/a**	
Net Present Value @ 8% (period to 2053)		R1 105 million	
Unit Reference Value @ 8% (period to 2053)		R1,16	

PRE-RECONNAISSANCE PHASE
SCHEME 3A
SMITHFIELD - RICHMOND - UMLAAS ROAD

		Phase 1	Phase 2
Transfer Capacity		6,3 m^3/s (200 million m^3/a)	Total 13,0 m^3/s (410 million m^3/a)
Transfer Route and Description		Smithfield Dam-pumpstation-shaft-tunnel to Lovu River near Richmond-new waterworks near Richmond-gravity pipeline-Umlaas Road reservoir	
Dam:	Name	Smithfield	Impendle
	Type	Rockfill with clay core	Rockfill with clay core
	Spillway	Side channel	Side channel
	Crest Level; **FSL**; River Bed Level	918 masl; **910 masl**; 858 masl	1 192 masl; **1 184 masl**; 1 095 masl
	Minimum operating level	875 masl	1 123 masl
	Height of wall	60 m	97 m
	Surface area at FSL	700 ha	2 000 ha
	Storage capacity at FSL	170 million m^3 (25% MAR)	560 million m^3 (100% MAR)
	Historical firm yield	200 million m^3/a	Total 461million m^3/a
Tunnel/Shaft:	Route	From Smithfield Dam to Lovu River near Richmond	
	Length	25,4 km	
	Diameter	3,5 m bored (3,0 m lined)	
	Description	Bored tunnel, fully concrete lined with membrane for 25% of its length. Free surface flow. Raisebored shaft, steel lined	
	Typical rock formation	Sandstones and mudstones, with dolerite intrusions	
	Average gradient	1 in 1 000	
	Inlet invert level	955 masl	
	Outlet invert level	930 masl	
	Intake works	Multi-level intake structure	
Pumpstation:	Location	Smithfield	Smithfield (upgrade)
	Capacity	6,3 m^3/s	13 m^3/s total
	Maximum/Average head	85 m/65 m	85 m/65 m
Pipelines:	Route	Clear water: Gravity main from Richmond waterworks to reservoir at Umlaas Road	
	General	All pipelines are buried	
	Diameter	1 600 mm	1 600 mm
	Length (total)	36,5 km	36,5 km
Waterworks:	Description	New waterworks near Richmond	Upgrade of Richmond Waterworks
	Capacity prior to upgrade	Nil	550 Ml/d
	Upgraded capacity	550 Ml/d	1 100 Ml/d
Features		Smithfield built to maximum height topography allows and avoids flooding of road to Bulwer at Lundy's Hill. Pumping required to minimise tunnel length. No obvious stability problems identified.	
Capital Costs:	Dam	R205 million	R321 million
(Aug '97 prices)	Tunnel	R440 million	
	Pumpstation	R53 million	R53 million
	Waterworks	R242 million	R242 million
	Pipelines	R251million	R251 million
	TOTAL	**R1 191 million**	**R867 million**
Running Costs:	Pumping	R13,0 million/a	R13,5 million/a
(Aug '97 prices)	Operation & Maint.	R6,9 million/a	R6,3 million/a
	TOTAL	**R19,9 million/a**	**R19,8 million/a**
Net Present Value @ 8% (period to 2053)		R1 187 million	
Unit Reference Value @ 8% (period to 2053		R0,91	

Note: Costs for Phase 2 represent incremental costs only

PRE-RECONNAISSANCE PHASE
SCHEME 3B
SMITHFIELD - BAYNESFIELD - UMLAAS ROAD

		Phase 1	Phase 2
Transfer Capacity		6,3 m^3/s (200 million m^3/a)	Total 13,0 m^3/s (410 million m^3/a)
Transfer Route and Description		Smithfield Dam-pumpstation-shaft-tunnel to Mlazi River near Baynesfield-new waterworks near Baynesfield-gravity pipeline-Umlaas Road reservoir	
Dam:	Name	Smithfield	Impendle
	Type	Rockfill with clay core	Rockfill with clay core
	Spillway	Side channel	Side channel
	Crest Level; **FSL**; River Bed Level	918 masl; **910 masl**; 858 masl	1 192 masl; **1 184 masl**; 1 095 masl
	Minimum operating level	875 masl	1 123 masl
	Height of wall	60 m	97 m
	Surface area at FSL	700 ha	2 000 ha
	Storage capacity at FSL	170 million m^3 (25% MAR)	560 million m^3 (100% MAR)
	Historical firm yield	200 million m^3/a	Total 461million m^3/a
Tunnel/Shaft:	Route	From Smithfield Dam to Mlazi River near Baynesfield	
	Length	32 km	
	Diameter	3,5 m bored (3,0 m lined)	
	Description	Bored tunnel, fully concrete lined with membrane for 25% of its length. Free surface flow. Drill and blasted shaft	
	Typical rock formation	Sandstones and mudstones, with dolerite intrusions	
	Average gradient	1 in 1 000	
	Inlet invert level	895 masl	
	Outlet invert level	860 masl	
	Intake works	Multi-level intake structure	
Pumpstation:	Location	Smithfield	Smithfield (upgrade)
	Capacity	6,3 m^3/s	13 m^3/s total
	Maximum/Average head	25 m/5 m	25 m/5 m
Pipelines:	Route	Clear water: Gravity main from Baynesfield waterworks to reservoir at Umlaas Road	
	General	All pipelines are buried	
	Diameter	1 600 mm	1 600 mm
	Length (total)	21 km	36,5 km
Waterworks:	Description	New waterworks near Baynesfield	Upgrade of Baynesfield Waterworks
	Capacity prior to upgrade	Nil	550 Ml/d
	Upgraded capacity	550 Ml/d	1 100 Ml/d
Features		Smithfield built to maximum height topography allows and avoids flooding of road to Bulwer at Lundy's Hill. Pumping required to minimise tunnel length. No obvious stability problems identified.	
Capital Costs:	Dam	R205 million	R321 million
(Aug '97 prices)	Tunnel	R513 million	
	Pumpstation	R38 million	R38 million
	Waterworks	R242 million	R242 million
	Pipelines	R145 million	R145 million
	TOTAL	**R1 143 million**	**R745 million**
Running Costs:	Pumping		
(Aug '97 prices)	Operation & Maint.	R3,7 million/a	R3,8 million/a
	TOTAL	R6,1 million/a	R5,5 million/a
		R9,8 million/a	**R9,3 million/a**
Net Present Value @ 8% (period to 2053)		R1 064 million	
Unit Reference Value @ 8% (period to 2053		R0,81	

Note: Costs for Phase 2 represent incremental costs only

PRE-RECONNAISSANCE PHASE
SCHEME 4
NDONYANE - RICHMOND - UMLAAS ROAD

		Phase 1	Phase 2
Transfer Capacity		6,3 m^3/s (200 million m^3/a)	Total 13,0 m^3/s (410 million m^3/a)
Transfer Route and Description		Ndonyane Dam-pumpstation-shaft-tunnel to Lovu River near Richmond-new waterworks near Richmond-gravity pipeline-Umlaas Road reservoir	
Dam:	Name	Ndonyane	Ndonyane
	Type	Rockfill with clay core	Rockfill with clay core
	Spillway	Side channel	Side channe
	Crest Level; **FSL**; River Bed Level	688 masl; **680 masl**; 600 masl	748 masl; **740 masl**; 600 masl
	Minimum operating level	620 masl	620 masl
	Height of wall	80 m	140 m
	Surface area at FSL	400 ha	870 ha
	Storage capacity at FSL	170 million m^3 (20% MAR)	560 million m^3 (70% MAR)
	Historical firm yield	200 million m^3/a	Total 464 million m^3/a
Tunnel/Shaft:	Route	From Ndonyane Dam to Lovu River near Richmond	
	Length	400 m (shaft), 14 km (tunnel)	
	Diameter	3,5 m bored (3,0 m lined)	
	Description	Bored tunnel, fully concrete lined with membrane for 25% of its length. Free surface flow. Raisebored shaft, steel lined	
	Typical rock formation	Sandstones and mudstones, with dolerite intrusions	
	Average gradient	1 in 1 000	
	Inlet invert level	945 masl	
	Outlet invert level	930 masl	
	Intake works	Multi-level intake structure	
Pumpstation:	Location	Ndonyane	Ndonyane (upgrade)
	Capacity	6,3 m^3/s	13 m^3/s total
	Maximum/Average head	340 m/300 m	340 m/300 m
Pipelines:	Route	Clear water: Gravity main from Richmond waterworks to reservoir at Umlaas Road	
	General	All pipelines are buried	
	Diameter	1 600 mm	1 600 mm
	Length (total)	36,5 km	36,5 km
Waterworks:	Description	New waterworks near Richmond	Upgrade of Richmond Waterworks
	Capacity prior to upgrade	Nil	550 Ml/d
	Upgraded capacity	550 Ml/d	1 100 Ml/d
Features		High dam, large raising will be problematic. Very high pumping head creates technical problems, costs will be very sensitive to Eskom tariffs. Also has indirect negative environmental impact due to fossil fuel combustion for energy generation. Small raw water balancing dam required at Riverdale near Richmond. No obvious stability problems identified. Significant population in basin will be affected.	
Capital Costs:	Dam	R488 million	R431 million
(Aug '97 prices)	Tunnel	R265 million	
	Pumpstation	R74 million	R74 million
	Waterworks	R242 million	R242 million
	Pipelines	R251 million	R251 million
	TOTAL	**R1 320 million**	**R998 million**
Running Costs:	Pumping	R24,8 million/a	R25,9 million/a
(Aug '97 prices)	Operation & Maint.	R7,5 million/a	R6,8 million/a
	TOTAL	**R32,3 million/a**	**R32,7 million/a**
Net Present Value @ 8% (period to 2053)		R1 382 million	
Unit Reference Value @ 8% (period to 2053		R1,06	

Note: Costs for Phase 2 represent incremental costs only

APPENDIX B2

COST ESTIMATES:
PRE-RECONNAISSANCE PHASE

DAM COST MODEL
IMPENDLE DAM (FSL = 1145)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
1.	Site and basin clearing	ha	1 836	500	918 000
2.	River Diversion	Sum			6 000 000
3.	Excavation				
	(a) all materials	m3	13	170 000	2 203 200
	(b) extra over for rock	m3	24	100 000	2 376 000
4.	Preparation of solum				
	(b) for embankment	m2	6	33 000	213 840
	(c) core trench	m2	13	9 000	116 640
5.	Drilling and Grouting				
	(a) curtain grouting	m	145	1 350	195 750
	(b) consolidation grouting	m	145	1 350	195 750
6.	Embankment				
	(a) earthfill,core	m3	17	213 000	3 680 640
	(b) rockfill	m3	33	723 000	23 859 000
	(c) filters	m3	68	53 000	3 606 120
	(d) rip-rap	m3	31	31 000	970 920
7.	SPILLWAY				
	(a)Excavation e/o to quarry	m3	10	170 000	1 700 000
	(b)Formwork	m3	70	23 000	1 610 000
	(c)Concrete	m3	380	22 000	8 360 000
	(d)Anchors and steel rebars	t	3 000	500	1 500 000
8.	Multilevel outlet structure				
	(a) civil	Sum			1 200 000
	(b) mechanical/electrical	Sum			2 500 000
	(c) River outlet	Sum			2 500 000
9.	Measuring weir	Sum			1 000 000
	Subtotal A (carried forward)				64 705 860
10.	Miscellaneous		15%		9 705 879
11.	Preliminary & General Items				
	(% of Subtotal A)	%	25%		16 176 465
	Subtotal B				90 588 204
12.	Contingencies (% of Subtotal B)	%	15%		2 426 470
	Subtotal C				93 014 674
13.	Planning design & supervision, fees, time cost & transport (% of Subtotal C)	%	15%		13 952 201
	Subtotal D				**106 966 875**
14.	VAT (% of Subtotal D)	%	14%		14 975 362
	TOTAL PROJECT COST				**121 942 237**

All rates are based on August 1997 prices

DAM COST MODEL
IMPENDLE DAM Raise from1145 (FSL = 1160)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
1.	Site and basin clearing	ha	1 836	500	918 000
2.	River Diversion	Sum			
3.	Excavation				
	(a) all materials	m3	13	100 000	1 296 000
	(b) extra over for rock	m3	24	40 000	950 400
4.	Preparation of solum				
	(b) for embankment	m2	6	20 000	129 600
	(c) core trench	m2	13	5 000	64 800
5.	Drilling and Grouting				
	(a) curtain grouting	m	145	2 000	290 000
	(b) consolidation grouting	m	145	1 000	145 000
6.	Embankment				
	(a) earthfill,core	m3	17	184 000	3 179 520
	(b) rockfill	m3	33	762 000	25 146 000
	(c) filters	m3	68	40 000	2 721 600
	(d) rip-rap	m3	31	24 000	751 680
7.	SPILLWAY				
	(a) Excavation e/o to quarry	m3	10	170 000	1 700 000
	(b) Formwork	m3	70	23 000	1 610 000
	(c) Concrete	m3	380	22 000	8 360 000
	(d) Anchors and steel rebars	t	3 000	500	1 500 000
8.	Multilevel outlet structure				
	(a) civil	Sum			2 500 000
	(b) mechanical/electrical	Sum			3 500 000
	(c) River outlet	Sum			15 500 000
9.	Measuring weir	Sum			0
	Subtotal A (carried forward)				70 262 600
10.	Miscellaneous		15%		10 539 390
11.	Preliminary & General Items				
	(% of Subtotal A)	%	25%		17 565 650
	Subtotal B				98 367 640
12.	Contingencies (% of Subtotal B)	%	15%		2 634 848
	Subtotal C				101 002 488
13.	Planning design & supervision, fees, time cost & transport				
	(% of Subtotal C)	%	15%		15 150 373
	Subtotal D				**116 152 861**
14.	VAT (% of Subtotal D)	%	14%		16 261 400
	TOTAL PROJECT COST				**132 414 261**

All rates are based on August 1997 prices

DAM COST MODEL

IMPENDLE DAM to raise from1160 to (FSL = 1195)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
			35 582		
1.	Site and basin clearing	ha	1 836	1 250	2 295 000
2.	River Diversion	Sum			
3.	Excavation				
	(a) all materials	m3	13	360 000	4 665 600
	(b) extra over for rock	m3	24	180 000	4 276 800
4.	Preparation of solum				
	(b) for embankment	m2	6	50 000	324 000
	(c) core trench	m2	13	12 000	155 520
5.	Drilling and Grouting				
	(a) curtain grouting	m	145	3 600	522 000
	(b) consolidation grouting	m	145	1 220	176 900
6.	Embankment				
	(a) earthfill,core	m3	17	654 000	11 301 120
	(b) rockfill	m3	33	2 990 000	98 670 000
	(c) filters	m3	68	120 000	8 164 800
	(d) rip-rap	m3	31	66 000	2 067 120
7.	SPILLWAY				
	(a) Excavation e/o to quarry	m3	10	170 000	1 700 000
	(b) Formwork	m3	70	23 000	1 610 000
	(c) Concrete	m3	380	22 000	8 360 000
	(d) Anchors and steel rebars	t	3 000	500	1 500 000
8.	Multilevel outlet structure				
	(a) civil	Sum			2 700 000
	(b) mechanical/electrical	Sum			5 062 500
	(c) River outlet	Sum			20 062 500
9.	Measuring weir	Sum			1 000 000
	Subtotal A (carried forward)				174 613 860
10.	Miscellaneous		15%		26 192 079
11.	Preliminary & General Items (% of Subtotal A)	%	25%		43 653 465
	Subtotal B				244 459 404
12.	Contingencies (% of Subtotal B)	%	15%		6 548 020
	Subtotal C				251 007 424
13.	Planning design & supervision, fees, time cost & transport (% of Subtotal C)	%	15%		37 651 114
	Subtotal D				**288 658 537**
14.	VAT (% of Subtotal D)	%	14%		40 412 195
	TOTAL PROJECT COST				**329 070 733**

All rates are based on August 1997 prices

DAM COST MODEL
SMITHFIELD DAM (Original Site) (FSL = 910)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
1.	Site and basin clearing	ha	1 836	1 000	1 836 000
2.	River Diversion	Sum			12 000 000
3.	Excavation				
	(a) all materials	m3	13	276 000	1 718 496
	(b) extra over for rock	m3	24	130 000	1 663 200
4.	Preparation of solum				
	(b) for embankment	m2	6	115 000	745 200
	(c) core trench	m2	13	37 000	479 520
5.	Drilling and Grouting				
	(a) curtain grouting	m2	145	4 800	696 000
	(b) consolidation grouting	m3	145	3 000	435 000
6.	Embankment				
	(a) earthfill,core	m3	17	513 000	8 864 640
	(b) rockfill	m3	33	1 705 000	56 265 000
	(c) filters	m3	68	128 000	8 709 120
	(d) rip-rap	m3	31	77 000	2 411 640
7.	SPILLWAY				
	(a)Excavation e/o to quarry	m3	10	216 000	2 160 000
	(b)Formwork	m3	70	27 000	1 890 000
	(c)Concrete	m3	380	26 000	9 880 000
	(d)Anchors and steel rebars	t	3 000	550	1 650 000
8.	Multilevel outlet structure				
	(a) civil	Sum			1 875 000
	(b) mechanical/electrical	Sum			3 375 000
	(c) River outlet	Sum			3 375 000
9.	Measuring weir	Sum			1 000 000
	Subtotal A (carried forward)				121 028 816
10.	Miscellaneous		15%		18 154 322
14.	Preliminary & General Items				
	(% of Subtotal A)	%	25%		30 257 204
	Subtotal B				169 440 342
15.	Contingencies (% of Subtotal B)	%	15%		4 538 581
	Subtotal C				173 978 923
20	Planning design & supervision, fees, time cost & transport				
	(% of Subtotal C)	%	15%		26 096 838
	Subtotal D				200 075 761
21.	VAT (% of Subtotal D)	%	14%		28 010 607
	TOTAL PROJECT COST				**228 086 368**

All rates are based on August 1997 prices

DAM COST MODEL
IMPENDLE DAM (FSL = 1184)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
1.	Site and basin clearing	ha	1 836	2 000	3 672 000
2.	River Diversion	Sum			12 000 000
3.	Excavation				
	(a) all materials	m3	13	550 000	7 128 000
	(b) extra over for rock	m3	24	260 000	6 177 600
4.	Preparation of solum				
	(b) for embankment	m2	6	85 000	550 800
	(c) core trench	m2	13	20 000	259 200
5.	Drilling and Grouting				
	(a) curtain grouting	m	145	5 400	783 000
	(b) consolidation grouting	m	145	3 300	478 500
6.	Embankment				
	(a) earthfill,core	m3	17	795 000	13 737 600
	(b) rockfill	m3	33	3 250 000	107 250 000
	(c) filters	m3	68	170 000	11 566 800
	(d) rip-rap	m3	31	100 000	3 132 000
7.	SPILLWAY				
	(a) Excavation e/o to quarry	m3	10	170 000	1 700 000
	(b) Formwork	m3	70	23 000	1 610 000
	(c) Concrete	m3	380	22 000	8 360 000
	(d) Anchors and steel rebars	t	3 000	500	1 500 000
8.	Multilevel outlet structure				
	(a) civil	Sum			2 400 000
	(b) mechanical/electrical	Sum			4 000 000
	(c) River outlet	Sum			4 000 000
9.	Measuring weir	Sum			1 000 000
	Subtotal A (carried forward)				191 305 500
10.	Miscellaneous		15%		28 695 825
11.	Preliminary & General Items (% of Subtotal A)	%	25%		47 826 375
	Subtotal B				267 827 700
12.	Contingencies (% of Subtotal B)	%	15%		7 173 956
	Subtotal C				275 001 656
13.	Planning design & supervision, fees, time cost & transport (% of Subtotal C)	%	15%		41 250 248
	Subtotal D				316 251 905
14.	VAT (% of Subtotal D)	%	14%		44 275 267
	TOTAL PROJECT COST				**360 527 171**

All rates are based on August 1997 prices

DAM COST MODEL
NDONYANE DAM (FSL = 680)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
1.	Site and basin clearing	ha	1 836	400	734 400
2.	River Diversion	Sum			15 000 000
3.	Excavation				
	(a) all materials	m3	13	460 000	5 961 600
	(b) extra over for rock	m3	24	200 000	4 752 000
4.	Preparation of solum				
	(b) for embankment	m2	6	139 000	900 720
	(c) core trench	m2	13	29 000	375 840
5.	Drilling and Grouting				
	(a) curtain grouting	m	145	6 500	942 500
	(b) consolidation grouting	m	145	3 250	471 250
6.	Embankment				
	(a) earthfill,core	m3	17	1 352 000	23 362 560
	(b) rockfill	m3	33	5 805 000	191 565 000
	(c) filters	m3	68	239 000	16 261 560
	(d) rip-rap	m3	31	107 000	3 351 240
7.	SPILLWAY				
	(a)Excavation e/o to quarry	m3	10	255 000	2 550 000
	(b)Formwork	m3	70	32 000	2 240 000
	(c)Concrete	m3	380	30 000	11 400 000
	(d)Anchors and steel rebars	t	3 000	600	1 800 000
8.	Multilevel outlet structure				
	(a) civil	Sum			3 750 000
	(b) mechanical/electrical	Sum			3 375 000
	(c) River outlet	Sum			3 375 000
9.	Measuring weir	Sum			0
	Subtotal A (carried forward)				292 168 670
10.	Miscellaneous		15%		43 825 301
11.	Preliminary, General and Preliminary works				
	(% of Subtotal A)	%	25%		73 042 168
	Subtotal B				409 036 138
12.	Contingencies (% of Subtotal B)	%	15%		10 956 325
	Subtotal C				419 992 463
13.	Planning design & supervision, fees, time cost & transport				
	(% of Subtotal C)	%	15%		62 998 869
	Subtotal D				**482 991 333**
14.	VAT (% of Subtotal D)	%	14%		67 618 787
	TOTAL PROJECT COST				**550 610 119**

All rates are based on August 1997 prices

DAM COST MODEL
NDONYANE DAM (FSL = 740 (Raised from 680))

05-05-98

No	Description	Unit	Rate	Quantity	Amount
1.	Site and basin clearing	ha	1 836	470	862 920
2.	River Diversion	Sum			0
3.	Excavation				
	(a) all materials	m3	13	430 000	5 572 800
	(b) extra over for rock	m3	24	170 000	4 039 200
4.	Preparation of solum				
	(b) for embankment	m2	6	126 000	816 480
	(c) core trench	m2	13	24 800	321 408
5.	Drilling and Grouting				
	(a) curtain grouting	m	145	2 167	314 167
	(b) consolidation grouting	m	145	1 083	157 083
6.	Embankment				
	(a) earthfill,core	m3	17	1 125 000	19 440 000
	(b) rockfill	m3	33	5 334 000	176 022 000
	(c) filters	m3	68	211 000	14 356 440
	(d) rip-rap	m3	31	105 000	3 288 600
7.	SPILLWAY				
	(a)Excavation e/o to quarry	m3	10	295 000	2 950 000
	(b)Formwork	m3	70	36 000	2 520 000
	(c)Concrete	m3	380	38 000	14 440 000
	(d)Anchors and steel rebars	t	3 000	600	1 800 000
8.	Multilevel outlet structure				
	(a) civil	Sum			3 750 000
	(b) mechanical/electrical	Sum			3 375 000
	(c) River outlet	Sum			3 375 000
9.	Measuring weir	Sum			0
	Subtotal A (carried forward)				257 401 098
10.	Miscellaneous		15%		38 610 165
11.	Preliminary, General and Preliminary works				
	(% of Subtotal A)	%	25%		64 350 274
	Subtotal B				360 361 537
12.	Contingencies (% of Subtotal B)	%	15%		9 652 541
	Subtotal C				370 014 078
13.	Planning design & supervision, fees, time cost & transport				
	(% of Subtotal C)	%	15%		55 502 112
	Subtotal D				**425 516 190**
14.	VAT (% of Subtotal D)	%	14%		59 572 267
	TOTAL PROJECT COST				**485 088 457**

All rates are based on August 1997 prices

TUNNEL COSTS
(Pre-Reconnaissance Phase)

Impendle

Item	Unit	Quantity	Rate(R)	Amount (R)
Portal development	No	3	5 000 000	15 000 000
TBM driven tunnel	m	35 500	15 300	543 150 000
Concrete Structures	Sum			15 000 000
E/O for downgrade drive	m	12 000	1 500	18 000 000
Drill and blast adits	m	3 000	15 000	45 000 000
Sub-total				**636 150 000**
VAT @ 14%				89 061 000
TOTAL				**725 211 000**

Smithfield-Richmond

Item	Unit	Quantity	Rate(R)	Amount (R)
Portal development	No	2	5 000 000	10 000 000
TBM driven tunnel	m	25 400	15 300	388 620 000
Concrete Structures	Sum			15 000 000
E/O for downgrade drive	m	12 500	1 500	18 750 000
Shaft	m	90	80 000	7 200 000
Sub-total				**439 570 000**
VAT @ 14%				61 539 800
TOTAL				**501 109 800**

Smithfield-Baynesfield

Item	Unit	Quantity	Rate(R)	Amount (R)
Portal development	No	2	5 000 000	10 000 000
TBM driven tunnel	m	31 000	15 200	471 200 000
Concrete Structures	Sum			15 000 000
E/O for downgrade drive	m	11 000	1 500	16 500 000
Sub-total				**512 700 000**
VAT @ 14%				71 778 000
TOTAL				**584 478 000**

Ndonyane

Item	Unit	Quantity	Rate(R)	Amount (R)
Portal development	No	2	5 000 000	10 000 000
TBM driven tunnel	m	13 900	15 200	211 280 000
Concrete Structures	Sum			15 000 000
Shaft	m	400	80 000	32 000 000
Inlet and outlet structures	Sum			6 500 000
Sub-total				**264 780 000**
VAT @ 14%				37 069 200
TOTAL				**301 849 200**

Costs include engineering fees

Base date Aug 1997

PIPELINE COSTS
(Pre-Reconnaissance Phase)

Impendle Phase 1

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1400 dia)	4 530	41.0	185 730
E/O for connecting to existing			10 000
Sub-total			195 730
Engineering fees @ 15 %			29 360
Sub-total			**225 090**
VAT @ 14%			31 513
TOTAL			**256 602**

Impendle Phase 2

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1800 dia)	5 850	41.0	239 850
E/O for connecting to existing			15 000
Sub-total			254 850
Engineering fees @ 15 %			38 228
Sub-total			**293 078**
VAT @ 14%			41 031
TOTAL			**334 108**

Richmond-Umlaas Rd
(Clayborne, Smithfield-Richmond & Ndonyane Schemes)

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1900 dia)	6 000	36.3	217 800
Engineering fees @ 15 %			32 670
Sub-total			**250 470**
VAT @ 14%			35 066
TOTAL			**285 536**

Baynesfield-Umlaas Rd (Smithfield-Baynesfield Scheme)

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1900 dia)	6 000	21.0	126 000
Engineering fees @ 15 %			18 900
Sub-total			**144 900**
VAT @ 14%			20 286
TOTAL			**165 186**

WATERWORKS COSTS

Based on Umgeni Water all-in unit rate of R375 000 /Ml,(excl VAT and engineering fees)

August 1997 Base Date

APPENDIX B3

ECONOMICS:
PRE-RECONNAISSANCE PHASE

Project Name	MKOMAZI-MGENI TRANSFER STUDY		**File Name**	TEST_19.WB1	
Option	SCHEME 1: IMPENDLE		**Date**	22-Aug-97	
Base Year	1997		**Component Life**	50	
Phase	1	**Commission Year**	2004	**Output (m3/s)**	3.34

Element	Type	Name	Characteristics		Capital Costs		Electricity	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.	Costs per year	Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Impendle-Midmar	3.5	34.8	543000	10000		2000	2003	4	20.0%	217200.0	4000.0	108600.0	2000.0
				Cap											
Treatment Works		Midmar		320	83000	35000		2002	2003	2	20.0%	49800.0	21000.0	33200.0	14000.0
Treatment Works															
			Dia.	**Length**											
Pipeline		Midmar-Umlaas Rd	1400	41	166000	30000		2002	2003	2	20.0%	99600.0	18000.0	66400.0	12000.0
			FSL	**h**											
Dam	Rockfill	Impendle	1145	58	78000	15000		2001	2003	3	20.0%	36400.0	7000.0	20800.0	4000.0
Dam															
			No.	**m3**											
Pump Station		Midmar	1	3.6	3000	1600	306	2003	2003	1	20.0%	3000.0	1600.0	2400.0	1280.0
Infrastructure			N/A	N/A				2000	1999						
Infrastructure			N/A	N/A											
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					873000	91600	306								
					1114290										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost
(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 1: IMPENDLE	**Date**	22-Aug-97
Base Year	1997	**Component Life**	50

Phase	2	**Commission Year**	2012	**Output (m3/s)**	3.07

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Breadth	**Length**											
Canal															
				Cap											
Treatment Works		Midmar		230	52000	25000		2010	2011	2	20.0%	31200.0	15000.0	20800.0	10000.0
Treatment Works															
			Dia.	**Length**											
Pipeline		Midmar-Umlaas Rd	1800	41	225000	30000		2010	2011	2	20.0%	135000.0	18000.0	90000.0	12000.0
			FSL	**h**											
Dam	Rockfill	Impendle (Raised)	1160	73	91000	10000		2010	2012	3	20.0%	42466.7	4666.7	24266.7	2666.7
Dam															
			No.	**m3**											
Pump Station		Midmar	1	3.6	3000	1600	306	2011	2011	1	20.0%	3000.0	1600.0	2400.0	1280.0
Infrastructure			N/A	N/A				2010	2009						
Infrastructure			N/A	N/A											
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					371000	66600	306								
					508240										

Year	Cost Factors	
	Social & Environ.	Admin.
2010	0.3000	0.0434
2011	0.4000	0.0800
2012	0.3000	0.0980
2013		0.1110
2014		0.1191
2015		0.1232
2016		0.1214
2017		0.1093
2018		0.0873
2019		0.0534
2020		0.0220
2021		0.0094
2022		0.0045
2023		0.0045
2024		0.0045
2025		0.0045
2026		0.0045
Total	0.7000	1.0000

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost
(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment Works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original	2011	
Sensitivity		
Sensitised	2011	

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 1: IMPENDLE	**Date**	22-Aug-97
Base Year	1997	**Component Life**	50

Phase	3	**Commission Year**	2018	Output (m3/s)	4.41

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Breadth	**Length**											
Canal															
Canal															
Canal															
Canal															
Canal															
Canal															
Canal															
Canal															
Canal															
Canal															
			Dia.	**Length**											
Tunnel															
Tunnel															
Tunnel															
Tunnel															
Tunnel															
Tunnel															
Tunnel															
Tunnel															
Tunnel															
			Dia.	**Length**											
Pipeline															
Pipeline															
Pipeline															
Pipeline															
Pipeline															
Pipeline															
Pipeline															
Pipeline															
			FSL	**h**											
Dam	Rockfill	Impendle	1190	103	221000	30000		2015	2017	3	20.0%	103133.3	14000.0	58933.3	8000.0
Dam															
Dam															
Dam															
Dam															
				Cap											
Treatment Works		Midmar		150	104000	50000		2016	2017	2	20.0%	62400.0	30000.0	41600.0	20000.0
Pump Station		Midmar		4.4	4000	2000	460	2017	2017	1	20.0%	4000.0	2000.0	3200.0	1600.0
Pump Station															
Pump Station															
Pump Station															
Pump Station															
Pump Station															
Total					329000	82000	460								

Year	Cost Factors	
	Social & Environ.	Admin.
2015		
2016	0.3000	
2017	0.4000	
2018	0.3000	
2019		
2020		
2021		
2022		
2023		
2024		
2025		
2026		
2027		
2028		
2029		
2030		
2031		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost
(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment Works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 1: IMPENDLE

YEAR	PHASE 1			PHASE 2			PHASE 3						TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	19 355.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19 355.00	0.00	0.00
1999	22 610.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22 610.00	0.00	0.00
2000	253 141.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	253 141.00	0.00	0.00
2001	177 471.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	177 471.00	0.00	0.00
2002	351 365.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	351 365.00	0.00	0.00
2003	288 848.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	288 848.00	0.00	0.00
2004	1 500.00	5 032.00	40.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1 500.00	5 032.00	40.87
2005	0.00	5 032.00	75.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5 032.00	75.48
2006	0.00	5 032.00	110.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5 032.00	110.89
2007	0.00	5 032.00	147.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5 032.00	147.42
2008	0.00	5 032.00	185.13	15 155.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15 155.00	5 032.00	185.13
2009	0.00	5 032.00	224.04	15 316.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	15 316.00	5 032.00	224.04
2010	0.00	5 032.00	264.19	267 701.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	267 701.00	5 032.00	264.19
2011	0.00	5 032.00	306.10	179 480.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	179 480.00	5 032.00	306.10
2012	0.00	5 032.00	306.10	30 588.00	2 964.00	47.06	0.00	0.00	0.00	0.00	0.00	0.00	30 588.00	7 996.00	353.16
2013	0.00	5 032.00	306.10	0.00	1 829.00	95.64	8 785.00	0.00	0.00	0.00	0.00	0.00	8 785.00	6 861.00	401.74
2014	0.00	5 032.00	306.10	0.00	3 591.50	145.80	14 175.00	0.00	0.00	0.00	0.00	0.00	14 175.00	8 623.50	451.90
2015	0.00	5 032.00	306.10	0.00	3 591.50	197.57	132 104.00	0.00	0.00	0.00	0.00	0.00	132 104.00	8 623.50	503.68
2016	0.00	5 032.00	306.10	0.00	3 591.50	250.86	173 790.00	0.00	0.00	0.00	0.00	0.00	173 790.00	8 623.50	556.97
2017	0.00	5 032.00	306.10	0.00	3 591.50	305.87	147 296.00	0.00	0.00	0.00	0.00	0.00	147 296.00	8 623.50	611.98
2018	0.00	10 522.00	306.10	0.00	3 591.50	305.87	1 500.00	4 102.50	59.47	0.00	0.00	0.00	1 500.00	18 216.00	671.44
2019	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	120.85	0.00	0.00	0.00	0.00	12 726.00	732.83
2020	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	184.21	0.00	0.00	0.00	0.00	12 726.00	796.19
2021	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	249.92	0.00	0.00	0.00	0.00	12 726.00	861.90
2022	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	317.76	0.00	0.00	0.00	0.00	12 726.00	929.74
2023	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	387.80	0.00	0.00	0.00	0.00	12 726.00	999.77
2024	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2025	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2026	0.00	5 032.00	306.10	0.00	7 581.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	16 716.00	1 072.08
2027	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2028	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2029	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2030	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2031	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2032	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	11 902.50	460.10	0.00	0.00	0.00	0.00	20 526.00	1 072.08
2033	0.00	10 522.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	18 216.00	1 072.08
2034	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2035	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2036	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2037	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2038	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2039	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2040	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2041	0.00	5 032.00	306.10	0.00	7 581.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	16 716.00	1 072.08
2042	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2043	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2044	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2045	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2046	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2047	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	11 902.50	460.10	0.00	0.00	0.00	0.00	20 526.00	1 072.08
2048	0.00	10 522.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	18 216.00	1 072.08
2049	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2050	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2051	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2052	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
2053	0.00	5 032.00	306.10	0.00	3 591.50	305.87	0.00	4 102.50	460.10	0.00	0.00	0.00	0.00	12 726.00	1 072.08
TOTAL	**1 114 290**	**268 070**	**14 210**	**508 240**	**156 433**	**12 054**	**477 650**	**163 290**	**15 123**	**0**	**0**	**0**	**2 100 180**	**587 793**	**41 388**
Commission date		2004			2012			2018			0				
Transfer capacity (m3/s)		3.34			3.07			4.41			0.00				

(CONTINUED.....)

Check	**R 1 114 290**	**R 508 240**	**R 477 650**	**R 0**

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 1: IMPENDLE

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	18 259	0	0	17 921	0	0	17 595	0	0
1999	20 123	0	0	19 384	0	0	18 686	0	0
2000	212 542	0	0	200 951	0	0	190 189	0	0
2001	140 574	0	0	130 446	0	0	121 215	0	0
2002	262 560	0	0	239 133	0	0	218 170	0	0
2003	203 626	0	0	182 023	0	0	163 047	0	0
2004	998	3 347	27	875	2 936	24	770	2 582	21
2005	0	3 157	47	0	2 719	41	0	2 347	35
2006	0	2 978	66	0	2 517	55	0	2 134	47
2007	0	2 810	82	0	2 331	68	0	1 940	57
2008	7 983	2 651	98	6 500	2 158	79	5 312	1 764	65
2009	7 612	2 501	111	6 082	1 998	89	4 880	1 603	71
2010	125 509	2 359	124	98 433	1 850	97	77 543	1 458	77
2011	79 384	2 226	135	61 106	1 713	104	47 263	1 325	81
2012	12 763	3 336	147	9 643	2 521	111	7 323	1 914	85
2013	3 458	2 701	158	2 564	2 003	117	1 912	1 493	87
2014	5 264	3 202	168	3 831	2 331	122	2 804	1 706	89
2015	46 282	3 021	176	33 059	2 158	126	23 760	1 551	91
2016	57 440	2 850	184	40 269	1 998	129	28 416	1 410	91
2017	45 928	2 689	191	31 602	1 850	131	21 895	1 282	91
2018	441	5 358	198	298	3 619	133	203	2 462	91
2019	0	3 532	203	0	2 341	135	0	1 563	90
2020	0	3 332	208	0	2 167	136	0	1 421	89
2021	0	3 143	213	0	2 007	136	0	1 292	88
2022	0	2 965	217	0	1 858	136	0	1 175	86
2023	0	2 797	220	0	1 721	135	0	1 068	84
2024	0	2 639	222	0	1 593	134	0	971	82
2025	0	2 490	210	0	1 475	124	0	882	74
2026	0	3 085	198	0	1 794	115	0	1 054	68
2027	0	2 216	187	0	1 265	107	0	729	61
2028	0	2 090	176	0	1 171	99	0	663	56
2029	0	1 972	166	0	1 084	91	0	603	51
2030	0	1 860	157	0	1 004	85	0	548	46
2031	0	1 755	148	0	930	78	0	498	42
2032	0	2 671	139	0	1 388	73	0	730	38
2033	0	2 236	132	0	1 141	67	0	589	35
2034	0	1 474	124	0	738	62	0	374	32
2035	0	1 390	117	0	683	58	0	340	29
2036	0	1 311	110	0	633	53	0	309	26
2037	0	1 237	104	0	586	49	0	281	24
2038	0	1 167	98	0	542	46	0	256	22
2039	0	1 101	93	0	502	42	0	232	20
2040	0	1 039	88	0	465	39	0	211	18
2041	0	1 287	83	0	566	36	0	252	16
2042	0	925	78	0	399	34	0	175	15
2043	0	872	73	0	369	31	0	159	13
2044	0	823	69	0	342	29	0	144	12
2045	0	776	65	0	316	27	0	131	11
2046	0	732	62	0	293	25	0	119	10
2047	0	1 114	58	0	438	23	0	175	9
2048	0	933	55	0	360	21	0	141	8
2049	0	615	52	0	233	20	0	90	8
2050	0	580	49	0	215	18	0	81	7
2051	0	547	46	0	199	17	0	74	6
2052	0	516	43	0	185	16	0	67	6
RES+2050	0	487	41	0	171	14	0	61	5
TOTAL	**1 250 746**	**102 897**	**6 218**	**1 084 122**	**65 875**	**3 738**	**950 982**	**44 432**	**2 362**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 359 861**	**2 023**	**67.23**
8%	**R 1 153 735**	**1 223**	**94.37**
10%	**R 997 777**	**777**	**128.41**

"

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 3A: SMITHFIELD-RICHMOND	**Date**	22-Aug-97
Base Year	1997	**Component Life**	50

Phase	1	**Commission Year**	2004	**Output (m3/s)**	6.41

Element	Type	Name	Characteristics		Capital Costs		Electricity	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.	Costs per year	Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Smithfield-Lovu	3.5	25.4	373000	10000		2000	2003	4	20.0%	149200.0	4000.0	74600.0	2000.0
				Cap											
Treatment Works		Richmond		550	157000	53000		2002	2003	2	20.0%	94200.0	31800.0	62800.0	21200.0
Treatment Works											20.0%				
			Dia.	**Length**											
Pipeline		Richmond-Umlaas Rd	1600	36.5	188000	30000		2002	2003	2	20.0%	112800.0	18000.0	75200.0	12000.0
			FSL	**h**											
Dam	Rockfill	Smithfield	910	75	154000	20000		2001	2003	3	20.0%	71866.7	9333.3	41066.7	5333.3
Dam															
			No.	**m3**											
Pump Station		Smithfield		6.5	30100	16300	13000	2003	2003	1		30100.0	16300.0	30100.0	16300.0
			Cap	**Length**				2000	1999						
Canals											20.0%				
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					902100	129300	13000								
					1191110										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 3A: SMITHFIELD-RICHMOND	**Date**	22-Aug-97
Base Year	1997	**Component Life**	50

Phase	2	**Commission Year**	2018	**Output (m3/s)**	6.64

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Breadth	**Length**											
Canal															
				Cap											
Treatment Works		Richmond		550	157000	53000		2016	2017	2	20.0%	94200.0	31800.0	62800.0	21200.0
Treatment Works															
			Dia.	**Length**											
Pipeline		Richmond-Umlaas Rd	1600	36.5	188000	30000		2016	2017	2	20.0%	112800.0	18000.0	75200.0	12000.0
			FSL	**h**											
Dam	Rockfill	Impendle	1184	97	255000	20000		2015	2017	3	20.0%	119000.0	9333.3	68000.0	5333.3
Dam															
			No.	**m3**											
Pump Station		Smithfield		6.5	30100	16300	13500	2017	2017	1	20.0%	30100.0	16300.0	24080.0	13040.0
Infrastructure			N/A	N/A				2015	2014						
Infrastructure			N/A	N/A											
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					630100	119300	13500								
					866810										

Year	Cost Factors	
	Social & Environ.	Admin.
2015		
2016	0.3000	
2017	0.4000	
2018	0.3000	
2019		
2020		
2021		
2022		
2023		
2024		
2025		
2026		
2027		
2028		
2029		
2030		
2031		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment Works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3A: SMITHFIELD-RICHMOND

YEAR	PHASE 1			PHASE 2									TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
1998	13 405.00	0.00	0.00	0.00	0.00	0.00							13 405.00	0.00	0.00
1999	19 495.00	0.00	0.00	0.00	0.00	0.00							19 495.00	0.00	0.00
2000	186 526.00	0.00	0.00	0.00	0.00	0.00							186 526.00	0.00	0.00
2001	187 028.00	0.00	0.00	0.00	0.00	0.00							187 028.00	0.00	0.00
2002	413 308.00	0.00	0.00	0.00	0.00	0.00							413 308.00	0.00	0.00
2003	369 848.00	0.00	0.00	0.00	0.00	0.00							369 848.00	0.00	0.00
2004	1 500.00	6 867.75	736.98	0.00	0.00	0.00							1 500.00	6 867.75	736.98
2005	0.00	6 867.75	1 670.79	0.00	0.00	0.00							0.00	6 867.75	1 670.79
2006	0.00	6 867.75	2 454.39	0.00	0.00	0.00							0.00	6 867.75	2 454.39
2007	0.00	6 867.75	3 263.07	0.00	0.00	0.00							0.00	6 867.75	3 263.07
2008	0.00	6 867.75	4 097.64	0.00	0.00	0.00							0.00	6 867.75	4 097.64
2009	0.00	6 867.75	4 958.91	0.00	0.00	0.00							0.00	6 867.75	4 958.91
2010	0.00	6 867.75	5 847.75	0.00	0.00	0.00							0.00	6 867.75	5 847.75
2011	0.00	6 867.75	6 775.35	0.00	0.00	0.00							0.00	6 867.75	6 775.35
2012	0.00	6 867.75	7 732.97	0.00	0.00	0.00							0.00	6 867.75	7 732.97
2013	0.00	6 867.75	8 721.59	9 625.00	0.00	0.00							9 625.00	6 867.75	8 721.59
2014	0.00	6 867.75	9 742.20	24 605.00	0.00	0.00							24 605.00	6 867.75	9 742.20
2015	0.00	6 867.75	10 795.85	155 204.00	0.00	0.00							155 204.00	6 867.75	10 795.85
2016	0.00	6 867.75	11 880.27	359 668.00	0.00	0.00							359 668.00	6 867.75	11 880.27
2017	0.00	6 867.75	12 999.68	316 208.00	0.00	0.00							316 208.00	6 867.75	12 999.68
2018	0.00	17 262.75	13 000.00	1 500.00	6 347.25	1 155.66							1 500.00	23 610.00	14 155.66
2019	0.00	6 867.75	13 000.00	0.00	6 347.25	2 348.94							0.00	13 215.00	15 348.94
2020	0.00	6 867.75	13 000.00	0.00	6 347.25	3 580.71							0.00	13 215.00	16 580.71
2021	0.00	6 867.75	13 000.00	0.00	6 347.25	4 858.04							0.00	13 215.00	17 858.04
2022	0.00	6 867.75	13 000.00	0.00	6 347.25	6 176.77							0.00	13 215.00	19 176.77
2023	0.00	6 867.75	13 000.00	0.00	6 347.25	7 538.24							0.00	13 215.00	20 538.24
2024	0.00	6 867.75	13 000.00	0.00	6 347.25	8 943.84							0.00	13 215.00	21 943.84
2025	0.00	6 867.75	13 000.00	0.00	6 347.25	10 395.00							0.00	13 215.00	23 395.00
2026	0.00	6 867.75	13 000.00	0.00	6 347.25	11 900.78							0.00	13 215.00	24 900.78
2027	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2028	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2029	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2030	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2031	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2032	0.00	6 867.75	13 000.00	0.00	16 742.25	13 455.62							0.00	23 610.00	26 455.62
2033	0.00	17 262.75	13 000.00	0.00	6 347.25	13 455.62							0.00	23 610.00	26 455.62
2034	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2035	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2036	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2037	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2038	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2039	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2040	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2041	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2042	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2043	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2044	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2045	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2046	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2047	0.00	6 867.75	13 000.00	0.00	16 742.25	13 455.62							0.00	23 610.00	26 455.62
2048	0.00	17 262.75	13 000.00	0.00	6 347.25	13 455.62							0.00	23 610.00	26 455.62
2049	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2050	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2051	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2052	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
2053	0.00	6 867.75	13 000.00	0.00	6 347.25	13 455.62							0.00	13 215.00	26 455.62
TOTAL	**1 191 110**	**374 573**	**559 677**	**866 810**	**249 291**	**420 200**							**2 057 920**	**623 864**	**979 877**
Commission date		2004			2018			0			0				
Transfer capacity (m3/s)		6.41			6.64			0.00			0.00				

(CONTINUED.....)

Check	**R 1 191 110**	**R 866 810**	**R 0**	**R 0**

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3A: SMITHFIELD-RICHMOND

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	12 646	0	0	12 412	0	0	12 186	0	0
1999	17 350	0	0	16 714	0	0	16 112	0	0
2000	156 611	0	0	148 070	0	0	140 140	0	0
2001	148 144	0	0	137 471	0	0	127 743	0	0
2002	308 848	0	0	281 290	0	0	256 632	0	0
2003	260 728	0	0	233 067	0	0	208 770	0	0
2004	998	4 567	490	875	4 007	430	770	3 524	378
2005	0	4 309	1 048	0	3 710	903	0	3 204	779
2006	0	4 065	1 453	0	3 436	1 228	0	2 913	1 041
2007	0	3 835	1 822	0	3 181	1 511	0	2 648	1 258
2008	0	3 618	2 159	0	2 945	1 757	0	2 407	1 436
2009	0	3 413	2 464	0	2 727	1 969	0	2 188	1 580
2010	0	3 220	2 742	0	2 525	2 150	0	1 989	1 694
2011	0	3 038	2 997	0	2 338	2 307	0	1 808	1 784
2012	0	2 866	3 227	0	2 165	2 438	0	1 644	1 851
2013	3 789	2 703	3 433	2 809	2 005	2 546	2 095	1 495	1 898
2014	9 137	2 550	3 618	6 650	1 856	2 633	4 868	1 359	1 927
2015	54 375	2 406	3 782	38 840	1 719	2 702	27 915	1 235	1 942
2016	118 875	2 270	3 927	83 339	1 591	2 753	58 809	1 123	1 943
2017	98 595	2 141	4 053	67 842	1 473	2 789	47 002	1 021	1 932
2018	441	6 945	4 164	298	4 690	2 812	203	3 190	1 913
2019	0	3 667	4 259	0	2 431	2 823	0	1 623	1 886
2020	0	3 460	4 341	0	2 251	2 824	0	1 476	1 852
2021	0	3 264	4 411	0	2 084	2 816	0	1 342	1 813
2022	0	3 079	4 468	0	1 930	2 800	0	1 220	1 770
2023	0	2 905	4 515	0	1 787	2 777	0	1 109	1 723
2024	0	2 740	4 550	0	1 654	2 747	0	1 008	1 674
2025	0	2 585	4 577	0	1 532	2 712	0	916	1 622
2026	0	2 439	4 596	0	1 418	2 673	0	833	1 570
2027	0	2 301	4 606	0	1 313	2 629	0	757	1 516
2028	0	2 171	4 345	0	1 216	2 434	0	688	1 378
2029	0	2 048	4 099	0	1 126	2 254	0	626	1 253
2030	0	1 932	3 867	0	1 043	2 087	0	569	1 139
2031	0	1 823	3 649	0	965	1 932	0	517	1 036
2032	0	3 072	3 442	0	1 597	1 789	0	840	941
2033	0	2 898	3 247	0	1 479	1 657	0	764	856
2034	0	1 530	3 063	0	766	1 534	0	389	778
2035	0	1 444	2 890	0	710	1 420	0	353	707
2036	0	1 362	2 726	0	657	1 315	0	321	643
2037	0	1 285	2 572	0	608	1 218	0	292	585
2038	0	1 212	2 426	0	563	1 128	0	265	531
2039	0	1 143	2 289	0	522	1 044	0	241	483
2040	0	1 079	2 160	0	483	967	0	219	439
2041	0	1 018	2 037	0	447	895	0	199	399
2042	0	960	1 922	0	414	829	0	181	363
2043	0	906	1 813	0	383	767	0	165	330
2044	0	854	1 711	0	355	711	0	150	300
2045	0	806	1 614	0	329	658	0	136	273
2046	0	760	1 522	0	304	609	0	124	248
2047	0	1 282	1 436	0	503	564	0	201	225
2048	0	1 209	1 355	0	466	522	0	183	205
2049	0	639	1 278	0	242	484	0	93	186
2050	0	602	1 206	0	224	448	0	85	169
2051	0	568	1 138	0	207	415	0	77	154
2052	0	536	1 073	0	192	384	0	70	140
RES+2050	0	506	1 012	0	178	355	0	64	127
TOTAL	**1 190 537**	**112 030**	**141 596**	**1 029 678**	**72 747**	**84 149**	**903 242**	**49 846**	**52 672**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 444 164**	**2 203**	**65.55**
8%	**R 1 186 574**	**1 309**	**90.62**
10%	**R 1 005 760**	**820**	**122.72**

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Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 3B: SMITHFIELD-BAYNESFIELD	**Date**	22-Aug-97
Base Year	1997	**Component Life**	50

Phase	1	**Commission Year**	2004	**Output (m3/s)**	6.41

Element	Type	Name	Characteristics		Capital Costs		Electricity	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.	Costs per year	Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Smithfield-Baynesfield	3.5	32	436000	10000		2000	2003	4	20.0%	174400.0	4000.0	87200.0	2000.0
				Cap											
Treatment Works		Baynesfield		550	157000	53000		2002	2003	2	20.0%	94200.0	31800.0	62800.0	21200.0
Treatment Works											20.0%				
			Dia.	**Length**											
Pipeline		Baynesfield-Umlaas Rd	1600	21	106000	20000		2002	2003	2	20.0%	63600.0	12000.0	42400.0	8000.0
			FSL	**h**											
Dam	Rockfill	Smithfield	910	75	154000	20000		2001	2003	3	20.0%	71866.7	9333.3	41066.7	5333.3
Dam															
			No.	**m3**											
Pump Station		Smithfield		6.5	21400	11600	3670	2003	2003	1		21400.0	11600.0	21400.0	11600.0
			Cap	**Length**				2000	1999						
Canals											20.0%				
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					874400	114600	3670								
					1142350										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 3B: SMITHFIELD-BAYNESFIELD	**Date**	22-Aug-97
Base Year	1997	**Component Life**	50

Phase	2	**Commission Year**	2018	**Output (m3/s)**	6.64

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Breadth	**Length**											
Canal															
				Cap											
Treatment Works		Baynesfield		550	157000	53000		2016	2017	2	20.0%	94200.0	31800.0	62800.0	21200.0
Treatment Works															
			Dia.	**Length**											
Pipeline		Baynesfield-Umlaas Rd	1600	21	106000	20000		2016	2017	2	20.0%	63600.0	12000.0	42400.0	8000.0
			FSL	**h**											
Dam	Rockfill	Impendle	1184	97	255000	20000		2015	2017	3	20.0%	119000.0	9333.3	68000.0	5333.3
Dam															
			No.	**m3**											
Pump Station		Smithfield		6.5	21400	11600	3800	2017	2017	1	20.0%	21400.0	11600.0	17120.0	9280.0
Infrastructure			N/A	N/A				2015	2014						
Infrastructure			N/A	N/A											
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					539400	104600	3800								
					745600										

Year	Cost Factors	
	Social & Environ.	Admin.
2015		
2016	0.3000	
2017	0.4000	
2018	0.3000	
2019		
2020		
2021		
2022		
2023		
2024		
2025		
2026		
2027		
2028		
2029		
2030		
2031		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment Works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3B: SMITHFIELD-BAYNESFIELD

YEAR	PHASE 1			PHASE 2									TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
1998	15 610.00	0.00	0.00	0.00	0.00	0.00							15 610.00	0.00	0.00
1999	21 700.00	0.00	0.00	0.00	0.00	0.00							21 700.00	0.00	0.00
2000	210 522.00	0.00	0.00	0.00	0.00	0.00							210 522.00	0.00	0.00
2001	196 947.00	0.00	0.00	0.00	0.00	0.00							196 947.00	0.00	0.00
2002	366 831.00	0.00	0.00	0.00	0.00	0.00							366 831.00	0.00	0.00
2003	329 240.00	0.00	0.00	0.00	0.00	0.00							329 240.00	0.00	0.00
2004	1 500.00	6 116.00	208.05	0.00	0.00	0.00							1 500.00	6 116.00	208.05
2005	0.00	6 116.00	471.68	0.00	0.00	0.00							0.00	6 116.00	471.68
2006	0.00	6 116.00	692.89	0.00	0.00	0.00							0.00	6 116.00	692.89
2007	0.00	6 116.00	921.19	0.00	0.00	0.00							0.00	6 116.00	921.19
2008	0.00	6 116.00	1 156.79	0.00	0.00	0.00							0.00	6 116.00	1 156.79
2009	0.00	6 116.00	1 399.94	0.00	0.00	0.00							0.00	6 116.00	1 399.94
2010	0.00	6 116.00	1 650.87	0.00	0.00	0.00							0.00	6 116.00	1 650.87
2011	0.00	6 116.00	1 912.73	0.00	0.00	0.00							0.00	6 116.00	1 912.73
2012	0.00	6 116.00	2 183.08	0.00	0.00	0.00							0.00	6 116.00	2 183.08
2013	0.00	6 116.00	2 462.17	9 625.00	0.00	0.00							9 625.00	6 116.00	2 462.17
2014	0.00	6 116.00	2 750.30	21 385.00	0.00	0.00							21 385.00	6 116.00	2 750.30
2015	0.00	6 116.00	3 047.75	151 515.00	0.00	0.00							151 515.00	6 116.00	3 047.75
2016	0.00	6 116.00	3 353.89	299 583.00	0.00	0.00							299 583.00	6 116.00	3 353.89
2017	0.00	6 116.00	3 669.91	261 992.00	0.00	0.00							261 992.00	6 116.00	3 669.91
2018	0.00	15 806.00	3 670.00	1 500.00	5 532.50	325.30							1 500.00	21 338.50	3 995.30
2019	0.00	6 116.00	3 670.00	0.00	5 532.50	661.18							0.00	11 648.50	4 331.18
2020	0.00	6 116.00	3 670.00	0.00	5 532.50	1 007.90							0.00	11 648.50	4 677.90
2021	0.00	6 116.00	3 670.00	0.00	5 532.50	1 367.45							0.00	11 648.50	5 037.45
2022	0.00	6 116.00	3 670.00	0.00	5 532.50	1 738.65							0.00	11 648.50	5 408.65
2023	0.00	6 116.00	3 670.00	0.00	5 532.50	2 121.87							0.00	11 648.50	5 791.87
2024	0.00	6 116.00	3 670.00	0.00	5 532.50	2 517.52							0.00	11 648.50	6 187.52
2025	0.00	6 116.00	3 670.00	0.00	5 532.50	2 926.00							0.00	11 648.50	6 596.00
2026	0.00	6 116.00	3 670.00	0.00	5 532.50	3 349.85							0.00	11 648.50	7 019.85
2027	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2028	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2029	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2030	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2031	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2032	0.00	6 116.00	3 670.00	0.00	15 222.50	3 787.51							0.00	21 338.50	7 457.51
2033	0.00	15 806.00	3 670.00	0.00	5 532.50	3 787.51							0.00	21 338.50	7 457.51
2034	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2035	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2036	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2037	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2038	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2039	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2040	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2041	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2042	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2043	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2044	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2045	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2046	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2047	0.00	6 116.00	3 670.00	0.00	15 222.50	3 787.51							0.00	21 338.50	7 457.51
2048	0.00	15 806.00	3 670.00	0.00	5 532.50	3 787.51							0.00	21 338.50	7 457.51
2049	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2050	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2051	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2052	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
2053	0.00	6 116.00	3 670.00	0.00	5 532.50	3 787.51							0.00	11 648.50	7 457.51
TOTAL	**1 142 350**	**334 870**	**158 001**	**745 600**	**218 550**	**118 278**							**1 887 950**	**553 420**	**276 280**
Commission date		2004			2018			0			0				
Transfer capacity (m3/s)		6.41			6.64			0.00			0.00				

(CONTINUED.....)

Check	R 1 142 350	R 745 600	R 0	R 0

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3B: SMITHFIELD-BAYNESFIELD

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	14 726	0	0	14 454	0	0	14 191	0	0
1999	19 313	0	0	18 604	0	0	17 934	0	0
2000	176 758	0	0	167 119	0	0	158 168	0	0
2001	156 000	0	0	144 762	0	0	134 517	0	0
2002	274 117	0	0	249 659	0	0	227 773	0	0
2003	232 101	0	0	207 477	0	0	185 847	0	0
2004	998	4 067	138	875	3 569	121	770	3 138	107
2005	0	3 837	296	0	3 304	255	0	2 853	220
2006	0	3 620	410	0	3 060	347	0	2 594	294
2007	0	3 415	514	0	2 833	427	0	2 358	355
2008	0	3 222	609	0	2 623	496	0	2 144	405
2009	0	3 039	696	0	2 429	556	0	1 949	446
2010	0	2 867	774	0	2 249	607	0	1 772	478
2011	0	2 705	846	0	2 082	651	0	1 611	504
2012	0	2 552	911	0	1 928	688	0	1 464	523
2013	3 789	2 408	969	2 809	1 785	719	2 095	1 331	536
2014	7 942	2 271	1 021	5 780	1 653	743	4 231	1 210	544
2015	53 082	2 143	1 068	37 916	1 531	763	27 251	1 100	548
2016	99 016	2 021	1 109	69 417	1 417	777	48 984	1 000	548
2017	81 690	1 907	1 144	56 210	1 312	787	38 943	909	546
2018	441	6 277	1 175	298	4 239	794	203	2 883	540
2019	0	3 233	1 202	0	2 143	797	0	1 431	532
2020	0	3 050	1 225	0	1 984	797	0	1 301	522
2021	0	2 877	1 244	0	1 837	794	0	1 183	511
2022	0	2 714	1 260	0	1 701	790	0	1 075	499
2023	0	2 560	1 273	0	1 575	783	0	977	486
2024	0	2 416	1 283	0	1 458	775	0	889	472
2025	0	2 279	1 290	0	1 350	765	0	808	457
2026	0	2 150	1 296	0	1 250	753	0	734	443
2027	0	2 028	1 298	0	1 158	741	0	668	427
2028	0	1 913	1 225	0	1 072	686	0	607	389
2029	0	1 805	1 156	0	992	635	0	552	353
2030	0	1 703	1 090	0	919	588	0	502	321
2031	0	1 606	1 028	0	851	545	0	456	292
2032	0	2 776	970	0	1 443	504	0	759	265
2033	0	2 619	915	0	1 336	467	0	690	241
2034	0	1 349	864	0	675	432	0	343	219
2035	0	1 272	815	0	625	400	0	311	199
2036	0	1 200	769	0	579	371	0	283	181
2037	0	1 132	725	0	536	343	0	257	165
2038	0	1 068	684	0	496	318	0	234	150
2039	0	1 008	645	0	460	294	0	213	136
2040	0	951	609	0	426	273	0	193	124
2041	0	897	574	0	394	252	0	176	113
2042	0	846	542	0	365	234	0	160	102
2043	0	798	511	0	338	216	0	145	93
2044	0	753	482	0	313	200	0	132	85
2045	0	711	455	0	290	185	0	120	77
2046	0	670	429	0	268	172	0	109	70
2047	0	1 158	405	0	455	159	0	182	64
2048	0	1 093	382	0	421	147	0	165	58
2049	0	563	360	0	213	136	0	82	53
2050	0	531	340	0	197	126	0	75	48
2051	0	501	321	0	183	117	0	68	43
2052	0	473	303	0	169	108	0	62	39
RES+2050	0	446	285	0	157	100	0	56	36
TOTAL	**1 119 975**	**99 503**	**39 936**	**975 381**	**64 643**	**23 737**	**860 908**	**44 312**	**14 859**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 259 414**	**2 203**	**57.16**
8%	**R 1 063 760**	**1 309**	**81.24**
10%	**R 920 079**	**820**	**112.26**

"

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 4: NDONYANE	**Date**	22-Aug-97
Base Year	1997	**Component Life**	50

Phase	1	**Commission Year**	2004	**Output (m3/s)**	6.41

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Ndonyane-Lovu	3.5	14	220000	10000		2000	2003	4	20.0%	88000.0	4000.0	44000.0	2000.0
				Cap											
Treatment Works		Richmond		550	157000	53000		2002	2003	2	20.0%	94200.0	31800.0	62800.0	21200.0
Treatment Works											20.0%				
			Dia.	**Length**											
Pipeline		Richmond-Umlaas Rd	1600	36.5	188000	30000		2002	2003	2	20.0%	112800.0	18000.0	75200.0	12000.0
			FSL	**h**											
Dam	Rockfill	Ndonyane	680	110	400000	20000		2001	2003	3	20.0%	186666.7	9333.3	106666.7	5333.3
Dam															
			No.	**m3**											
Pump Station		Ndonyane		6.5	44400	20000	24800	2003	2003	1		44400.0	20000.0	44400.0	20000.0
			Cap	**Length**				2000	1999						
Canals											20.0%				
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					1009400	133000	24800								
					1318760										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 4: NDONYANE	**Date**	22-Aug-97
Base Year	1997	**Component Life**	50

Phase	2	**Commission Year**	2018	**Output (m3/s)**	6.64

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Breadth	**Length**											
Canal															
				Cap											
Treatment Works		Richmond		550	157000	53000		2016	2017	2	20.0%	94200.0	31800.0	62800.0	21200.0
Treatment Works															
			Dia.	**Length**											
Pipeline		Richmond-Umlaas Rd	1600	36.5	188000	30000		2016	2017	2	20.0%	112800.0	18000.0	75200.0	12000.0
			FSL	**h**											
Dam	Rockfill	Ndonyane (Raised)	740	145	350000	20000		2015	2017	3	20.0%	163333.3	9333.3	93333.3	5333.3
Dam															
			No.	**m3**											
Pump Station		Ndonyane		6.5	44400	20000	26000	2017	2017	1	20.0%	44400.0	20000.0	35520.0	16000.0
Infrastructure			N/A	N/A				2015	2014						
Infrastructure			N/A	N/A											
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					739400	123000	26000								
					996760										

Year	Cost Factors	
	Social & Environ.	Admin.
2015		
2016	0.3000	
2017	0.4000	
2018	0.3000	
2019		
2020		
2021		
2022		
2023		
2024		
2025		
2026		
2027		
2028		
2029		
2030		
2031		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment Works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 4: NDONYANE

YEAR	PHASE 1			PHASE 2									TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
1998	8 050.00	0.00	0.00	0.00	0.00	0.00							8 050.00	0.00	0.00
1999	22 750.00	0.00	0.00	0.00	0.00	0.00							22 750.00	0.00	0.00
2000	129 040.00	0.00	0.00	0.00	0.00	0.00							129 040.00	0.00	0.00
2001	278 594.00	0.00	0.00	0.00	0.00	0.00							278 594.00	0.00	0.00
2002	451 738.00	0.00	0.00	0.00	0.00	0.00							451 738.00	0.00	0.00
2003	427 088.00	0.00	0.00	0.00	0.00	0.00							427 088.00	0.00	0.00
2004	1 500.00	7 513.50	1 405.93	0.00	0.00	0.00							1 500.00	7 513.50	1 405.93
2005	0.00	7 513.50	3 187.35	0.00	0.00	0.00							0.00	7 513.50	3 187.35
2006	0.00	7 513.50	4 682.22	0.00	0.00	0.00							0.00	7 513.50	4 682.22
2007	0.00	7 513.50	6 224.94	0.00	0.00	0.00							0.00	7 513.50	6 224.94
2008	0.00	7 513.50	7 817.03	0.00	0.00	0.00							0.00	7 513.50	7 817.03
2009	0.00	7 513.50	9 460.08	0.00	0.00	0.00							0.00	7 513.50	9 460.08
2010	0.00	7 513.50	11 155.71	0.00	0.00	0.00							0.00	7 513.50	11 155.71
2011	0.00	7 513.50	12 925.29	0.00	0.00	0.00							0.00	7 513.50	12 925.29
2012	0.00	7 513.50	14 752.13	0.00	0.00	0.00							0.00	7 513.50	14 752.13
2013	0.00	7 513.50	16 638.11	12 950.00	0.00	0.00							12 950.00	7 513.50	16 638.11
2014	0.00	7 513.50	18 585.12	27 930.00	0.00	0.00							27 930.00	7 513.50	18 585.12
2015	0.00	7 513.50	20 595.16	203 714.00	0.00	0.00							203 714.00	7 513.50	20 595.16
2016	0.00	7 513.50	22 663.90	387 658.00	0.00	0.00							387 658.00	7 513.50	22 663.90
2017	0.00	7 513.50	24 799.40	363 008.00	0.00	0.00							363 008.00	7 513.50	24 799.40
2018	0.00	18 463.50	24 800.00	1 500.00	6 768.50	2 225.72							1 500.00	25 232.00	27 025.72
2019	0.00	7 513.50	24 800.00	0.00	6 768.50	4 523.88							0.00	14 282.00	29 323.88
2020	0.00	7 513.50	24 800.00	0.00	6 768.50	6 896.19							0.00	14 282.00	31 696.19
2021	0.00	7 513.50	24 800.00	0.00	6 768.50	9 356.22							0.00	14 282.00	34 156.22
2022	0.00	7 513.50	24 800.00	0.00	6 768.50	11 895.99							0.00	14 282.00	36 695.99
2023	0.00	7 513.50	24 800.00	0.00	6 768.50	14 518.09							0.00	14 282.00	39 318.09
2024	0.00	7 513.50	24 800.00	0.00	6 768.50	17 225.17							0.00	14 282.00	42 025.17
2025	0.00	7 513.50	24 800.00	0.00	6 768.50	20 020.00							0.00	14 282.00	44 820.00
2026	0.00	7 513.50	24 800.00	0.00	6 768.50	22 920.03							0.00	14 282.00	47 720.03
2027	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2028	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2029	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2030	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2031	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2032	0.00	7 513.50	24 800.00	0.00	17 718.50	25 914.53							0.00	25 232.00	50 714.53
2033	0.00	18 463.50	24 800.00	0.00	6 768.50	25 914.53							0.00	25 232.00	50 714.53
2034	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2035	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2036	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2037	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2038	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2039	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2040	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2041	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2042	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2043	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2044	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2045	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2046	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2047	0.00	7 513.50	24 800.00	0.00	17 718.50	25 914.53							0.00	25 232.00	50 714.53
2048	0.00	18 463.50	24 800.00	0.00	6 768.50	25 914.53							0.00	25 232.00	50 714.53
2049	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2050	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2051	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2052	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
2053	0.00	7 513.50	24 800.00	0.00	6 768.50	25 914.53							0.00	14 282.00	50 714.53
TOTAL	**1 318 760**	**408 525**	**1 067 692**	**996 760**	**265 566**	**809 274**							**2 315 520**	**674 091**	**1 876 966**
Commission date		2004			2018			0			0				
Transfer capacity (m3/s)		6.41			6.64			0.00			0.00				

(CONTINUED.....)

Check	**R 1 318 760**	**R 996 760**	**R 0**	**R 0**

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 4: NDONYANE

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	7 594	0	0	7 454	0	0	7 318	0	0
1999	20 247	0	0	19 504	0	0	18 802	0	0
2000	108 344	0	0	102 436	0	0	96 950	0	0
2001	220 673	0	0	204 775	0	0	190 283	0	0
2002	337 565	0	0	307 445	0	0	280 494	0	0
2003	301 080	0	0	269 138	0	0	241 080	0	0
2004	998	4 997	935	875	4 384	820	770	3 856	721
2005	0	4 714	2 000	0	4 059	1 722	0	3 505	1 487
2006	0	4 447	2 771	0	3 759	2 342	0	3 186	1 986
2007	0	4 195	3 476	0	3 480	2 883	0	2 897	2 400
2008	0	3 958	4 118	0	3 222	3 353	0	2 633	2 740
2009	0	3 734	4 701	0	2 984	3 757	0	2 394	3 014
2010	0	3 523	5 230	0	2 763	4 102	0	2 176	3 231
2011	0	3 323	5 717	0	2 558	4 401	0	1 979	3 404
2012	0	3 135	6 156	0	2 369	4 650	0	1 799	3 532
2013	5 098	2 958	6 550	3 780	2 193	4 857	2 818	1 635	3 621
2014	10 372	2 790	6 902	7 549	2 031	5 023	5 526	1 487	3 677
2015	71 370	2 632	7 215	50 979	1 880	5 154	36 640	1 351	3 704
2016	128 126	2 483	7 491	89 825	1 741	5 251	63 385	1 229	3 706
2017	113 188	2 343	7 733	77 883	1 612	5 321	53 959	1 117	3 686
2018	441	7 422	7 950	298	5 012	5 369	203	3 410	3 652
2019	0	3 963	8 138	0	2 627	5 394	0	1 754	3 602
2020	0	3 739	8 298	0	2 432	5 398	0	1 595	3 540
2021	0	3 527	8 436	0	2 252	5 386	0	1 450	3 468
2022	0	3 328	8 550	0	2 085	5 358	0	1 318	3 387
2023	0	3 139	8 643	0	1 931	5 316	0	1 198	3 299
2024	0	2 962	8 715	0	1 788	5 261	0	1 089	3 206
2025	0	2 794	8 768	0	1 655	5 195	0	990	3 108
2026	0	2 636	8 807	0	1 533	5 122	0	900	3 008
2027	0	2 487	8 830	0	1 419	5 040	0	818	2 906
2028	0	2 346	8 330	0	1 314	4 667	0	744	2 642
2029	0	2 213	7 859	0	1 217	4 321	0	676	2 402
2030	0	2 088	7 414	0	1 127	4 001	0	615	2 184
2031	0	1 970	6 994	0	1 043	3 704	0	559	1 985
2032	0	3 283	6 598	0	1 707	3 430	0	898	1 805
2033	0	3 097	6 225	0	1 580	3 176	0	816	1 641
2034	0	1 654	5 872	0	828	2 941	0	420	1 491
2035	0	1 560	5 540	0	767	2 723	0	382	1 356
2036	0	1 472	5 226	0	710	2 521	0	347	1 233
2037	0	1 389	4 931	0	657	2 334	0	316	1 121
2038	0	1 310	4 651	0	609	2 162	0	287	1 019
2039	0	1 236	4 388	0	564	2 001	0	261	926
2040	0	1 166	4 140	0	522	1 853	0	237	842
2041	0	1 100	3 905	0	483	1 716	0	216	765
2042	0	1 038	3 684	0	447	1 589	0	196	696
2043	0	979	3 476	0	414	1 471	0	178	633
2044	0	923	3 279	0	384	1 362	0	162	575
2045	0	871	3 094	0	355	1 261	0	147	523
2046	0	822	2 918	0	329	1 168	0	134	475
2047	0	1 370	2 753	0	538	1 081	0	215	432
2048	0	1 292	2 597	0	498	1 001	0	195	393
2049	0	690	2 450	0	261	927	0	101	357
2050	0	651	2 312	0	242	858	0	91	325
2051	0	614	2 181	0	224	795	0	83	295
2052	0	579	2 057	0	207	736	0	76	268
RES+2050	0	547	1 941	0	192	681	0	69	244
TOTAL	**1 325 096**	**121 488**	**270 945**	**1 141 941**	**78 989**	**160 956**	**998 227**	**54 188**	**100 710**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 717 529**	**2 203**	**77.96**
8%	**R 1 381 887**	**1 309**	**105.54**
10%	**R 1 153 125**	**820**	**140.70**

"

APPENDIX C1

SCHEME DETAILS:
RECONNAISSANCE PHASE

RECONNAISSANCE PHASE
SCHEME 1
IMPENDLE - MIDMAR - NORTHERN FEEDER

		Phase 1	Phase 2	Phase 3
Transfer Capacity		3,6 m^3/s raw water, 4,6 m^3/s clear water (115 million m^3/a ave.)	Total 6,3 m^3/s raw water, 7,9 m^3/a clear water (200 million m^3/a ave.)	Total 10,8 m^3/s raw water, 13,5 m^3/s clear water (340 million m^3/a ave.)
Transfer Route and Description		Impendle Dam-gravity tunnel-uGqishi River-Midmar Dam-pumpstation-Midmar Waterworks-gravity pipeline/tunnel-Midmar Tunnel-gravity pipeline (Northern Feeder)-Umlaas Road reservoir		
Dam:	Name	Impendle	Impendle raised	Impendle raised
	Type	Rockfill with clay core	Rockfill with clay core	Rockfill with clay core
	Spillway	Side channel	Side channel	Side channel
	Crest Level; **FSL**; River Bed Level	1 153 masl; **1 145 masl**; 1 095 masl	1 168 masl; **1 160 masl**; 1 095 masl	1 198 masl; **1 190 masl**; 1095 masl
	Minimum operating level	1 123 masl	1 123 masl	1 123 masl
	Height of wall	58 m	73 m	90 m
	Surface area at FSL	500 ha	1 000 ha	2 250 ha
	Storage capacity at FSL	58 million m^3 (10% MAR)	200 million m^3 (35% MAR)	680 million m^3
	Historical firm yield	115 million m^3/a	200 million m^3/a	380 million m^3/a
Tunnel:	Route	From Impendle Dam to uGqishi River immediately upstream of Midmar Dam		
	Length	35,1 km		
	Diameter	3,5 m bored (3,0 m lined)		
	Description	Bored tunnel, fully concrete lined with membrane for 25% of its length. Free surface flow.		
	Typical rock formation	Sandstones and mudstones, with dolerite intrusions		
	Average gradient	1 in 1 000		
	Inlet invert level	1 115 masl		
	Outlet invert level	1 080 masl		
	Intake works	Multi-level intake structure		
Pumpstation:	Location	Midmar	Midmar (upgrade)	Midmar (upgrade)
	Capacity	4,5 m^3/s peak	8 m^3/s total peak	13,5 m^3/s total peak
	Average head	10 m	10 m	10 m
Pipelines:	Route	Raw water: Rising main from Midmar Dam to Midmar Water Treatment Works; Clear water: Gravity main to proposed Howick Tunnel, gravity link to existing Midmar Tunnel, gravity main from portal to reservoir at Umlaas Road, along route of proposed Northern Feeder		
	General	All pipelines are buried. Proposed Northern Feeder and existing pipelines will not be utilised.		
	Diameter	1 400 mm	1 900 mm	–
	Length (total)	41 km	41 km	
Waterworks:	Description	Upgrade of existing Midmar Waterworks	Upgrade of existing Midmar Waterworks	Upgrade of existing Midmar Waterworks
	Capacity prior to upgrade	370 Ml/d average	760 Ml/d peak	1 050 Ml/d peak
	Upgraded capacity	760 Ml/d peak	1 050 Ml/d peak	1 530 Ml/d peak
Features:		Gravity scheme making maximum use of existing facilities at Midmar and proposed Northern Feeder. Impendle Dam is located on a dolerite dyke. Existing geological data indicates deep excavation for dam foundation may be required. To be consistent with other schemes and as detailed geological reports not available at this stage, the deep excavation not allowed for in preliminary costing.		
Capital Costs: (Aug '97 prices):	Dam	R112 million	R121 million	R294 million
	Tunnel	R634 million		
	Pumpstation	R6 million	R6 million	R9 million
	Waterworks	R170 million	R125 million	R207 million
	Pipelines	R225 million	R377 million	
	TOTAL	**R1 147 million**	**R629 million**	**R510 million**
Running Costs: (Aug '97 prices):	Pumping	R0,3 million/a	R0,3 million/a	R0,5 million/a
	Operation & Maint.	R5,4 million/a	R4,4 million/a	R4,6 million/a
	TOTAL	**R5,7 million/a**	**R4,7 million/a**	**R5,1 million/a**
Net Present Value @ 8% (period to 2053)		R1 234 million		
Unit Reference Value @ 8% (period to 2053)		R1,01		

Note: Costs for Phases 2 and 3 represent incremental costs only

RECONNAISSANCE PHASE
SCHEME 3A
SMITHFIELD - RICHMOND - UMLAAS ROAD

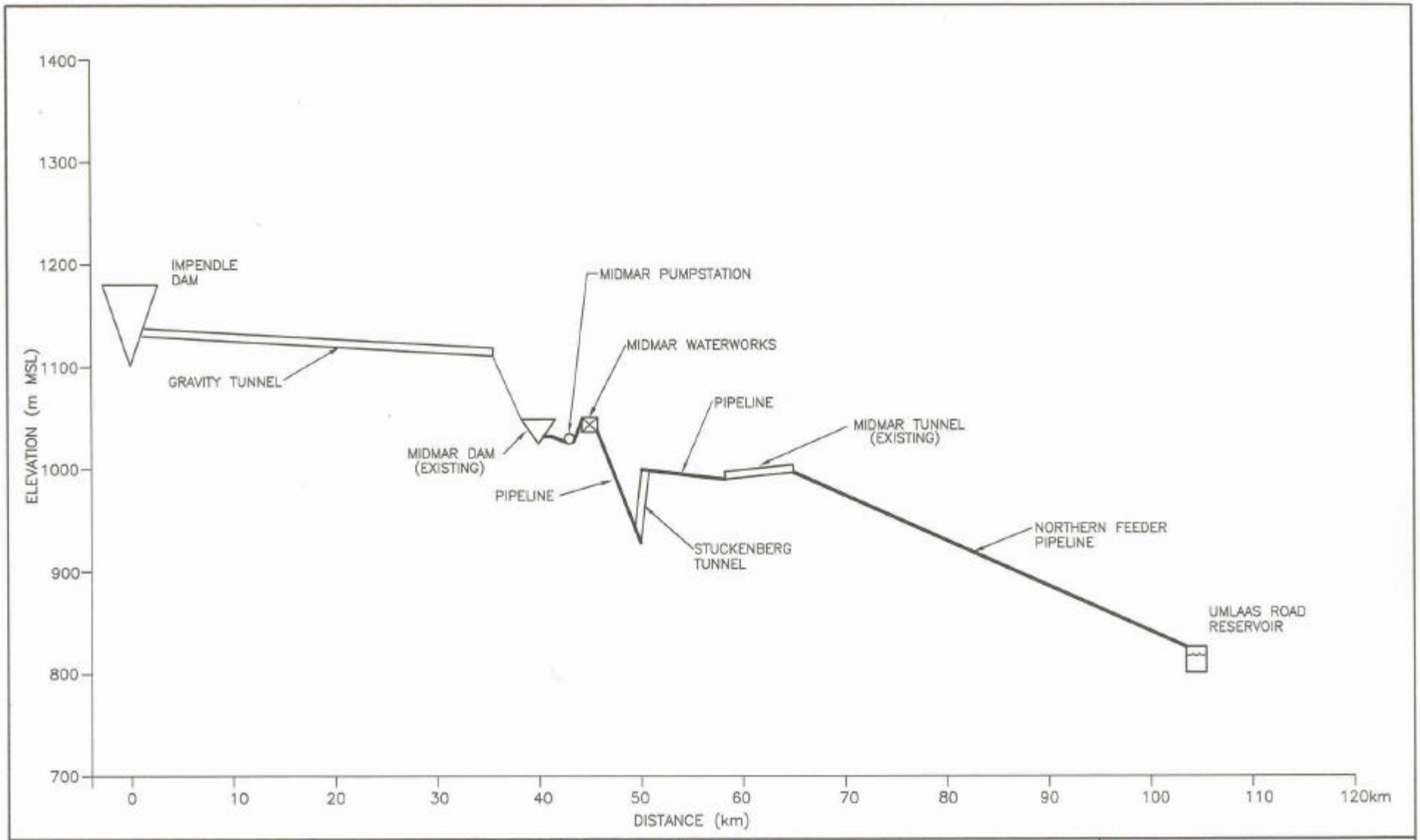
		Phase 1	Phase 2
Transfer Capacity		7,9 m^3/s (200 million m^3/a ave.)	Total 16,3 m^3/s (410 million m^3/a ave.)
Transfer Route and Description		Smithfield Dam-pumpstation-shaft-tunnel to Lovu River near Richmond-new waterworks near Richmond-gravity pipeline-Umlaas Road reservoir	
Dam:	Name	Smithfield	Impendle
	Type	Rockfill with clay core	Rockfill with clay core
	Spillway	Side channel	Side channel
	Crest Level; **FSL**; River Bed Level	918 masl; **910 masl**; 858 masl	1 192 masl; **1 184 masl**; 1 095 masl
	Minimum operating level	875 masl	1 123 masl
	Height of wall	60 m	97 m
	Surface area at FSL	700 ha	2 000 ha
	Storage capacity at FSL	170 million m^3 (25% MAR)	560 million m^3 (100% MAR)
	Historical firm yield	200 million m^3/a	Total 461million m^3/a
Tunnel/Shaft:	Route	From Smithfield Dam to Lovu River near Richmond	
	Length	25,4 km	
	Diameter	3,5 m bored (3,0 m lined)	
	Description	Bored tunnel, fully concrete lined with membrane for 25% of its length. Free surface flow. Raisebored shaft, steel lined	
	Typical rock formation	Sandstones and mudstones, with dolerite intrusions	
	Average gradient	1 in 1 000	
	Inlet invert level	1 010 masl	
	Outlet invert level	980 masl	
	Intake works	Multi-level intake structure	
Pumpstation:	Location	Smithfield	Smithfield (upgrade)
	Capacity	7,9 m^3/s peak	15,8 m^3/s total peak
	Maximum/Average head	135 m/115 m	135 m/115 m
Pipelines:	Route	Clear water: Gravity main from Richmond waterworks to reservoir at Umlaas Road	
	General	All pipelines are buried	
	Diameter	1 900 mm	1 900 mm
	Length (total)	38 km	38 km
Waterworks:	Description	New waterworks near Richmond	Upgrade of Richmond Waterworks
	Capacity prior to upgrade	Nil	690 Ml/d peak
	Upgraded capacity	690 Ml/d peak	1 380 Ml/d peak
Features		Smithfield built to maximum height topography allows and avoids flooding of road to Bulwer at Lundy's Hill. Pumping required to minimise tunnel length. 500 000 m^3 raw water balancing dam on Lovu River near waterworks. No obvious stability problems identified.	
Capital Costs:	Dam	R132 million	R321 million
(Aug '97 prices)	Tunnel	R432 million	
	Pumpstation	R100 million	R100 million
	Waterworks	R298 million	R298 million
	Balancing dam	R12million	R351 million
	Pipelines	R351 million	**R1 070 million**
	TOTAL	**R1325 million**	
			R15,2 million/a
Running Costs:	Pumping	R14,0 million/a	R8,7 million/a
(Aug '97 prices)	Operation & Maint.	R9,1 million/a	**R23,9 million/a**
	TOTAL	**R23,6 million/a**	
Net Present Value @ 8% (period to 2053)		R1 352 million	
Unit Reference Value @ 8% (period to 2053		R1,03	

Note: Costs for Phase 2 represent incremental costs only

RECONNAISSANCE PHASE
SCHEME 3B
SMITHFIELD - BAYNESFIELD - UMLAAS ROAD

		Phase 1	Phase 2
Transfer Capacity		7,9 m³/s (200 million m³/a ave.)	Total 13,0 m³/s (410 million m³/a ave.)
Transfer Route and Description		Smithfield Dam-pumpstation-shaft-tunnel to Mlazi River near Baynesfield-new waterworks near Baynesfield-gravity pipeline-Umlaas Road reservoir	
Dam:	Name	Smithfield	Impendle
	Type	Rockfill with clay core	Rockfill with clay core
	Spillway	Side channel	Side channe
	Crest Level; **FSL**; River Bed Level	918 masl; **910 masl**; 858 masl	1 192 masl; **1 184 masl**; 1 095 mas
	Minimum operating level	875 masl	1 123 mas
	Height of wall	60 m	97 m
	Surface area at FSL	700 ha	2 000 ha
	Storage capacity at FSL	170 million m³(25% MAR)	560 million m³ (100% MAR)
	Historical firm yield	200 million m³/a	Total 461million m³/a
Tunnel/Shaft:	Route	From Smithfield Dam to Mlazi River near Baynesfield	
	Length	32 km	
	Diameter	3,5 m bored (3,0 m lined)	
	Description	Bored tunnel, fully concrete lined with membrane for 25% of its length. Free surface flow. Drill and blasted shaft	
	Typical rock formation	Sandstones and mudstones, with dolerite intrusions	
	Average gradient	1 in 1 000	
	Inlet invert level	940 masl	
	Outlet invert level	900 masl	
	Intake works	Multi-level intake structure	
Pumpstation:	Location	Smithfield	Smithfield (upgrade)
	Capacity	6,3 m³/s peak	13 m³/s total peak
	Maximum/Average head	70 m/50 m	25 m/5 m
Pipelines:	Route	Clear water: Gravity main from Baynesfield waterworks to reservoir at Umlaas Road.	
	General	All pipelines are buried.	
	Diameter	1 900 mm	1 900 mm
	Length (total)	21 km	21 km
Waterworks:	Description	New waterworks near Baynesfield	Upgrade of Baynesfield Waterworks
	Capacity prior to upgrade	Nil	690 Ml/d peak
	Upgraded capacity	690 Ml/d peak	1 380 Ml/d
Features		Smithfield built to maximum height topography allows and avoids flooding of road to Bulwer at Lundy's Hill. Pumping required to minimise tunnel length. 500 000 m³ raw water balancing dam on Mlazi River near Baynesfield. No obvious stability problems identified.	
Capital Costs:	Dam	R132 million	R321 million
(Aug '97 prices)	Tunnel	R546 million	-
	Pumpstation	R48 million	R48 million
	Waterworks	R298 million	R298 million
	Balancing dam	R1 million	-
	Pipelines	R222 million	R222 million
	TOTAL	**R1 247 million**	**R889 million**
Running Costs:	Pumping		
(Aug '97 prices)	Operation & Maint.	R6,2 million/a	R6,4 million/a
	TOTAL	R7,8 million/a	R7,3 million/a
		R14,0 million/a	**R13,7 million/a**
Net Present Value @ 8% (period to 2053)		R1 201 million	
Unit Reference Value @ 8% (period to 2053		R0,92	

Note: Costs for Phase 2 represent incremental costs only

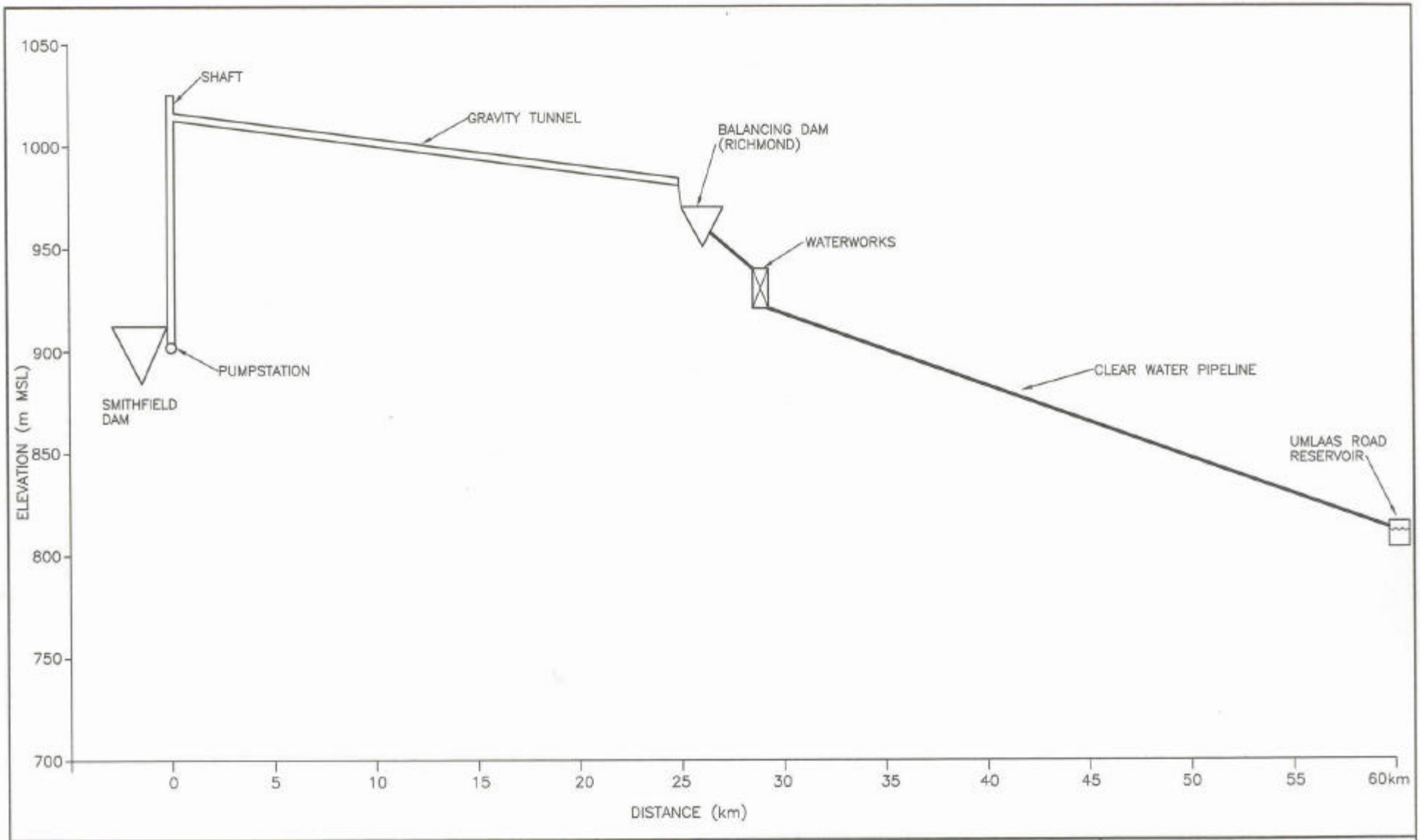


NINHAM SHAND
CONSULTING ENGINEERS

MKOMAZI MGENI TRANSFER SCHEME

SCHEME 1 : IMPENDLE

SCALE
HOR 1:500 000
VER 1:5000

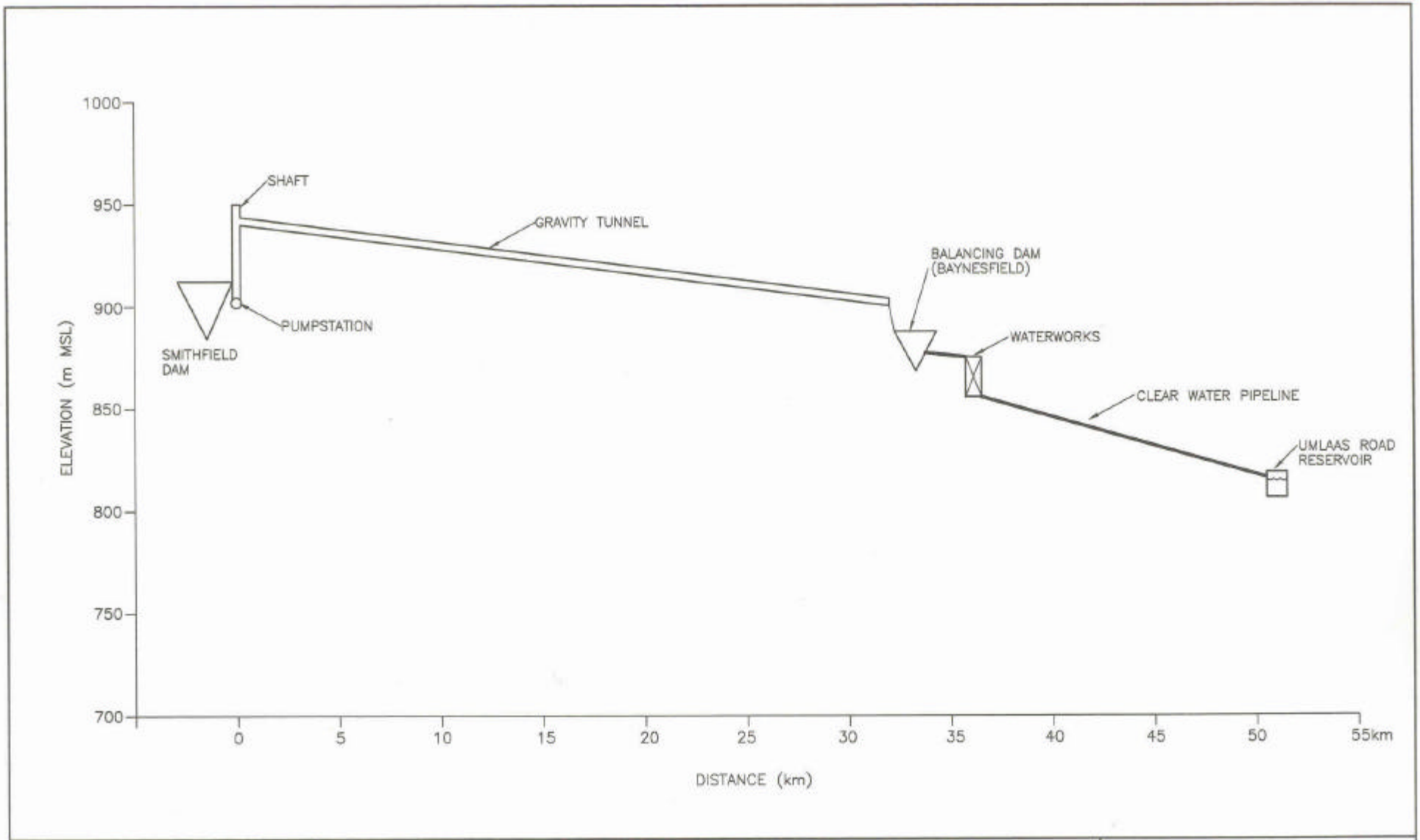


NINHAM SHAND
CONSULTING ENGINEERS

MKOMAZI MGENI TRANSFER SCHEME

SCHEME 3A : SMITHFIELD–RICHMOND

SCALE
HOR 1:250 000
VER 1:2500

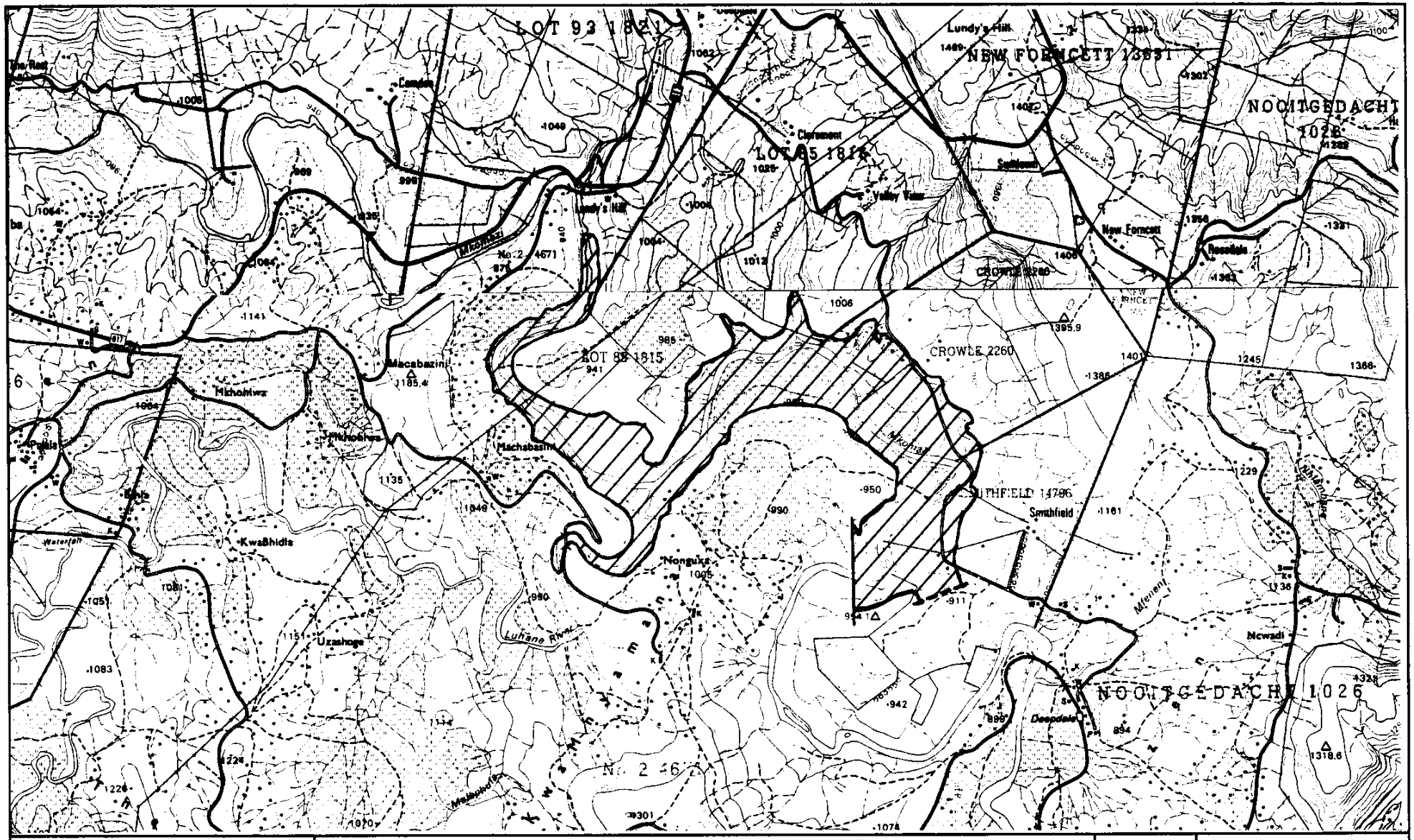


NINHAM SHAND
CONSULTING ENGINEERS

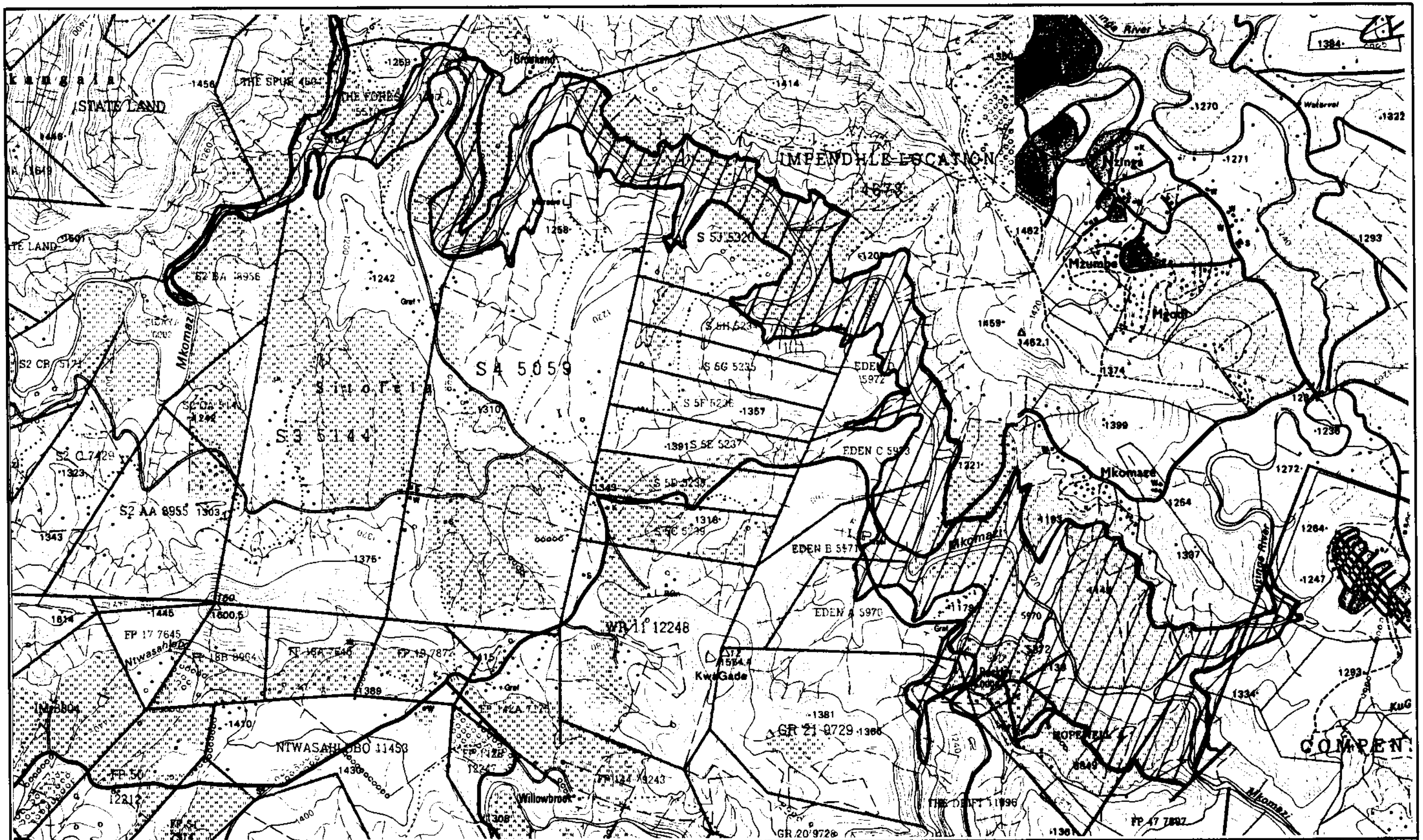
MKOMAZI MGENI TRANSFER SCHEME

SCHEME 3B : SMITHFIELD–BAYNESFIELD

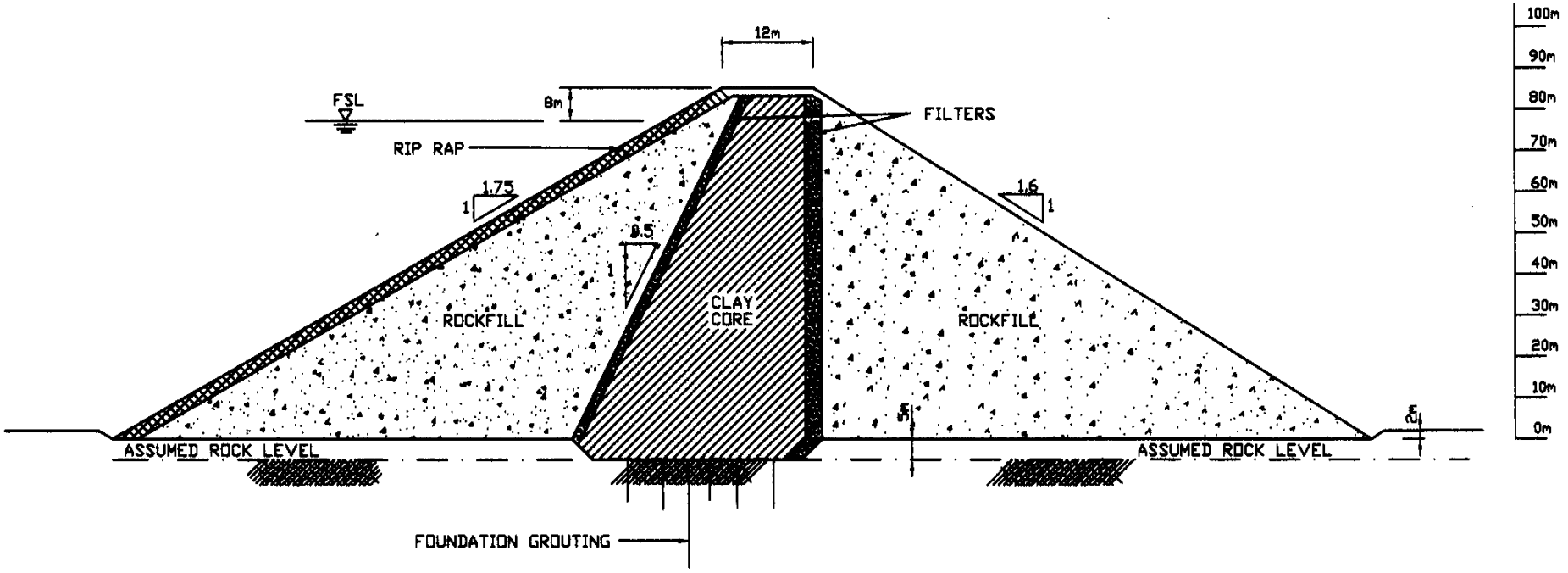
SCALE
HOR 1:250 000
VER 1:2500



NINHAM SHAND CONSULTING ENGINEERS	DEPARTMENT OF WATER AFFAIRS AND FORESTRY MKOMAZI–MGENI PRE–FEASIBILITY STUDY	SCALE	DRAWING No
	SMITHFIELD DAM BASIN AT 910m FSL	1 : 50 000	



NINHAM SHAND CONSULTING ENGINEERS	DEPARTMENT OF WATER AFFAIRS AND FORESTRY MKOMAZI–MGENI PRE–FEASIBILITY STUDY	SCALE	DRAWING No
	IMPENDLE DAM BASIN AT 1160m FSL	1 : 50 000	



SMITHFIELD AND IMPENDLE ROCKFILL DAMS

NINHAM SHAND CONSULTING ENGINEERS	DEPARTMENT OF WATER AFFAIRS AND FORESTRY MKOMAZI–MGENI PRE–FEASIBILITY STUDY TYPICAL SECTION	SCALE NTS	DRAWING No

APPENDIX C2

COST ESTIMATES:
RECONNAISSANCE PHASE

DAM COST MODEL
IMPENDLE DAM (FSL = 1145)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
1.	Site and basin clearing	ha	1 836	500	918 000
2.	River Diversion	Sum			6 000 000
3.	Excavation				
	(a) all materials	m3	13	170 000	2 203 200
	(b) extra over for rock	m3	24	100 000	2 376 000
4.	Preparation of solum				
	(b) for embankment	m2	6	33 000	213 840
	(c) core trench	m2	13	9 000	116 640
5.	Drilling and Grouting				
	(a) curtain grouting	m	145	1 350	195 750
	(b) consolidation grouting	m	145	1 350	195 750
6.	Embankment				
	(a) earthfill,core	m3	17	213 000	3 680 640
	(b) rockfill	m3	33	723 000	23 859 000
	(c) filters	m3	68	53 000	3 606 120
	(d) rip-rap	m3	31	31 000	970 920
7.	SPILLWAY				
	(a)Excavation e/o to quarry	m3	10	170 000	1 700 000
	(b)Formwork	m3	70	23 000	1 610 000
	(c)Concrete	m3	380	22 000	8 360 000
	(d)Anchors and steel rebars	t	3 000	500	1 500 000
8.	Multilevel outlet structure				
	(a) civil	Sum			1 200 000
	(b) mechanical/electrical	Sum			2 500 000
	(c) River outlet	Sum			2 500 000
9.	Measuring weir	Sum			1 000 000
	Subtotal A (carried forward)				64 705 860
10.	Miscellaneous		15%		9 705 879
11.	Preliminary & General Items				
	(% of Subtotal A)	%	25%		16 176 465
	Subtotal B				90 588 204
12.	Contingencies (% of Subtotal B)	%	15%		2 426 470
	Subtotal C				93 014 674
13.	Planning design & supervision, fees, time cost & transport (% of Subtotal C)	%	15%		13 952 201
	Subtotal D				**106 966 875**
14.	VAT (% of Subtotal D)	%	14%		14 975 362
	TOTAL PROJECT COST				**121 942 237**

All rates are based on August 1997 prices

DAM COST MODEL
IMPENDLE DAM Raise from1145 (FSL = 1160)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
1.	Site and basin clearing	ha	1 836	500	918 000
2.	River Diversion	Sum			
3.	Excavation				
	(a) all materials	m3	13	100 000	1 296 000
	(b) extra over for rock	m3	24	40 000	950 400
4.	Preparation of solum				
	(b) for embankment	m2	6	20 000	129 600
	(c) core trench	m2	13	5 000	64 800
5.	Drilling and Grouting				
	(a) curtain grouting	m	145	2 000	290 000
	(b) consolidation grouting	m	145	1 000	145 000
6.	Embankment				
	(a) earthfill,core	m3	17	184 000	3 179 520
	(b) rockfill	m3	33	762 000	25 146 000
	(c) filters	m3	68	40 000	2 721 600
	(d) rip-rap	m3	31	24 000	751 680
7.	SPILLWAY				
	(a) Excavation e/o to quarry	m3	10	170 000	1 700 000
	(b) Formwork	m3	70	23 000	1 610 000
	(c) Concrete	m3	380	22 000	8 360 000
	(d) Anchors and steel rebars	t	3 000	500	1 500 000
8.	Multilevel outlet structure				
	(a) civil	Sum			2 500 000
	(b) mechanical/electrical	Sum			3 500 000
	(c) River outlet	Sum			15 500 000
9.	Measuring weir	Sum			0
	Subtotal A (carried forward)				70 262 600
10.	Miscellaneous		15%		10 539 390
11.	Preliminary & General Items				
	(% of Subtotal A)	%	25%		17 565 650
	Subtotal B				98 367 640
12.	Contingencies (% of Subtotal B)	%	15%		2 634 848
	Subtotal C				101 002 488
13.	Planning design & supervision, fees, time cost & transport				
	(% of Subtotal C)	%	15%		15 150 373
	Subtotal D				**116 152 861**
14.	VAT (% of Subtotal D)	%	14%		16 261 400
	TOTAL PROJECT COST				**132 414 261**

All rates are based on August 1997 prices

DAM COST MODEL

IMPENDLE DAM to raise from1160 to (FSL = 1190)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
			35 582		
1.	Site and basin clearing	ha	1 836	1 250	2 295 000
2.	River Diversion	Sum			
3.	Excavation				
	(a) all materials	m3	13	360 000	4 665 600
	(b) extra over for rock	m3	24	180 000	4 276 800
4.	Preparation of solum				
	(b) for embankment	m2	6	50 000	324 000
	(c) core trench	m2	13	12 000	155 520
5.	Drilling and Grouting				
	(a) curtain grouting	m	145	3 600	522 000
	(b) consolidation grouting	m	145	1 220	176 900
6.	Embankment				
	(a) earthfill,core	m3	17	654 000	11 301 120
	(b) rockfill	m3	33	2 990 000	98 670 000
	(c) filters	m3	68	120 000	8 164 800
	(d) rip-rap	m3	31	66 000	2 067 120
7.	SPILLWAY				
	(a) Excavation e/o to quarry	m3	10	170 000	1 700 000
	(b) Formwork	m3	70	23 000	1 610 000
	(c) Concrete	m3	380	22 000	8 360 000
	(d) Anchors and steel rebars	t	3 000	500	1 500 000
8.	Multilevel outlet structure				
	(a) civil	Sum			2 700 000
	(b) mechanical/electrical	Sum			5 062 500
	(c) River outlet	Sum			20 062 500
9.	Measuring weir	Sum			1 000 000
	Subtotal A (carried forward)				174 613 860
10.	Miscellaneous		15%		26 192 079
11.	Preliminary & General Items (% of Subtotal A)	%	25%		43 653 465
	Subtotal B				244 459 404
12.	Contingencies (% of Subtotal B)	%	15%		6 548 020
	Subtotal C				251 007 424
13.	Planning design & supervision, fees, time cost & transport (% of Subtotal C)	%	15%		37 651 114
	Subtotal D				**288 658 537**
14.	VAT (% of Subtotal D)	%	14%		40 412 195
	TOTAL PROJECT COST				**329 070 733**

All rates are based on August 1997 prices

DAM COST MODEL
SMITHFIELD DAM (Upstream Site) (FSL = 910)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
1.	Site and basin clearing	ha	1 836	1 000	1 836 000
2.	River Diversion	Sum			12 000 000
3.	Excavation				
	(a) all materials	m3	13	250 000	1 718 496
	(b) extra over for rock	m3	24	120 000	1 663 200
4.	Preparation of solum				
	(b) for embankment	m2	6	68 000	440 640
	(c) core trench	m2	13	20 000	259 200
5.	Drilling and Grouting				
	(a) curtain grouting	m2	145	3 350	485 750
	(b) consolidation grouting	m3	145	2 700	391 500
6.	Embankment				
	(a) earthfill,core	m3	17	213 200	3 684 096
	(b) rockfill	m3	33	705 900	23 294 700
	(c) filters	m3	68	63 700	4 334 148
	(d) rip-rap	m3	31	37 700	1 180 764
7.	SPILLWAY				
	(a)Excavation e/o to quarry	m3	10	216 000	2 160 000
	(b)Formwork	m3	70	27 000	1 890 000
	(c)Concrete	m3	380	26 000	9 880 000
	(d)Anchors and steel rebars	t	3 000	550	1 650 000
8.	Multilevel outlet structure				
	(a) civil	Sum			1 875 000
	(b) mechanical/electrical	Sum			3 375 000
	(c) River outlet	Sum			3 375 000
9.	Measuring weir	Sum			1 000 000
	Subtotal A (carried forward)				76 493 494
10.	Miscellaneous		15%		11 474 024
14.	Preliminary & General Items				
	(% of Subtotal A)	%	25%		19 123 374
	Subtotal B				107 090 892
15.	Contingencies (% of Subtotal B)	%	15%		2 868 506
	Subtotal C				109 959 398
20	Planning design & supervision, fees, time cost & transport				
	(% of Subtotal C)	%	15%		16 493 910
	Subtotal D				126 453 307
21.	VAT (% of Subtotal D)	%	14%		17 703 463
	TOTAL PROJECT COST				**144 156 770**

All rates are based on August 1997 prices

DAM COST MODEL
IMPENDLE DAM (FSL = 1184)

05-05-98

No	Description	Unit	Rate	Quantity	Amount
1.	Site and basin clearing	ha	1 836	2 000	3 672 000
2.	River Diversion	Sum			12 000 000
3.	Excavation				
	(a) all materials	m3	13	550 000	7 128 000
	(b) extra over for rock	m3	24	260 000	6 177 600
4.	Preparation of solum				
	(b) for embankment	m2	6	85 000	550 800
	(c) core trench	m2	13	20 000	259 200
5.	Drilling and Grouting				
	(a) curtain grouting	m	145	5 400	783 000
	(b) consolidation grouting	m	145	3 300	478 500
6.	Embankment				
	(a) earthfill,core	m3	17	795 000	13 737 600
	(b) rockfill	m3	33	3 250 000	107 250 000
	(c) filters	m3	68	170 000	11 566 800
	(d) rip-rap	m3	31	100 000	3 132 000
7.	SPILLWAY				
	(a) Excavation e/o to quarry	m3	10	170 000	1 700 000
	(b) Formwork	m3	70	23 000	1 610 000
	(c) Concrete	m3	380	22 000	8 360 000
	(d) Anchors and steel rebars	t	3 000	500	1 500 000
8.	Multilevel outlet structure				
	(a) civil	Sum			2 400 000
	(b) mechanical/electrical	Sum			4 000 000
	(c) River outlet	Sum			4 000 000
9.	Measuring weir	Sum			1 000 000
	Subtotal A (carried forward)				191 305 500
10.	Miscellaneous		15%		28 695 825
11.	Preliminary & General Items (% of Subtotal A)	%	25%		47 826 375
	Subtotal B				267 827 700
12.	Contingencies (% of Subtotal B)	%	15%		7 173 956
	Subtotal C				275 001 656
13.	Planning design & supervision, fees, time cost & transport (% of Subtotal C)	%	15%		41 250 248
	Subtotal D				316 251 905
14.	VAT (% of Subtotal D)	%	14%		44 275 267
	TOTAL PROJECT COST				**360 527 171**

All rates are based on August 1997 prices

TUNNEL SCHEDULE BASED ON MOOI-MGENI COSTING IMPENDLE TUNNEL

	Description	Wellington	Factor	Impendle	Notes
Section 1	Fixed P&G	8 116 145	3.00	24 348 435	Three Major TBM sites
Section 2	Time Related Charges	36 824 669	3.31	121 921 570	Three times ratio of duration
Section 3	Portal Development	4 706 446	3.00	14 119 338	Three Major portals
Section 4	TBM excavation, support & lining	51 088 784	3.41	174 098 672	Ratio of tunnel lengths
Section 5	Concrete Structures	5 344 772	1.88	10 048 171	
Section 6	E/O for downgrade drives	0		18 000 000	@ R1500 per m for 12 km
Section 7	Adits	0		45 000 000	@ R15000 per m
Section 8	Miscellaneous	2 170 627	3.00	6 511 881	
	Sub-Total 1	108 251 443		414 048 067	
	Escalation from 03/95 to 08/97		0.21	86 950 094	
	Sub-Total 2	108 251 443		500 998 161	
	Contingencies 10%	10 825 144		50 099 816	
	TOTAL	119 076 587		551 097 977	
	Engineering design and supervision (15%)			82 664 697	
	TOTAL			**633 762 674**	

Notes

1	Rate per m of tunnel	35.1	km	15 701
2	Full concrete lining plus waterproof membrane for 25%			
3	All costs exclude VAT, engineering, access to working area, land acquisition, bulk services to site			
4	Fully lined tunnel maintenance costs are effectively zero			
5	Tunnel inlet IL is approximately	1 115	masl	
6	Tunnel outlet IL is approximately	1 080	masl	
7	Tunnel slope is therefore 1 in	1 003		
8	Good outlet portal conditions			

TUNNEL SCHEDULE BASED ON MOOI-MGENI COSTING RICHMOND TUNNEL

	Description	Wellington	Factor	Richmond	Notes
Section 1	Fixed P&G	8 116 145	2.00	16 232 290	Two Major TBM sites
Section 2	Time Related Charges	36 824 669	2.35	86 595 986	Two times ratio of duration
Section 3	Portal Development	4 706 446	2.00	9 412 892	Two Major portals
Section 4	TBM excavation, support & lining	51 088 784	2.46	125 737 930	Ratio of tunnel lengths
Section 5	Concrete Structures	5 344 772	1.88	10 048 171	
Section 6	E/O for downgrade drives	0		18 000 000	@ R1500 per m for 12 km
Section 7	Adits	0		0	@ R15000 per m
Section 8	Miscellaneous	2 170 627	3.00	6 511 881	
	Sub-Total 1	108 251 443		272 539 150	
	Escalation from 03/95 to 08/97		0.21	57 233 222	
	Sub-Total 2	108 251 443		329 772 372	
	Contingencies 10%	10 825 144		32 977 237	
	SUBTOTAL TUNNEL	119 076 587		362 749 609	
Section 9	Shaft excavation 115m deep	0		7 532 500	@ R65500 per m
Section 10	Shaft steel lining	0		2 300 000	@ R20000 per m
	TOTAL			372 582 109	
	Engineering design and supervision (15%)			59 613 137	
	TOTAL			**432 195 246**	

Notes

1	Rate per m of tunnel	25.35	km	14 310
2	Full concrete lining plus waterproof membrane for 25%			
3	All costs exclude VAT, engineering, access to working area, land acquisition, bulk services to site			
4	Fully lined tunnel maintenance costs are effectively zero			
5	Tunnel inlet IL is approximately	990	masl	
6	Tunnel outlet IL is approximately	960	masl	
7	Tunnel slope is therefore 1 in	845		
8	Outlet portal conditions O.K.			
9	Two tunnels on this line 10,050 km and 13,925 km and 1,375 km siphon			
10	Priced as one tunnel 23.350 km long			

TUNNEL SCHEDULE BASED ON MOOI-MGENI COSTING BAYNESFIELD TUNNEL

	Description	Wellington	Factor	Baynesfield	Notes
Section 1	Fixed P&G	8 116 145	3.00	24 348 435	Three Major TBM sites
Section 2	Time Related Charges	36 824 669	3.11	114 426 142	Three times ratio of duration
Section 3	Portal Development	4 706 446	3.00	14 119 338	Three Major portals
Section 4	TBM excavation, support & lining	51 088 784	3.14	160 458 462	Ratio of tunnel lengths
Section 5	Concrete Structures	5 344 772	1.88	10 048 171	
Section 6	E/O for downgrade drives	0		22 500 000	@ R1500 per m for 13 km
Section 7	Adits	0		0	@ R15000 per m
Section 8	Miscellaneous	2 170 627	3.00	6 511 881	
	Sub-Total 1	108 251 443		352 412 430	
	Escalation from 03/95 to 08/97		0.21	74 006 610	
	Sub-Total 2	108 251 443		426 419 040	
	Contingencies 10%	10 825 144		42 641 904	
	SUBTOTAL TUNNEL	119 076 587		469 060 944	
Section 9	Shaft excavation	0		4 257 500	@ R65500 per m
Section 10	Shaft steel lining	0		1 300 000	@ R20000 per m
	TOTAL			474 618 444	
	Engineering design and supervision (15%)			71 192 767	
	TOTAL			**545 811 210**	

Notes

1	Rate per m of tunnel	32.35	km	14 500
2	Full concrete lining plus waterproof membrane for 25%			
3	All costs exclude VAT, engineering, access to working area, land acquisition, bulk services to site			
4	Fully lined tunnel maintenance costs are effectively zero			
5	Tunnel inlet IL is approximately	940	masl	
6	Tunnel outlet IL is approximately	900	masl	
7	Tunnel slope is therefore 1 in	809		
8	Poor portal conditions			

PIPELINE COSTS

Unit rates derived from curve, with 14% VAT and 10% engineering fees deducted

Impendle Phase 1

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1400 dia)	4 800	41.0	196 800
Engineering fees @ 15 %			29 520
Sub-total			**226 320**
VAT @ 14%			31 685
TOTAL			**258 005**

Impendle Phase 2

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1900 dia)	8 000	41.0	328 000
Engineering fees @ 15 %			49 200
Sub-total			**377 200**
VAT @ 14%			52 808
TOTAL			**430 008**

Smithfield-Richmond (Each phase)

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1900 dia)	8 000	38.1	304 800
Engineering fees @ 15 %			45 720
Sub-total			**350 520**
VAT @ 14%			49 073
TOTAL			**399 593**

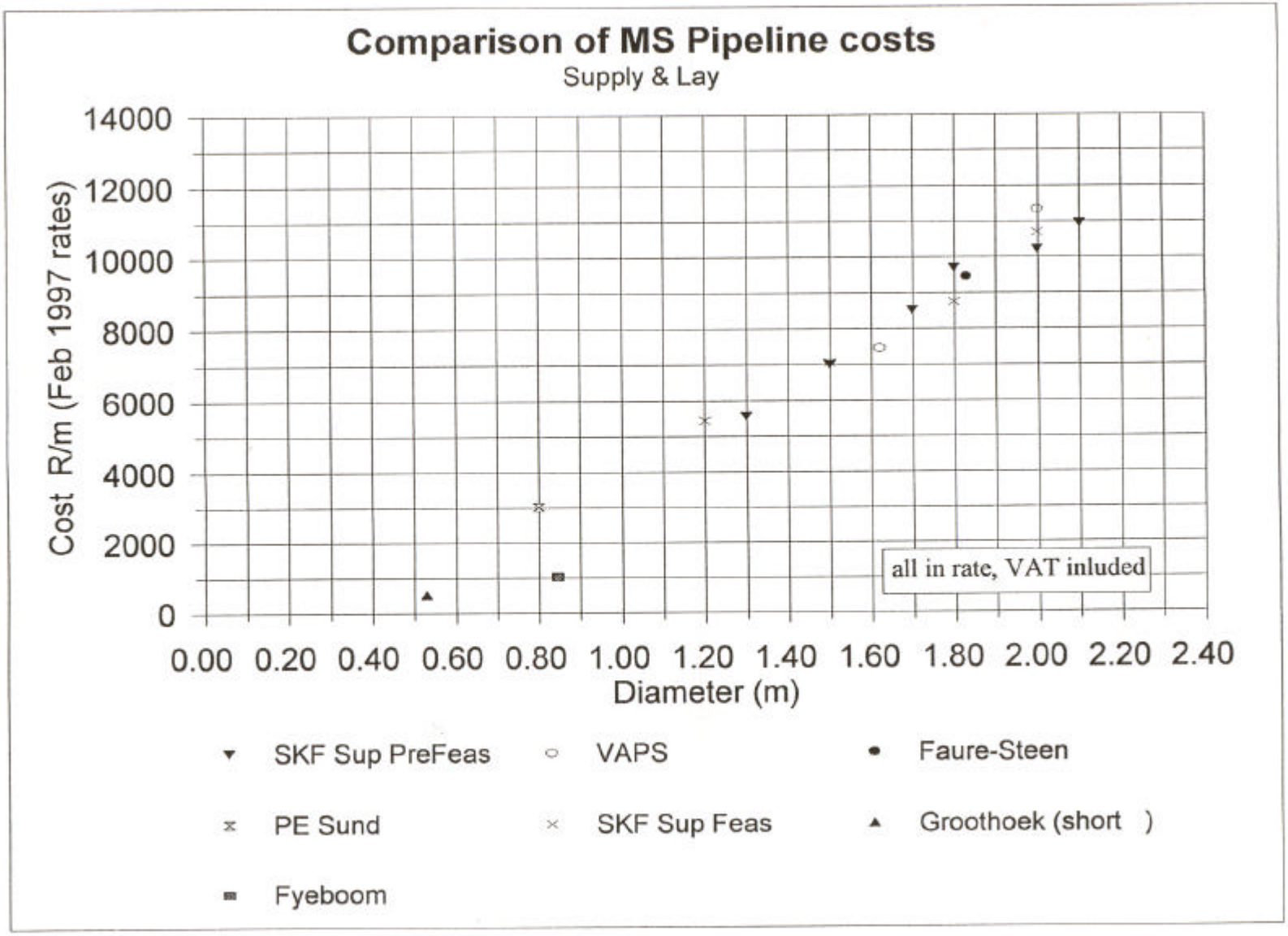
Smithfield-Baynesfield (each phase)

Item	Rate (R000/km)	Total length (km)	Amount (R000)
Pipeline (1900 dia)	8 000	24.1	192 800
Engineering fees @ 15 %			28 920
Sub-total			**221 720**
VAT @ 14%			31 041
TOTAL			**252 761**

WATERWORKS COSTS

Based on Umgeni Water all-in unit rate of R375 000 /Ml,(excl VAT and engineering fees)

August 1997 Base Date


Comparison of MS Pipeline costs
Supply & Lay
Cost R/m (Feb 1997 rates)
14000
12000
10000
8000
6000
4000
2000
0
0.00 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.20 2.40
Diameter (m)
all in rate, VAT inluded
SKF Sup PreFeas
VAPS
Faure-Steen
PE Sund
SKF Sup Feas
Groothoek (short)
Fyeboom

MKOMAZI-MGENI TRANSFER STUDY: PRE-FEASIBILITY STUDY

PUMPING COSTS ONLY

Delivery and Lift Required	Capital Cost Complete M & E Installation	Capital Cost Civil Installation (excl. rising main)	Total Capital Cost (excl. rising main)	Allowance for Contingencies	Estimated Capital Expenditure	Estimated Annual Operating Cost
Lift = 20 m						
Phase 1 100 Ml/day	R 1 737 500	R 3 205 912	R 4 943 412	R 741 512	R 5 684 923	R 612 600
Phase 2 200 Ml/day	R 1 737 500	R 3 205 912	R 4 943 412	R 741 512	R 5 684 923	R 1 218 000
Phase 3 400 Ml/day	R 3 475 000	R 6 411 823	R 9 886 823	R 1 483 023	R 11 369 847	R 2 507 000
Phase 4 600 Ml/day	R 3 475 000	R 6 411 823	R 9 886 823	R 1 483 023	R 11 369 847	R 3 875 100
Phase 5 800 Ml/day	R 3 475 000	R 6 411 823	R 9 886 823	R 1 483 023	R 11 369 847	R 5 307 000
Lift = 90 m						
Phase 1 100 Ml/day	R 2 590 000	R 4 778 884	R 7 368 884	R 1 105 333	R 8 474 217	R 2 250 500
Phase 2 200 Ml/day	R 2 590 000	R 4 778 884	R 7 368 884	R 1 105 333	R 8 474 217	R 4 436 000
Phase 3 400 Ml/day	R 5 180 000	R 9 557 768	R 14 737 768	R 2 210 665	R 16 948 433	R 9 016 000
Phase 4 600 Ml/day	R 5 180 000	R 9 557 768	R 14 737 768	R 2 210 665	R 16 948 433	R 13 806 000
Phase 5 800 Ml/day	R 5 180 000	R 9 557 768	R 14 737 768	R 2 210 665	R 16 948 433	R 18 766 000
Lift = 200 m						
Phase 1 100 Ml/day	R 5 620 000	R 10 369 625	R 15 989 625	R 2 398 444	R 18 388 069	R 4 583 000
Phase 2 200 Ml/day	R 5 620 000	R 10 369 625	R 15 989 625	R 2 398 444	R 18 388 069	R 8 956 600
Phase 3 400 Ml/day	R 11 240 000	R 20 739 250	R 31 979 250	R 4 796 887	R 36 776 137	R 17 936 400
Phase 4 600 Ml/day	R 11 240 000	R 20 739 250	R 31 979 250	R 4 796 887	R 36 776 137	R 27 142 250
Phase 5 800 Ml/day	R 11 240 000	R 20 739 250	R 31 979 250	R 4 796 887	R 36 776 137	R 36 532 400
Lift = 380 m						
Phase 1 100 Ml/day	R 11 240 000	R 20 739 250	R 31 979 250	R 4 796 887	R 36 776 137	R 9 166 000
Phase 2 200 Ml/day	R 11 240 000	R 20 739 250	R 31 979 250	R 4 796 887	R 36 776 137	R 17 913 200
Phase 3 400 Ml/day	R 22 480 000	R 41 478 500	R 63 958 500	R 9 593 775	R 73 552 275	R 35 872 800
Phase 4 600 Ml/day	R 22 480 000	R 41 478 500	R 63 958 500	R 9 593 775	R 73 552 275	R 54 284 500
Phase 5 800 Ml/day	R 22 480 000	R 41 478 500	R 63 958 500	R 9 593 775	R 73 552 275	R 73 064 800

Note that all costs exclude the following:

VAT
Site services and accommodation
Access to the working areas
Land acquisition and servitudes

Costs for intermediate lifts and/or deliveries were interpolated.

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APPENDIX C3

ECONOMICS:
RECONNAISSANCE PHASE

Project Name	MKOMAZI-MGENI TRANSFER STUDY		**File Name**	TEST_19.WB1	
Option	SCHEME 1: IMPENDLE		**Date**	03-Oct-97	
Base Year	1997		**Component Life**	50	
Phase	1	**Commission Year**	2004	**Output (m3/s)**	3.34

Element	Type	Name	Characteristics		Capital Costs		Electricity	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.	Costs per year	Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Impendle-Midmar	3.5	34.8	541000	10000		2000	2003	4	20.0%	216400.0	4000.0	108200.0	2000.0
				Cap											
Treatment Works		Midmar		390	103750	43750		2002	2003	2	20.0%	62250.0	26250.0	41500.0	17500.0
Treatment Works															
			Dia.	**Length**											
Pipeline		Midmar-Umlaas Rd	1400	41	166000	30000		2002	2003	2	20.0%	99600.0	18000.0	66400.0	12000.0
			FSL	**h**											
Dam	Rockfill	Impendle	1145	58	78000	15000		2001	2003	3	20.0%	36400.0	7000.0	20800.0	4000.0
Dam															
			No.	**m3**											
Pump Station		Midmar	1	4.6	3000	2000	306	2003	2003	1	20.0%	3000.0	2000.0	2400.0	1600.0
Infrastructure			N/A	N/A				2000	1999						
Infrastructure			N/A	N/A											
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					891750	100750	306								
					1146375										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost
(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 1: IMPENDLE	**Date**	03-Oct-97
Base Year	1997	**Component Life**	50

Phase	2	**Commission Year**	2012	**Output (m3/s)**	3.07

Element	Type	Name	Characteristics		Capital Costs		Electricity	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.	Costs per year	Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Breadth	**Length**											
Canal															
				Cap											
Treatment Works		Midmar		290	74000	35000		2010	2011	2	20.0%	44400.0	21000.0	29600.0	14000.0
Treatment Works															
			Dia.	**Length**											
Pipeline		Midmar-Umlaas Rd	1900	41	293000	35000		2010	2011	2	20.0%	175800.0	21000.0	117200.0	14000.0
			FSL	**h**											
Dam	Rockfill	Impendle (Raised)	1160	73	91000	10000		2010	2012	3	20.0%	42466.7	4666.7	24266.7	2666.7
Dam															
			No.	**m3**											
Pump Station		Midmar	1	4.6	3000	2000	306	2011	2011	1	20.0%	3000.0	2000.0	2400.0	1600.0
Infrastructure			N/A	N/A				2010	2009						
Infrastructure			N/A	N/A											
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					461000	82000	306								
					629450										

Year	Cost Factors	
	Social & Environ.	Admin.
2010	0.3000	0.0434
2011	0.4000	0.0800
2012	0.3000	0.0980
2013		0.1110
2014		0.1191
2015		0.1232
2016		0.1214
2017		0.1093
2018		0.0873
2019		0.0534
2020		0.0220
2021		0.0094
2022		0.0045
2023		0.0045
2024		0.0045
2025		0.0045
2026		0.0045
Total	0.7000	1.0000

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost
(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment Works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original	2011	
Sensitivity		
Sensitised	2011	

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 1: IMPENDLE	**Date**	03-Oct-97
Base Year	1997	**Component Life**	50

Phase	3	**Commission Year**	2018	Output (m3/s)	4.41

Element	Type	Name	Characteristics		Capital Costs		Electricity	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.	Costs per year	Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Breadth	**Length**											
Canal															
Canal															
Canal															
Canal															
Canal															
Canal															
Canal															
Canal															
Canal															
Canal															
			Dia.	**Length**											
Tunnel															
Tunnel															
Tunnel															
Tunnel															
Tunnel															
Tunnel															
Tunnel															
Tunnel															
Tunnel															
			Dia.	**Length**											
Pipeline															
Pipeline															
Pipeline															
Pipeline															
Pipeline															
Pipeline															
Pipeline															
Pipeline															
			FSL	**h**											
Dam	Rockfill	Impendle	1190	103	221000	30000		2015	2017	3	20.0%	103133.3	14000.0	58933.3	8000.0
Dam															
Dam															
Dam															
Dam															
				Cap											
Treatment Works		Midmar		480	120000	60000		2016	2017	2	20.0%	72000.0	36000.0	48000.0	24000.0
Pump Station		Midmar		5.5	5000	2500	460	2017	2017	1	20.0%	5000.0	2500.0	4000.0	2000.0
Pump Station															
Pump Station															
Pump Station															
Pump Station															
Pump Station															
Total					346000	92500	460								

Year	Cost Factors	
	Social & Environ.	Admin.
2015		
2016	0.3000	
2017	0.4000	
2018	0.3000	
2019		
2020		
2021		
2022		
2023		
2024		
2025		
2026		
2027		
2028		
2029		
2030		
2031		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost
(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment Works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 1: IMPENDLE

YEAR	PHASE 1			PHASE 2			PHASE 3						TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1998	19 285.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19 285.00	0.00	0.00
1999	22 540.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	22 540.00	0.00	0.00
2000	253 309.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	253 309.50	0.00	0.00
2001	178 085.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	178 085.50	0.00	0.00
2002	370 063.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	370 063.00	0.00	0.00
2003	301 592.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	301 592.00	0.00	0.00
2004	1 500.00	5 447.88	40.87	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1 500.00	5 447.88	40.87
2005	0.00	5 447.88	75.48	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5 447.88	75.48
2006	0.00	5 447.88	110.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5 447.88	110.89
2007	0.00	5 447.88	147.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5 447.88	147.42
2008	0.00	5 447.88	185.13	18 830.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	18 830.00	5 447.88	185.13
2009	0.00	5 447.88	224.04	19 005.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	19 005.00	5 447.88	224.04
2010	0.00	5 447.88	264.19	335 755.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	335 755.00	5 447.88	264.19
2011	0.00	5 447.88	306.10	225 272.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	225 272.00	5 447.88	306.10
2012	0.00	5 447.88	306.10	30 588.00	3 805.00	47.06	0.00	0.00	0.00	0.00	0.00	0.00	30 588.00	9 252.88	353.16
2013	0.00	5 447.88	306.10	0.00	2 300.00	95.64	8 785.00	0.00	0.00	0.00	0.00	0.00	8 785.00	7 747.88	401.74
2014	0.00	5 447.88	306.10	0.00	4 432.50	145.80	15 085.00	0.00	0.00	0.00	0.00	0.00	15 085.00	9 880.38	451.90
2015	0.00	5 447.88	306.10	0.00	4 432.50	197.57	133 066.50	0.00	0.00	0.00	0.00	0.00	133 066.50	9 880.38	503.68
2016	0.00	5 447.88	306.10	0.00	4 432.50	250.86	190 690.50	0.00	0.00	0.00	0.00	0.00	190 690.50	9 880.38	556.97
2017	0.00	5 447.88	306.10	0.00	4 432.50	305.87	160 148.00	0.00	0.00	0.00	0.00	0.00	160 148.00	9 880.38	611.98
2018	0.00	12 310.38	306.10	0.00	4 432.50	305.87	1 500.00	4 565.00	59.47	0.00	0.00	0.00	1 500.00	21 307.88	671.44
2019	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	120.85	0.00	0.00	0.00	0.00	14 445.38	732.83
2020	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	184.21	0.00	0.00	0.00	0.00	14 445.38	796.19
2021	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	249.92	0.00	0.00	0.00	0.00	14 445.38	861.90
2022	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	317.76	0.00	0.00	0.00	0.00	14 445.38	929.74
2023	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	387.80	0.00	0.00	0.00	0.00	14 445.38	999.77
2024	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2025	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2026	0.00	5 447.88	306.10	0.00	9 982.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	19 995.38	1 072.08
2027	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2028	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2029	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2030	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2031	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2032	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	13 940.00	460.10	0.00	0.00	0.00	0.00	23 820.38	1 072.08
2033	0.00	12 310.38	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	21 307.88	1 072.08
2034	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2035	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2036	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2037	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2038	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2039	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2040	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2041	0.00	5 447.88	306.10	0.00	9 982.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	19 995.38	1 072.08
2042	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2043	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2044	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2045	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2046	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2047	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	13 940.00	460.10	0.00	0.00	0.00	0.00	23 820.38	1 072.08
2048	0.00	12 310.38	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	21 307.88	1 072.08
2049	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2050	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2051	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2052	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
2053	0.00	5 447.88	306.10	0.00	4 432.50	305.87	0.00	4 565.00	460.10	0.00	0.00	0.00	0.00	14 445.38	1 072.08
TOTAL	**1 146 375**	**292 981**	**14 210**	**629 450**	**194 505**	**12 054**	**509 275**	**183 090**	**15 123**	**0**	**0**	**0**	**2 285 100**	**670 576**	**41 388**
Commission date		2004			2012			2018			0				
Transfer capacity (m3/s)		3.34			3.07			4.41			0.00				

(CONTINUED.....)

Check	**R 1 146 375**	**R 629 450**	**R 509 275**	**R 0**

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 1: IMPENDLE

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	18 193	0	0	17 856	0	0	17 532	0	0
1999	20 061	0	0	19 324	0	0	18 628	0	0
2000	212 684	0	0	201 085	0	0	190 315	0	0
2001	141 060	0	0	130 898	0	0	121 635	0	0
2002	276 533	0	0	251 859	0	0	229 780	0	0
2003	212 610	0	0	190 054	0	0	170 241	0	0
2004	998	3 623	27	875	3 179	24	770	2 796	21
2005	0	3 418	47	0	2 943	41	0	2 541	35
2006	0	3 225	66	0	2 725	55	0	2 310	47
2007	0	3 042	82	0	2 523	68	0	2 100	57
2008	9 919	2 870	98	8 076	2 337	79	6 600	1 909	65
2009	9 445	2 707	111	7 547	2 163	89	6 056	1 736	71
2010	157 415	2 554	124	123 456	2 003	97	97 256	1 578	77
2011	99 638	2 410	135	76 696	1 855	104	59 321	1 435	81
2012	12 763	3 861	147	9 643	2 917	111	7 323	2 215	85
2013	3 458	3 050	158	2 564	2 262	117	1 912	1 686	87
2014	5 602	3 669	168	4 077	2 670	122	2 984	1 955	89
2015	46 619	3 462	176	33 300	2 473	126	23 933	1 777	91
2016	63 026	3 266	184	44 185	2 289	129	31 179	1 616	91
2017	49 935	3 081	191	34 359	2 120	131	23 805	1 469	91
2018	441	6 268	198	298	4 233	133	203	2 879	91
2019	0	4 009	203	0	2 657	135	0	1 775	90
2020	0	3 782	208	0	2 460	136	0	1 613	89
2021	0	3 568	213	0	2 278	136	0	1 467	88
2022	0	3 366	217	0	2 109	136	0	1 333	86
2023	0	3 175	220	0	1 953	135	0	1 212	84
2024	0	2 996	222	0	1 808	134	0	1 102	82
2025	0	2 826	210	0	1 674	124	0	1 002	74
2026	0	3 690	198	0	2 146	115	0	1 260	68
2027	0	2 515	187	0	1 436	107	0	828	61
2028	0	2 373	176	0	1 329	99	0	753	56
2029	0	2 238	166	0	1 231	91	0	684	51
2030	0	2 112	157	0	1 140	85	0	622	46
2031	0	1 992	148	0	1 055	78	0	565	42
2032	0	3 099	139	0	1 611	73	0	848	38
2033	0	2 615	132	0	1 334	67	0	689	35
2034	0	1 673	124	0	838	62	0	425	32
2035	0	1 578	117	0	776	58	0	386	29
2036	0	1 489	110	0	718	53	0	351	26
2037	0	1 404	104	0	665	49	0	319	24
2038	0	1 325	98	0	616	46	0	290	22
2039	0	1 250	93	0	570	42	0	264	20
2040	0	1 179	88	0	528	39	0	240	18
2041	0	1 540	83	0	677	36	0	302	16
2042	0	1 049	78	0	453	34	0	198	15
2043	0	990	73	0	419	31	0	180	13
2044	0	934	69	0	388	29	0	164	12
2045	0	881	65	0	359	27	0	149	11
2046	0	831	62	0	333	25	0	135	10
2047	0	1 293	58	0	508	23	0	203	9
2048	0	1 091	55	0	421	21	0	165	8
2049	0	698	52	0	264	20	0	102	8
2050	0	658	49	0	244	18	0	92	7
2051	0	621	46	0	226	17	0	84	6
2052	0	586	43	0	210	16	0	76	6
RES+2050	0	553	41	0	194	14	0	69	5
TOTAL	**1 340 400**	**116 485**	**6 218**	**1 156 154**	**74 319**	**3 738**	**1 009 472**	**49 950**	**2 362**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 463 102**	**2 023**	**72.33**
8%	**R 1 234 212**	**1 223**	**100.95**
10%	**R 1 061 785**	**777**	**136.65**

"

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1		
Option	SCHEME 3A: SMITHFIELD-RICHMOND	**Date**	03-Oct-97		
Base Year	1997	**Component Life**	50		
Phase	1	**Commission Year**	2004	**Output (m3/s)**	6.41

Element	Type	Name	Characteristics		Capital Costs		Electricity	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.	Costs per year	Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Smithfield-Lovu	3.5	25.4	366000	10000		2000	2003	4	20.0%	146400.0	4000.0	73200.0	2000.0
				Cap											
Treatment Works		Richmond		690	169000	90000		2002	2003	2	20.0%	101400.0	54000.0	67600.0	36000.0
Treatment Works											20.0%				
			Dia.	**Length**											
Pipeline		Richmond-Umlaas Rd	1900	38	275000	30000		2002	2003	2	20.0%	165000.0	18000.0	110000.0	12000.0
			FSL	**h**											
Dam	Rockfill	Smithfield	910	60	90000	20000		2001	2003	3	20.0%	42000.0	9333.3	24000.0	5333.3
Dam	Earthfill	Richmond		25	9500	500		2003	2003	1		9500.0	500.0	9500.0	500.0
			No.	**m3**											
Pump Station		Smithfield		7.9	57000	30000	14478	2003	2003	1		57000.0	30000.0	57000.0	30000.0
			Cap	**Length**				2000	1999						
Canals											20.0%				
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					966500	180500	14478								
					1324050										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 3A: SMITHFIELD-RICHMOND	**Date**	03-Oct-97
Base Year	1997	**Component Life**	50

Phase	2	**Commission Year**	2018	**Output (m3/s)**	6.64

Element	Type	Name	Characteristics		Capital Costs		Electricity	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.	Costs per year	Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Breadth	**Length**											
Canal															
				Cap											
Treatment Works		Richmond		690	169000	90000		2016	2017	2	20.0%	101400.0	54000.0	67600.0	36000.0
Treatment Works															
			Dia.	**Length**											
Pipeline		Richmond-Umlaas Rd	1900	38	275000	30000		2016	2017	2	20.0%	165000.0	18000.0	110000.0	12000.0
			FSL	**h**											
Dam	Rockfill	Impendle	1184	97	255000	20000		2015	2017	3	20.0%	119000.0	9333.3	68000.0	5333.3
Dam															
			No.	**m3**											
Pump Station		Smithfield		7.9	57000	30000	15200	2017	2017	1	20.0%	57000.0	30000.0	45600.0	24000.0
Infrastructure			N/A	N/A				2015	2014						
Infrastructure			N/A	N/A											
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					756000	170000	15200								
					1069900										

Year	Cost Factors	
	Social & Environ.	Admin.
2015		
2016	0.3000	
2017	0.4000	
2018	0.3000	
2019		
2020		
2021		
2022		
2023		
2024		
2025		
2026		
2027		
2028		
2029		
2030		
2031		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment Works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3A: SMITHFIELD-RICHMOND

YEAR	PHASE 1			PHASE 2									TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
1998	13 160.00	0.00	0.00	0.00	0.00	0.00							13 160.00	0.00	0.00
1999	17 010.00	0.00	0.00	0.00	0.00	0.00							17 010.00	0.00	0.00
2000	186 022.00	0.00	0.00	0.00	0.00	0.00							186 022.00	0.00	0.00
2001	159 791.00	0.00	0.00	0.00	0.00	0.00							159 791.00	0.00	0.00
2002	483 263.00	0.00	0.00	0.00	0.00	0.00							483 263.00	0.00	0.00
2003	463 304.00	0.00	0.00	0.00	0.00	0.00							463 304.00	0.00	0.00
2004	1 500.00	9 087.25	820.77	0.00	0.00	0.00							1 500.00	9 087.25	820.77
2005	0.00	9 087.25	1 860.74	0.00	0.00	0.00							0.00	9 087.25	1 860.74
2006	0.00	9 087.25	2 733.43	0.00	0.00	0.00							0.00	9 087.25	2 733.43
2007	0.00	9 087.25	3 634.06	0.00	0.00	0.00							0.00	9 087.25	3 634.06
2008	0.00	9 087.25	4 563.50	0.00	0.00	0.00							0.00	9 087.25	4 563.50
2009	0.00	9 087.25	5 522.70	0.00	0.00	0.00							0.00	9 087.25	5 522.70
2010	0.00	9 087.25	6 512.60	0.00	0.00	0.00							0.00	9 087.25	6 512.60
2011	0.00	9 087.25	7 545.66	0.00	0.00	0.00							0.00	9 087.25	7 545.66
2012	0.00	9 087.25	8 612.15	0.00	0.00	0.00							0.00	9 087.25	8 612.15
2013	0.00	9 087.25	9 713.17	9 625.00	0.00	0.00							9 625.00	9 087.25	9 713.17
2014	0.00	9 087.25	10 849.82	29 365.00	0.00	0.00							29 365.00	9 087.25	10 849.82
2015	0.00	9 087.25	12 023.25	161 385.00	0.00	0.00							161 385.00	9 087.25	12 023.25
2016	0.00	9 087.25	13 230.97	449 217.00	0.00	0.00							449 217.00	9 087.25	13 230.97
2017	0.00	9 087.25	14 477.65	418 808.00	0.00	0.00							418 808.00	9 087.25	14 477.65
2018	0.00	27 087.25	14 478.00	1 500.00	8 690.00	1 301.19							1 500.00	35 777.25	15 779.19
2019	0.00	9 087.25	14 478.00	0.00	8 690.00	2 644.73							0.00	17 777.25	17 122.73
2020	0.00	9 087.25	14 478.00	0.00	8 690.00	4 031.62							0.00	17 777.25	18 509.62
2021	0.00	9 087.25	14 478.00	0.00	8 690.00	5 469.79							0.00	17 777.25	19 947.79
2022	0.00	9 087.25	14 478.00	0.00	8 690.00	6 954.58							0.00	17 777.25	21 432.58
2023	0.00	9 087.25	14 478.00	0.00	8 690.00	8 487.50							0.00	17 777.25	22 965.50
2024	0.00	9 087.25	14 478.00	0.00	8 690.00	10 070.10							0.00	17 777.25	24 548.10
2025	0.00	9 087.25	14 478.00	0.00	8 690.00	11 704.00							0.00	17 777.25	26 182.00
2026	0.00	9 087.25	14 478.00	0.00	8 690.00	13 399.40							0.00	17 777.25	27 877.40
2027	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2028	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2029	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2030	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2031	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2032	0.00	9 087.25	14 478.00	0.00	26 690.00	15 150.04							0.00	35 777.25	29 628.04
2033	0.00	27 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	35 777.25	29 628.04
2034	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2035	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2036	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2037	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2038	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2039	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2040	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2041	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2042	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2043	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2044	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2045	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2046	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2047	0.00	9 087.25	14 478.00	0.00	26 690.00	15 150.04							0.00	35 777.25	29 628.04
2048	0.00	27 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	35 777.25	29 628.04
2049	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2050	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2051	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2052	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
2053	0.00	9 087.25	14 478.00	0.00	8 690.00	15 150.04							0.00	17 777.25	29 628.04
TOTAL	**1 324 050**	**508 363**	**623 308**	**1 069 900**	**348 840**	**473 114**							**2 393 950**	**857 203**	**1 096 422**
Commission date		2004			2018			0			0				
Transfer capacity (m3/s)		6.41			6.64			0.00			0.00				

(CONTINUED.....)

Check	**R 1 324 050**	**R 1 069 900**	**R 0**	**R 0**

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3A: SMITHFIELD-RICHMOND

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	12 415	0	0	12 185	0	0	11 964	0	0
1999	15 139	0	0	14 583	0	0	14 058	0	0
2000	156 188	0	0	147 670	0	0	139 761	0	0
2001	126 569	0	0	117 451	0	0	109 139	0	0
2002	361 122	0	0	328 901	0	0	300 068	0	0
2003	326 611	0	0	291 960	0	0	261 523	0	0
2004	998	6 044	546	875	5 302	479	770	4 663	421
2005	0	5 701	1 167	0	4 910	1 005	0	4 239	868
2006	0	5 379	1 618	0	4 546	1 367	0	3 854	1 159
2007	0	5 074	2 029	0	4 209	1 683	0	3 504	1 401
2008	0	4 787	2 404	0	3 897	1 957	0	3 185	1 599
2009	0	4 516	2 745	0	3 609	2 193	0	2 895	1 760
2010	0	4 260	3 053	0	3 341	2 395	0	2 632	1 886
2011	0	4 019	3 337	0	3 094	2 569	0	2 393	1 987
2012	0	3 792	3 594	0	2 865	2 715	0	2 175	2 062
2013	3 789	3 577	3 824	2 809	2 652	2 835	2 095	1 978	2 114
2014	10 905	3 375	4 029	7 936	2 456	2 932	5 810	1 798	2 147
2015	56 540	3 184	4 212	40 386	2 274	3 009	29 027	1 634	2 162
2016	148 472	3 003	4 373	104 089	2 106	3 066	73 451	1 486	2 163
2017	130 586	2 833	4 514	89 855	1 950	3 106	62 253	1 351	2 152
2018	441	10 524	4 642	298	7 107	3 135	203	4 835	2 132
2019	0	4 933	4 752	0	3 270	3 150	0	2 184	2 103
2020	0	4 654	4 846	0	3 028	3 152	0	1 985	2 067
2021	0	4 391	4 927	0	2 803	3 146	0	1 805	2 025
2022	0	4 142	4 994	0	2 596	3 130	0	1 641	1 978
2023	0	3 908	5 048	0	2 404	3 105	0	1 492	1 927
2024	0	3 686	5 090	0	2 225	3 073	0	1 356	1 872
2025	0	3 478	5 122	0	2 061	3 035	0	1 233	1 816
2026	0	3 281	5 145	0	1 908	2 992	0	1 121	1 757
2027	0	3 095	5 159	0	1 767	2 944	0	1 019	1 698
2028	0	2 920	4 867	0	1 636	2 726	0	926	1 544
2029	0	2 755	4 591	0	1 515	2 524	0	842	1 403
2030	0	2 599	4 331	0	1 402	2 337	0	765	1 276
2031	0	2 452	4 086	0	1 299	2 164	0	696	1 160
2032	0	4 655	3 855	0	2 420	2 004	0	1 273	1 054
2033	0	4 391	3 637	0	2 241	1 855	0	1 157	958
2034	0	2 058	3 431	0	1 031	1 718	0	523	871
2035	0	1 942	3 237	0	954	1 591	0	475	792
2036	0	1 832	3 053	0	884	1 473	0	432	720
2037	0	1 728	2 881	0	818	1 364	0	393	655
2038	0	1 631	2 717	0	758	1 263	0	357	595
2039	0	1 538	2 564	0	702	1 169	0	325	541
2040	0	1 451	2 419	0	650	1 083	0	295	492
2041	0	1 369	2 282	0	601	1 002	0	268	447
2042	0	1 292	2 152	0	557	928	0	244	406
2043	0	1 218	2 031	0	516	859	0	222	370
2044	0	1 149	1 916	0	477	796	0	202	336
2045	0	1 084	1 807	0	442	737	0	183	305
2046	0	1 023	1 705	0	409	682	0	167	278
2047	0	1 942	1 608	0	763	632	0	305	252
2048	0	1 832	1 517	0	706	585	0	277	229
2049	0	859	1 432	0	325	542	0	125	209
2050	0	810	1 350	0	301	501	0	114	190
2051	0	764	1 274	0	279	464	0	103	172
2052	0	721	1 202	0	258	430	0	94	157
RES+2050	0	680	1 134	0	239	398	0	85	142
TOTAL	**1 349 776**	**152 335**	**158 246**	**1 159 000**	**98 561**	**94 002**	**1 010 120**	**67 305**	**58 813**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 660 357**	**2 203**	**75.36**
8%	**R 1 351 562**	**1 309**	**103.22**
10%	**R 1 136 239**	**820**	**138.64**

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Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 3B: SMITHFIELD-BAYNESFIELD	**Date**	03-Oct-97
Base Year	1997	**Component Life**	50

Phase	1	**Commission Year**	2004	**Output (m3/s)**	6.41

Element	Type	Name	Characteristics		Capital Costs		Electricity	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.	Costs per year	Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Dia	**Length**											
Tunnel		Smithfield-Baynesfield	3.5	32	465000	10000		2000	2003	4	20.0%	186000.0	4000.0	93000.0	2000.0
				Cap											
Treatment Works		Baynesfield		690	169000	90000		2002	2003	2	20.0%	101400.0	54000.0	67600.0	36000.0
Treatment Works											20.0%				
			Dia.	**Length**											
Pipeline		Baynesfield-Umlaas Rd	1900	21	173000	20000		2002	2003	2	20.0%	103800.0	12000.0	69200.0	8000.0
			FSL	**h**											
Dam	Rockfill	Smithfield	910	60	90000	20000		2001	2003	3	20.0%	42000.0	9333.3	24000.0	5333.3
Dam		Baynesfield (raising)			300	50		2003	2003	1		300.0	50.0	300.0	50.0
			No.	**m3**											
Pump Station		Smithfield		7.9	27200	14700	6166	2003	2003	1		27200.0	14700.0	27200.0	14700.0
			Cap	**Length**				2000	1999						
Canals											20.0%				
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					924500	154750	6166								
					1246137.5										

Year	Cost Factors	
	Social & Environ.	Admin.
2000		
2001		
2002	0.3000	
2003	0.4000	
2004	0.3000	
2005		
2006		
2007		
2008		
2009		
2010		
2011		
2012		
2013		
2014		
2015		
2016		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

Project Name	MKOMAZI-MGENI TRANSFER STUDY	**File Name**	TEST_19.WB1
Option	SCHEME 3B: SMITHFIELD-BAYNESFIELD	**Date**	03-Oct-97
Base Year	1997	**Component Life**	50

Phase	2	**Commission Year**	2018	**Output (m3/s)**	6.64

Element	Type	Name	Characteristics		Capital Costs		Electricity Costs per year	Timing			Construction Cash Flow				
					Civil	Mech. & Elec.		Start	End	Duration	1st year %	Year 1		Annual	
												Civil	M & E	Civil	M & E
			Breadth	**Length**											
Canal															
				Cap											
Treatment Works		Baynesfield		690	169000	90000		2016	2017	2	20.0%	101400.0	54000.0	67600.0	36000.0
Treatment Works															
			Dia.	**Length**											
Pipeline		Baynesfield-Umlaas Rd	1900	21	173000	20000		2016	2017	2	20.0%	103800.0	12000.0	69200.0	8000.0
			FSL	**h**											
Dam	Rockfill	Impendle	1184	97	255000	20000		2015	2017	3	20.0%	119000.0	9333.3	68000.0	5333.3
Dam															
			No.	**m3**											
Pump Station		Smithfield		7.9	27200	14700	6474.3	2017	2017	1	20.0%	27200.0	14700.0	21760.0	11760.0
Infrastructure			N/A	N/A				2015	2014						
Infrastructure			N/A	N/A											
Advance Infr.			N/A	N/A											
Advance Infr.			N/A	N/A											
Total					624200	144700	6474.3								
					889235										

Year	Cost Factors	
	Social & Environ.	Admin.
2015		
2016	0.3000	
2017	0.4000	
2018	0.3000	
2019		
2020		
2021		
2022		
2023		
2024		
2025		
2026		
2027		
2028		
2029		
2030		
2031		
Total	1.0000	

Other Costs

Description	Cost
Social & Environ.	5000
Administration	

Maintenance as % of Construction Cost

(after Commissioning)

ANNUAL	Civil	Mech & Elec
Canal	0.75%	4.00%
Treatment Works	0.25%	4.00%
Pipeline	0.25%	4.00%
Dam	0.25%	4.00%
Pump Station	0.25%	4.00%
Tunnel	0.10%	4.00%
PERIODIC	Period (Yrs)	%
Pump Station (M & E)	15.0	15.00%

Sensitivity

	Comm Date	
Original		
Sensitivity		
Sensitised		

Engineering as % of Construction Cost

Pre - Engineering	7.00%
Construction	8.00%

Discount Rates

Low	6.0%
Medium	8.0%
High	10.0%

Note: 1st year's costs are not discounted.

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3B: SMITHFIELD-BAYNESFIELD

YEAR	PHASE 1			PHASE 2									TOTAL ANNUAL COST (EXCL. VAT)		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
1997	0.00	0.00	0.00	0.00	0.00	0.00							0.00	0.00	0.00
1998	16 625.00	0.00	0.00	0.00	0.00	0.00							16 625.00	0.00	0.00
1999	20 475.00	0.00	0.00	0.00	0.00	0.00							20 475.00	0.00	0.00
2000	224 870.00	0.00	0.00	0.00	0.00	0.00							224 870.00	0.00	0.00
2001	175 338.75	0.00	0.00	0.00	0.00	0.00							175 338.75	0.00	0.00
2002	430 154.75	0.00	0.00	0.00	0.00	0.00							430 154.75	0.00	0.00
2003	377 174.00	0.00	0.00	0.00	0.00	0.00							377 174.00	0.00	0.00
2004	1 500.00	7 803.75	349.55	0.00	0.00	0.00							1 500.00	7 803.75	349.55
2005	0.00	7 803.75	792.47	0.00	0.00	0.00							0.00	7 803.75	792.47
2006	0.00	7 803.75	1 164.14	0.00	0.00	0.00							0.00	7 803.75	1 164.14
2007	0.00	7 803.75	1 547.70	0.00	0.00	0.00							0.00	7 803.75	1 547.70
2008	0.00	7 803.75	1 943.54	0.00	0.00	0.00							0.00	7 803.75	1 943.54
2009	0.00	7 803.75	2 352.05	0.00	0.00	0.00							0.00	7 803.75	2 352.05
2010	0.00	7 803.75	2 773.63	0.00	0.00	0.00							0.00	7 803.75	2 773.63
2011	0.00	7 803.75	3 213.60	0.00	0.00	0.00							0.00	7 803.75	3 213.60
2012	0.00	7 803.75	3 667.81	0.00	0.00	0.00							0.00	7 803.75	3 667.81
2013	0.00	7 803.75	4 136.72	9 625.00	0.00	0.00							9 625.00	7 803.75	4 136.72
2014	0.00	7 803.75	4 620.80	25 445.00	0.00	0.00							25 445.00	7 803.75	4 620.80
2015	0.00	7 803.75	5 120.55	155 886.50	0.00	0.00							155 886.50	7 803.75	5 120.55
2016	0.00	7 803.75	5 634.90	375 062.50	0.00	0.00							375 062.50	7 803.75	5 634.90
2017	0.00	7 803.75	6 165.85	321 716.00	0.00	0.00							321 716.00	7 803.75	6 165.85
2018	0.00	23 508.75	6 166.00	1 500.00	7 348.50	554.23							1 500.00	30 857.25	6 720.23
2019	0.00	7 803.75	6 166.00	0.00	7 348.50	1 126.50							0.00	15 152.25	7 292.50
2020	0.00	7 803.75	6 166.00	0.00	7 348.50	1 717.23							0.00	15 152.25	7 883.23
2021	0.00	7 803.75	6 166.00	0.00	7 348.50	2 329.81							0.00	15 152.25	8 495.81
2022	0.00	7 803.75	6 166.00	0.00	7 348.50	2 962.24							0.00	15 152.25	9 128.24
2023	0.00	7 803.75	6 166.00	0.00	7 348.50	3 615.17							0.00	15 152.25	9 781.17
2024	0.00	7 803.75	6 166.00	0.00	7 348.50	4 289.27							0.00	15 152.25	10 455.27
2025	0.00	7 803.75	6 166.00	0.00	7 348.50	4 985.21							0.00	15 152.25	11 151.21
2026	0.00	7 803.75	6 166.00	0.00	7 348.50	5 707.35							0.00	15 152.25	11 873.35
2027	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2028	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2029	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2030	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2031	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2032	0.00	7 803.75	6 166.00	0.00	23 053.50	6 453.02							0.00	30 857.25	12 619.02
2033	0.00	23 508.75	6 166.00	0.00	7 348.50	6 453.02							0.00	30 857.25	12 619.02
2034	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2035	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2036	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2037	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2038	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2039	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2040	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2041	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2042	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2043	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2044	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2045	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2046	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2047	0.00	7 803.75	6 166.00	0.00	23 053.50	6 453.02							0.00	30 857.25	12 619.02
2048	0.00	23 508.75	6 166.00	0.00	7 348.50	6 453.02							0.00	30 857.25	12 619.02
2049	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2050	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2051	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2052	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
2053	0.00	7 803.75	6 166.00	0.00	7 348.50	6 453.02							0.00	15 152.25	12 619.02
TOTAL	**1 246 138**	**437 303**	**265 459**	**889 235**	**295 956**	**201 518**							**2 135 373**	**733 259**	**466 978**
Commission date		2004			2018			0			0				
Transfer capacity (m3/s)		6.41			6.64			0.00			0.00				

(CONTINUED.....)

Check	**R 1 246 138**	**R 889 235**	**R 0**	**R 0**

MKOMAZI-MGENI TRANSFER STUDY

SCHEME 3B: SMITHFIELD-BAYNESFIELD

YEAR	NET PRESENT COST (1994) AT 6%			NET PRESENT COST (1994) AT 8%			NET PRESENT COST (1994) AT 10%		
	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY	CAPITAL	MAINTENANCE & OPERATION	ELECTRICITY
SHADOW									
1997	0	0	0	0	0	0	0	0	0
1998	15 684	0	0	15 394	0	0	15 114	0	0
1999	18 223	0	0	17 554	0	0	16 921	0	0
2000	188 805	0	0	178 509	0	0	168 948	0	0
2001	138 885	0	0	128 879	0	0	119 759	0	0
2002	321 437	0	0	292 756	0	0	267 092	0	0
2003	265 893	0	0	237 684	0	0	212 905	0	0
2004	998	5 190	232	875	4 553	204	770	4 005	179
2005	0	4 896	497	0	4 216	428	0	3 641	370
2006	0	4 619	689	0	3 904	582	0	3 310	494
2007	0	4 358	864	0	3 615	717	0	3 009	597
2008	0	4 111	1 024	0	3 347	834	0	2 735	681
2009	0	3 878	1 169	0	3 099	934	0	2 487	749
2010	0	3 659	1 300	0	2 869	1 020	0	2 260	803
2011	0	3 452	1 421	0	2 657	1 094	0	2 055	846
2012	0	3 256	1 530	0	2 460	1 156	0	1 868	878
2013	3 789	3 072	1 628	2 809	2 278	1 207	2 095	1 698	900
2014	9 449	2 898	1 716	6 877	2 109	1 249	5 034	1 544	914
2015	54 614	2 734	1 794	39 010	1 953	1 281	28 038	1 404	921
2016	123 963	2 579	1 862	86 907	1 808	1 306	61 326	1 276	921
2017	100 313	2 433	1 923	69 024	1 674	1 323	47 821	1 160	917
2018	441	9 077	1 977	298	6 130	1 335	203	4 170	908
2019	0	4 205	2 024	0	2 787	1 341	0	1 861	896
2020	0	3 967	2 064	0	2 581	1 343	0	1 692	880
2021	0	3 742	2 098	0	2 389	1 340	0	1 538	863
2022	0	3 530	2 127	0	2 212	1 333	0	1 398	842
2023	0	3 331	2 150	0	2 049	1 322	0	1 271	821
2024	0	3 142	2 168	0	1 897	1 309	0	1 156	798
2025	0	2 964	2 182	0	1 756	1 293	0	1 051	773
2026	0	2 796	2 191	0	1 626	1 274	0	955	748
2027	0	2 638	2 197	0	1 506	1 254	0	868	723
2028	0	2 489	2 073	0	1 394	1 161	0	789	657
2029	0	2 348	1 955	0	1 291	1 075	0	718	598
2030	0	2 215	1 845	0	1 195	996	0	652	543
2031	0	2 090	1 740	0	1 107	922	0	593	494
2032	0	4 015	1 642	0	2 087	853	0	1 098	449
2033	0	3 787	1 549	0	1 932	790	0	998	408
2034	0	1 755	1 461	0	879	732	0	446	371
2035	0	1 655	1 378	0	814	678	0	405	337
2036	0	1 562	1 300	0	753	627	0	368	307
2037	0	1 473	1 227	0	697	581	0	335	279
2038	0	1 390	1 157	0	646	538	0	304	253
2039	0	1 311	1 092	0	598	498	0	277	230
2040	0	1 237	1 030	0	554	461	0	252	209
2041	0	1 167	972	0	513	427	0	229	190
2042	0	1 101	917	0	475	395	0	208	173
2043	0	1 039	865	0	440	366	0	189	157
2044	0	980	816	0	407	339	0	172	143
2045	0	924	770	0	377	314	0	156	130
2046	0	872	726	0	349	291	0	142	118
2047	0	1 675	685	0	658	269	0	263	107
2048	0	1 580	646	0	609	249	0	239	98
2049	0	732	610	0	277	231	0	107	89
2050	0	691	575	0	256	214	0	97	81
2051	0	652	543	0	237	198	0	88	73
2052	0	615	512	0	220	183	0	80	67
RES+2050	0	580	483	0	204	170	0	73	61
TOTAL	**1 242 492**	**130 460**	**67 398**	**1 076 576**	**84 444**	**40 036**	**946 025**	**57 689**	**25 049**

DISCOUNT RATE	PRESENT WORTH OF COSTS @ R1,00 / m3	NPV OF WATER DELIVERED	UNIT REFERENCE VALUE (cents/m3)
6%	**R 1 440 350**	**2 203**	**65.38**
8%	**R 1 201 056**	**1 309**	**91.73**
10%	**R 1 028 763**	**820**	**125.52**

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