DEVELOPMENT OF A RECONCILIATION STRATEGY FOR THE AMATOLE BULK WATER SUPPLY SYSTEM

FINAL REPORT

VOLUME 1 OF 2

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(Note: each appendix in Volume 2 is numbered according to the relevant chapter in Volume 1)

ABBREVIATIONS

ABWSS	Amatole Bulk Water Supply System
ADM	Amathole District Municipality
AIDS	Acquired Immune Deficiency Syndrome
ASCC	Amatole System Co-ordination Committee
ASOCC	Amatole System Operations Co-ordination Committee
ASSSC	Amatole System Strategy Steering Committee
AW	Amatola Water
AWRSA	Amatole Water Resources System Analysis
BCM	Buffalo City Municipality
BHN	Basic Human Needs
BKCB	Border Kei Chamber of Business
$CaCl_2$	Calcium Chloride
c/kℓ	Cents per kilolitre (cents per cubic metre)
$CaSO_4$	Calcium Sulphate
CMA	Catchment Management Agency
COD	Chemical Oxygen Demands
DEAET	Department of Economic Affairs, Environment and Tourism (East Cape Province)
DoA	Department of Agriculture
DSL	Dead Storage Level
DSS	Decision Support System
DST	Decision Support Tool
DWAF	Department of Water Affairs and Forestry
EC	Ecological Category
E.coli	Faecal Coliform
EFR	Estuarine Flow Requirement
EIA	Environmental Impact Assessment

EWR	Ecological Water Requirement
FSL	Full Supply Level
GWA	Groundwater Asset
H	High
ha	Hectare
HIV	Human Immunodeficiency Virus
I and M	Institutional/Management Arrangements
IAP	Invasive Alien Plants
IDP	Integrated Development Plan
IDZ	Industrial Development Zone (East London)
IFR	Instream Flow Requirements
IMPAQ	Impoundment / River Management and Planning Assessment Tool for Water Quality Simulation
IMS	Information Management System
ISP	Internal Strategic Perspective
kℓ/d	Kilolitre per day (cubic metre per day)
kℓ/m	Kilolitre per month (cubic metre per month)
km	Kilometre
km^2	Square kilometres
kWh	Kilowatt hour
KWT	King William's Town
L	Low
ℓ/c/d	Litres per capita per day
LM or LMs	Local Municipality or Local Municipalities
LoS	Level of Service
ℓ/s	Litres per second
M	Medium
m	Metre
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff

m^3	Cubic metre
m^3/a	Cubic metre per annum
m^3/d	Cubic metre per day
$m^3/ha/a$	Cubic metre per ha per annum
$MgCl_2$	Magnesium Chloride
mg/ℓ	Milligramme per litre
mgN/ℓ	Milligramme of Nitrogen per litre
mgP/ℓ	Milligramme of Phosphorus per Litre
$MgSO_4$	Magnesium Sulphate
MIS	Management Information System
Mkℓ/d	Million kilolitres per day (million cubic metres per day)
mℓ	Millilitres
Mℓ/d	Million litres per day
Mm^3/a	Million cubic metres per annum
MoR	Mitigation of Risk
mS/m	MilliSiemen per metre
N/100 mℓ	Number (counts) per 100 millilitre
$NaCl_2$	Sodium Chloride
Na_2SO_4	Sodium Sulphate
NH_3	Ammonia
NPV	Net Present Value
NWA	National Water Act (Act No. 36 of 1998)
NWRP	National Water Resource Planning Directorate of DWAF
O & M	Operation and Management
P	Phosphorus
PAC	Powdered Activated Carbon
PCMT	Project Co-ordination and Management Team
PES	Present Ecological State
PO_4	Phosphate

PSP	Professional Service Provider
RDM	Resources Directed Measures
RF	Return Flow of Treated Wastewater
RM	Million Rand
RO	Reverse Osmosis
RoA	Return on Assets
RWH	Rainwater Harvesting
SAB	South African Breweries
SANS	South African National Standards
SAPIA	Southern African Plant Invaders Atlas
SC	Steering Committee
SDA	Service Delivery Agreement
SP	Soluble Phosphate
SSC	Strategy Steering Committee
TDS	Total Dissolved Solids
TIN	Total Inorganic Nitrogen
ToR	Terms of Reference
U	Use of Treated Wastewater
µg/ℓ	Microgramme per litre
URV	Unit Reference Value
WC	Water Conservation
WCDM	Water Conservation and Demand Management
WDM	Water Demand Management
WfW	Working for Water Programme
WMA	Water Management Area
WMS	Water Management System
WQ	Water Quality
WQT	Water Quality TDS Model
WR90	Surface Water Resources of South Africa, 1990

WRFMC	Water Resources Functional Management Committee
WRPM	Water Resources Planning Model
WRSM2000	Water Resources Simulation Model (2000 Windows version)
WRYM	Water Resources Yield Model
WSA	Water Services Authority
WSAM	Water Situation Assessment Model
WSDP	Water Services Development Plan
WSP	Water Services Provider
WTW	Water Treatment Works
WUA	Water User Association
WW	Wastewater
WWT	Wastewater Treatment
WWTW	Wastewater Treatment Works

GLOSSARY OF TERMS

Aquifer	A saturated permeable geological unit that can transmit significant (economically useful) quantities of water under ordinary hydraulic gradients. Specific geologic materials are not innately defined as aquifers, but within the context of the stratigraphic sequence in the subsurface area of interest.
Assurance of Supply	The reliability at which a specified quantity of water can be provided, usually expressed either as a percentage or as a risk. For example "98% reliability" means that, over a long period of time, the specified quantity of water can be supplied for 98% of the time, and less for the remaining 2%. Alternatively, this situation may be described as a "1 in 50 year risk of failure" meaning that, on average, the specified quantity of water will not be fully available in 1 year out of 50 years, or 2% of time.
Catchment	The area of land drained by a watercourse. The term can be applied to a stream, a tributary of a large river or a whole river system.
Conjunctive use	The use of surface water to replenish aquifers or to increase the yield from aquifers.
Dam	Synonymous with reservoir.
"Deemed-to-use" households	Households that have an unmetered supply of water and which are charged a monthly amount for the use of water irrespective of the actual quantity that is used. The monthly amount is determined by a quantity of water that the WSA deems to be used by such households on average.
Groundwater	Water in the subsurface, which is beneath the water table, and thus present within the saturated zone. In contrast to water present in the unsaturated or vadose zone which is referred to as soil moisture.
Groundwater Asset	One or more boreholes, associated pumping installations, pipelines and reservoirs required to abstract water from an aquifer.
Intervention	An activity or measure to increase the availability of water or to reduce the requirement for water without having to create a surface water or groundwater asset.
Mean Annual Runoff	Frequently abbreviated to MAR, this is the long-term mean annual flow calculated for a specified period of time, at a particular point along a river and for a particular catchment and catchment development condition. In this report, the MARs are based on the 83-year period 1920 to 2003.

Options	Interventions that can be adopted, together with surface water assets and groundwater assets that can be created, to increase the availability of water or to decrease the requirement for water.
Potable Water	Water which is free from impurities that may cause disease or harmful physiological effects, such that the water is safe for human consumption.
Pour-flush	Sanitation system by means of which water is poured manually into the toilet cisterns for the purpose of flushing. The cisterns are not connected permanently to a source of water supply.
Quaternary Catchment	The basic unit of area resolution used in the WR90 series of reports published by the Water Research Commission and also in this report. The primary drainage regions are divided into secondary, tertiary and quaternary catchments. The quaternary catchments are numbered alpha-numerically in downstream order. A quaternary catchment number, for example R20D, may be interpreted as follows : the letter R denotes Primary Drainage Region R, the number 2 denotes secondary catchment 2 of Primary Drainage Region R, the number 0 shows that the secondary catchment has not, in this case, been sub-divided into tertiary catchments, and the letter D shows that the quaternary catchment is the fourth in sequence downstream from the head of secondary catchment R20.
Reconciliation	Process to effect (or establish) a favourable water availability/water requirement balance between divergent or conflicting needs.
Reserve	The quantity and quality of water required (a) to satisfy basic human needs by securing a basic water supply, as prescribed under the Water Services Act, 1997 (Act No. 108 of 1997) for people, who are now or who will, in the reasonably near future, be (i) relying upon; (ii) taking water from; or (iii) being supplied from, the relevant water resource; and (b) to protect aquatic ecosystems in order to secure ecologically sustainable development and use of the relevant water resource as indicated in the National Water Act (Act No. 36 of 1998).
Reservoir	The lake formed behind a dam wall. In this report the colloquial term dam is generally used for reservoir.
Resource Directed Measures	Measures that focus on the quality and overall health of water resources.
Resource Quality	The quality of all the aspects of a water resource including: (a) the quantity, pattern, timing, water level and assurance of in-stream flow; (b) the water quality, including the physical, chemical and biological characteristics of the

	water; (c) the character and condition of the in-stream and riparian habitat; and (d) the characteristics, condition and distribution of the aquatic biota.
Resource Quality Objective	Quantitative and verifiable statements about water quality, habitat integrity and biotic integrity that specify the requirements (goals needed to ensure a particular level of resource protection).
Salinity	The concentration of dissolved salts in water.
Scenario	A combination of options that when they are selected, provides a specific outcome in respect of water availability and water requirements.
Scheduled Area/Land	Irrigable land to which a water quota has been allocated.
Sub-Catchment	A sub-division of a catchment.
Supply System	A network of rivers ranging from streams to major rivers and, in some cases, including rivers draining naturally separate basins that have been inter-connected by man-made transfer infrastructure.
Surface Water Asset	A physical structure such as a dam, bulk water transfer pipeline and pump stations or desalination installation required to develop a surface water resource.
Surplus	Describes the situation where the availability of water at a particular assurance of supply is more than the unrestricted water requirement.
System	Components comprising rivers, dams, water transfer infrastructure, water and wastewater treatments works as well as desalination plants that are operated together to attain the most advantageous water yield and water quality from each component for all the water users who benefit from the water.
Water Transfers	Water transferred from one drainage basin or secondary sub-catchment to another. Transfers-in are synonymous with water imports.
Water Balance	The comparison of available water relative to water requirement. The balance could show a deficit or a surplus or be in equilibrium.
Yield	The maximum quantity of water obtainable on a sustainable basis from a dam or river in any hydrological year, in a sequence of years, and under specified conditions of catchment development and dam operation.

EXECUTIVE SUMMARY

ES 1 BACKGROUND

The Amatole to Kei Internal Strategic Perspective (ISP) study, which was completed by the Department of Water Affairs and Forestry (DWAF) in 2004, indicated that the area supplied by the Amatole Bulk Water Supply System (ABWSS) could be short of water soon after 2012. Furthermore, water is provided to users through several supply schemes, which are not fully integrated into a system. The purpose of the strategy developed during the course of this study is to:

- develop options which, when combined, will provide a strategy to ensure an adequate supply of water for the users in the designated area up to 2030 and to enable the ABWSS to be operated as a system;
- identify interventions and bulk water supply assets, which water resources managers can select to balance water requirements and water availability;
- identify dates by which studies for the required interventions and assets should commence and
- identify monitoring indicators, which will enable water resources managers to gauge the success of the strategy so that corrective action can be taken timeously.

The ABWSS provides water to between 630 000 and 800 000 people in the catchments of the Buffalo, the Nahoon and the Upper Kubusi rivers. Water is also supplied to industries in those catchments and to some 1 000 ha of scheduled irrigation areas along the upper and middle reaches of the Kubusi River.

There are seven dams in the ABWSS that provide water to users. They are the:

- Maden Dam, Rooikrantz Dam, Laing Dam and Bridle Drift Dam on the Buffalo River;
- Nahoon Dam on the Nahoon River;
- Gubu Dam on the Gubu River and
- Wriggleswade Dam on the Kubusi River.

The Wriggleswade Dam was constructed to augment the supply of water in the Buffalo and possibly in the Nahoon catchments by transferring water from the Kubusi River through the Wriggleswade Transfer Scheme. While the Wriggleswade Dam was built some twenty years ago, the Transfer Scheme is yet to be made fully operational.

Five main stakeholders own water supply assets within the ABWSS and/or draw water from the ABWSS. They are:

- Amathole District Municipality (ADM);
- Amatola Water (AW);
- Buffalo City Municipality (BCM);
- The Department of Water Affairs and Forestry (DWAF) and
- The Kubusi Irrigation Board.

AW, BCM and DWAF are the more dominant stakeholders.

A Steering Committee consisting of the main stakeholders and other interested parties guided the study while a Project Management Committee consisting of officials of DWAF managed the study.

In line with previous studies into the water resources of the Amatole Sub-region, the ABWSS is divided into 5 schemes as summarised in the table below.

Scheme	Dams	Owner	Operator
Upper Buffalo	Maden Rooikrantz	BCM DWAF	BCM AW
Middle Buffalo	Laing	DWAF	AW
Lower Buffalo	Bridle Drift Nahoon	BCM DWAF	BCM AW
Upper Kubusi	Gubu	DWAF	AW
Middle Kubusi	Wriggleswade	DWAF	AW

This study does not endeavour to identify a predetermined course of action. It develops options that, when they are combined, will enable stakeholders to select interventions and bulk water supply assets to be developed to address water requirement scenarios that range from the upper water requirements to the lower water requirements that have been determined by the study.

The options to balance the water requirements and the water that is available for different scenarios are selected with the assistance of a Decision Support Tool (DST).

The DST displays graphically and in the form of a spreadsheet scenarios of water balances comprising the impacts of demand-side measures (notably water conservation (WC) and water demand management (WDM) interventions) on the requirements for water and supply-side measures consisting of the current yields of the dams in the ABWSS together with the impacts of returns flows of treated wastewater to the rivers, the use of treated wastewater and the creation of bulk water supply assets.

The strategy is in the form of a schedule setting out interventions that can be implemented, assets that might have to be created, the dates by which studies into intervention and asset creation should commence, the stakeholder responsible for each intervention or asset and the priorities assigned to interventions and assets.

The study covers the following aspects:

- background to the study (Chapter 1);
- literature survey (Chapter 2);
- yields of the dams in the ABWSS (Chapter 3);
- water requirement scenarios for domestic, industrial and irrigation uses (Chapter 4);
- options for interventions and for the creation of assets (Chapter 5);
- risks that might affect the ABWSS and the implementation of the strategy (Chapter 6);
- operation of the ABWSS as a system (Chapter 7);
- indicators to monitor the progress of the strategy (Chapter 8);
- evaluation of scenarios using the DST (Chapter 9) and
- the reconciliation strategy for the ABWSS (Chapter 10).

The background to the study is outlined above. During the literature study, some 80 reports and documents were consulted. The documents that were consulted are listed in Appendix 2.

Each of the remaining aspects is considered in turn below.

ES2 YIELDS OF THE DAMS IN THE ABWSS (CHAPTER 3)

The hydrology of the Buffalo, Nahoon and Kubusi rivers was reviewed and the hydrological record used in the analysis was extended from the period 1920 to 1996, (the period used in the previous hydrological analysis) to the period 1920 to 2003, (the latest data available at the time the review was done) by using the Water Resources Simulation Model (WRSM2000).

The updated hydrology was used in the Water Resources Yield Model (WRYM) in order to determine the yields of the dams in the ABWSS. The proposed ecological water requirement (EWR) for each of the river reaches was agreed with the Directorate: Resource Directed Measures (RDM). In some river reaches, provision is also made for lower ecological categories (ECs) than those proposed by the Directorate: RDM.

In order to ascertain the impact of the EWRs on the yield of each dam and on the ABWSS as a whole (the system yield) various yield scenarios were prepared for each dam in the ABWSS.

The outlet works of the Rooikrantz, Laing, Bridle Drift and Wriggleswade dams are inadequate to release the full flood EWRs. Full flood EWRs and reduced flood EWRs (when water is passed through the dams' outlet structures) have been analysed and are recorded in this report. Due to the expense of increasing the capacities of the outlets, the yields of the dams with reduced flood EWRs have been adopted for the study.

The strategy makes provision for individual dams in the ABWSS to be operated at assurances of supply less than 98% (as is currently the case) but that the assurance of supply of the ABWSS as a whole would be 98%. To this end, a probabilistic yield analysis was conducted for each dam and for the ABWSS comprising the historic firm yield as well as the 99.5%, 99%, 98%, 95% and 90% assurances of supply. The analyses covered yields without provision for the EWRs as well as with provision for the EWRs for different ECs.

The results for the historic firm yield and an assurance of supply of 98%, without EWRs and with the ECs proposed by the Directorate: RDM and for reduced flood EWRs are summarised in the table below. The impacts of other assurances of supply, ECs and for the full floods are shown in the tables in the text.

System Yield (Mm^3/a)						
	Historic Firm Yield			98% Assurance of Supply		
Dam	Without EWR	With EWR		Without EWR	With EWR	
	(Mm^3/a)	EC	(Mm^3/a)	(Mm^3/a)	EC	(Mm^3/a)
Maden	0.35	None	0.35	0.48	None	0.48
Rooikrantz	2.86	C	1.19	3.70	C	1.49
Laing	14.44	C	11.56	18.27	C	12.54
Bridle Drift	24.61	C	25.59	29.41	C	28.91
Nahoon	6.78	C	2.00	8.41	C	3.45
Gubu	3.40	C/D	2.56	2.87	C/D	2.11
Wriggleswade	24.76	C	17.25	31.80	C	20.28
System Yield	77.20		60.50	94.94		69.26

If it becomes necessary for the full flood EWRs to be released, the system yield at 98% assurance of supply would be reduced by between 3 Mm^3/a and 4 Mm^3/a.

The study does not include the analysis of future operating criteria for each dam, such as would be given by the application of the Water Resources Planning Model (WRPM). One of the interventions recommended in the strategy is to undertake such a study.

An analysis was done of the impact of afforestation and invasive alien plants (IAP) on stream-flow reduction. While the system yield could increase by some 17 Mm^3/a if all the exotic forests are removed and by some 11 Mm^3/a if all the IAP are removed, such an intervention is impracticable. The conclusion was drawn that the reduction in afforestation and IAP to the extent necessary to materially increase the system yield of the ABWSS is also impracticable, but that the conversion of economically viable stands of invasive wattle would be beneficial from a socio-economic perspective, rather than to increase the system yield. The strategy includes an intervention, however, to investigate the practicality of deforestation and the removal of IAP to the extent necessary for a significant increase in the system yield.

A desk-top groundwater investigation was undertaken as part of the study to ascertain the likelihood of there being suitable aquifers that could be integrated into the ABWSS and which could be used conjunctively with surface water. The conclusion was reached that there might be a potential aquifer along the Nahoon River that could be operated conjunctively with water released from the Wriggleswade Transfer Scheme. Data is limited, but it might be possible to obtain some 0.2 Mm^3/a for inclusion in the ABWSS. An investigation into the potential aquifer has been included as one of the asset creation options in the strategy.

ES3 CURRENT AND FUTURE WATER REQUIREMENTS (CHAPTER 4)

The water requirements are based upon four population growth scenarios together with three water requirement scenarios for domestic, industrial and irrigation use. Three of the population scenarios were obtained from BCM. Two were determined by demographers appointed by BCM's IDP Department, while the third was established from a dwelling count undertaken by consulting engineers engaged by BCM's Water Department. The fourth population scenario was determined by demographers appointed by DWAF. All scenarios are based on either the 2001 population Census or on aerial photography taken in 2001. Account is taken of the impact of the natural growth of the population, of HIV/AIDS and of migration, to the extent that the data was available to the Planning Team.

The lower population growth scenario was taken as the "High HIV Impact Scenario" determined by the demographers engaged by BCM, while the upper population growth scenario is based on the dwelling counts and the population scenario of the demographers engaged by DWAF.

The results are shown in the table below for the area of supply of the ABWSS.

Year	Population	
	Lower Scenario	Upper Scenario
2001	644 246	766 653
2005	632 247	799 655
2010	605 246	821 322
2015	567 230	825 166
2020	523 043	819 436
2025	482 299	813 747
2030	444 728	808 096

The population scenarios, therefore, reflect the possibility of the population within the area of supply of the ABWSS either reducing or increasing over the planning period.

In order to obtain lower and upper water requirement scenarios, the lower and upper water requirements for domestic users were applied to the lower population and upper population scenarios respectively. Lower and upper requirement scenarios for industrial water use were taken as being the water used in 2005 for industrial purposes, together with 10% of the potable and industrial water requirements for the East London Industrial Development Zone (IDZ) when fully developed for the lower water requirement scenario and 50% of the potable and industrial water requirements of the IDZ when fully developed for the upper water requirement scenario. The lower water requirement scenario for irrigation water use was taken as the water for the scheduled areas along the Kubusi River between Gubu Dam and the Wriggleswade Dam. The upper water requirement scenario for irrigation was taken as being the water for the scheduled areas along the Kubusi River between the Gubu and the Wriggleswade dams together with compensation releases from the dams in the ABWSS and the irrigation water requirements for 375 ha along the Buffalo and Nahoon rivers.

The upper and lower water requirement scenarios for the area of supply of the ABWSS are summarised in the table below.

Year	Domestic		Industrial		Irrigation		Total	
	Lower	Upper	Lower	Upper	Lower	Upper	Lower	Upper
	(Mm³/a)	(Mm³/a)	(Mm³/a)	(Mm³/a)	(Mm³/a)	(Mm³/a)	(Mm³/a)	(Mm³/a)
2005	45.34	57.34	14.32	14.32	9.04	13.44	68.70	85.10
2010	43.45	64.50	14.52	15.32	9.04	13.44	67.01	93.26
2015	40.81	70.38	14.69	16.17	9.04	14.85	64.54	101.40
2020	37.73	75.57	14.87	17.07	9.04	16.25	61.64	108.89
2025	34.89	80.93	15.05	17.97	9.04	16.25	58.98	115.15
2030	32.27	80.62	15.23	18.87	9.04	16.25	56.54	115.74

The study takes into account the possibility of additional areas being incorporated into the area of supply of the ABWSS. The additional areas are the coastal developments to the north east and south west of East London, rural settlements that can be supplied from bulk water supply infrastructure to serve those developments and the Amahlati South Water Supply Scheme. The lower water requirement scenario includes only the Amahlati South Water Supply Scheme as it is already in hand, while a decision is yet to be made as to whether the areas to the north east and south west of East London will be included in the ABWSS. The upper water requirement includes all three areas. The lower water requirement for the additional areas has been taken as 0.21 Mm^3/a and the upper water requirement scenario amounts to some 11 Mm^3/a by the end of the planning period. The water requirements for the additional areas are in addition to the water requirements shown in the table above.

ES4 RECONCILIATION OPTIONS (OPTIONS) (CHAPTER 5)

Options have been proposed for interventions relating to WC and WDM, wastewater use and stream-flow reduction as summarised in the table below.

Measure	Description	Possible Reduction in Water Requirement		No. of Options
		Lower (Mm³/a)	Upper (Mm³/a)	
WC and WDM	Water use reduction	7	12	9
	Losses in conveyance from water treatment works (WTWs) and in reticulations	7	13	5
	Losses between dams and WTWs and through WTWs	3	5	3

		Possible Reduction in Water Requirement		
Measure	Description	Lower (Mm^3/a)	Upper (Mm^3/a)	No. of Options
Wastewater use (taken as 90% of wastewater treated)	Use of treated wastewater for domestic, industrial and irrigation purposes or return of treated wastewater to the rivers to enhance the system yield as well as to contribute towards meeting the EWR	24	18	29
Stream flow reductions	Deforestation and conversion of stands of wattle to forests	0	5	2
Total		41	53	48

The quality of the water in the rivers varies from near pristine in the headwaters to polluted or highly polluted where the water flows out of the area of supply of the ABWSS.

Water quality management targets and objectives have previously been proposed for the river reaches in the ABWSS, while preliminary water quality reserve and resource categories have been proposed by the Directorate: RDM. An intervention in the strategy is that the required modelling should be undertaken to finalize the quality targets and objectives.

The conclusion is drawn that the operating rules for the ABWSS should be driven by the best use of the water available from the system yield rather than from a water quality perspective. Water quality can best be addressed at the sources of pollution and interventions should be centred on:

- reduction in saline effluent sources (already partially in hand);
- elimination of sewer leaks in Mdantsane (already partially in hand);
- reduction of phosphate loading from point sources (improvements to wastewater treatment works (WWTWs)) and
- control of diffuse pollution from informal settlements to reduce bacterial loading.

In order to address the water quality aspects outlined above, 20 interventions are proposed in the strategy.

The most critical surface water assets that need to be created are the connections from the Wriggleswade Transfer Scheme to the water treatment works (WTWs) in which the water from the Wrigglewade Dam will be treated. Linked to that is the finalization of the manner in which the water from the Wriggleswade Dam can best be distributed to maximize the use of the assets of all the stakeholders that receive water from the ABWSS. Interventions are proposed in the strategy for the distribution of water from the

Wriggleswade Transfer Scheme to be agreed amongst stakeholders to best suit their water treatment, distribution and reticulation requirements and for the transfer scheme to be made fully operational as a matter of priority.

Previous studies have identified 14 potential new sources of bulk water for the ABWSS. These sources were all taken into account, but only the seven most favourable options have been included in the strategy.

A pilot investigation into the potential aquifer along the Nahoon River has been included as an asset creation option. The success or otherwise of the investigation will determine whether or not it is worth pursuing groundwater as an option for incorporation into the ABWSS.

Desalination of seawater has been taken into account, but other options are more favourable at this time. The strategy makes provision for a study into seawater desalination towards the end of the planning period if the cost of desalination declines sufficiently relative to the other bulk water supply options or if the other options prove less favourable than they seem at this time or if the water requirements are greater than the upper scenario that has been developed as part of this study.

ES5 RISKS THAT MIGHT AFFECT THE ABWSS AND THE IMPLEMENTATION OF THE STRATEGY (CHAPTER 6)

Fourteen potential risks that might affect the implementation of the strategy have been identified. They deal mainly with aspects surrounding stakeholder relationships, capacity and participation as well as difficulties that might arise with respect to the options that are proposed in the strategy.

Account is taken of climate change as a risk and the conclusion is reached that rainfall patterns could change which could require additional storage. An intervention is proposed in the strategy to review the requirements for additional storage once more information is available of the effects of climate change on rainfall patterns, the extent to which there is population growth/decline in the area of supply of the ABWSS and the impact that WC and WDM interventions have on the requirement for water.

Stakeholders have indicated that the institutional arrangements of the ABWSS are a matter of concern. A risk is that the issues surrounding the institutional arrangements cannot be resolved and that the ABWSS cannot be operated as a system.

ES6 OPERATION OF THE ABWSS AS A SYSTEM (CHAPTER 7)

The fragmentation of functions between stakeholders in the ABWSS is considered and four options for the ownership, operation, management and further development of the assets in the ABWSS are described. The conclusion is reached that the continuation and refinement of the present institutional arrangement is the most practicable option at this time, provided the current shortcomings can be addressed and that the relationship between the stakeholders is arranged through well-structured and well-managed service delivery agreements (SDAs).

The price of bulk water is a divisive matter amongst stakeholders and is a significant threat to the ABWSS being operated as a system. The costs reflected by AW, BCM and DWAF were analysed and the conclusion was reached that if all costs are taken into account the differences are not as great as they are perceived to be. Nevertheless, there are aspects in the pricing structures that require attention. It will be beneficial for a consistent manner of recording costs to be developed so that stakeholders are all aware of the manner in which costs are determined and the extent to which matters that are not directly related to the supply of water from the ABWSS are included in the tariffs. In consultation with the Amatole System Co-ordination Committee (ASCC) a *pro-forma* schedule for recording cost has been developed.

Present arrangements and the absence of SDAs also results in stakeholders, particularly DWAF, not recovering all the costs to which they should be entitled. As a result the financial management of the different components of the ABWSS is distorted.

Different institutional arrangements are proposed to manage the implementation of the strategy. Three options have promise, namely a Catchment Management Agency (CMA), a Water User Association (WUA) (both of which would be statutory) or a voluntary association of the stakeholders governed by a steering committee. The stakeholders prefer the latter option. In the event that a steering committee is not able to address the disparate requirements of the stakeholders, a statutory body could still be formed, in which event a WUA would be the most appropriate option.

This report contains a proposal for the management of the ABWSS as a system and for its further development. Consideration is given to the way in which water can be allocated and distributed to each of the five schemes in order to optimize the use of the assets of the stakeholders as well as of the treated wastewater emanating from WWTWs in the area of supply of the ABWSS and to minimize the need for the creation of new bulk water supply assets.

ES7 INDICATORS TO MONITOR THE PROGRESS OF THE STRATEGY (CHAPTER 8)

In order for the strategy to be reviewed annually or bi-annually, as is the intention, it is necessary to monitor the impacts that the implementation of the options has on the availability of water and the water requirements. The monitoring programme, as an intervention in itself, should enable stakeholders to take timeous action in the event of there being deviations from the strategy.

Monitoring indicators are proposed. The nature and number of the indicators are summarised in the table below.

Nature of Indicator	No. of Indicators
Bio-physical	6
Raw water	10
Water use	7
Wastewater	4
Water quality	7
Land use and population changes	5

The stakeholder(s) that will be responsible for each indicator are also identified.

ES8 EVALUATION OF THE SCENARIOS USING THE DST (CHAPTER 9)

Eleven scenarios for the reconciliation of water requirements and the availability of water were analysed using the DST. The nature of the scenarios is summarised in the table below.

Courses of Action	Scenario Number
Upper water requirement scenario, with reductions in water requirements as a result of the implementation of the WC/WDM interventions that BCM has in hand as well as the WC/WDM interventions proposed in this study (referred to as "Full WC/WDM interventions")	1 to 4
Upper water requirement scenario, with reductions in water requirements as a result of the implementation of only the WC/WDM interventions that BCM has in hand	5 and 6
Upper water requirement scenario, without WC/WDM interventions or the failure of the WC/WDM interventions that BCM has in hand and no wastewater use interventions	7
The extent to which current surface water assets coupled with the WC/WDM interventions that BCM has in hand can meet the lower water requirement scenario	8
The impact that the introduction of the EWR will have on the interventions and surface water assets required to meet the upper and lower water requirement scenarios	9 to 11

The interventions and asset creation options are divided into supply-side and demand-side measures. The supply-side measures are wastewater return flows, surface/groundwater asset creation and wastewater use. The demand-side measures are WC/WDM interventions.

Without releasing water from the dams for the EWRs, the WC/WDM interventions that BCM has in hand (and those interventions proposed in this study which are necessary to attain sustainability of those WC/WDM interventions) would be adequate to meet the upper water requirements until 2030 provided all of the wastewater return and wastewater use interventions can be implemented. If it is not possible to introduce most of the wastewater return and wastewater use interventions, additional surface water assets will be necessary even if the "full WC/WDM interventions" are successful.

The present system yield would be adequate to meet the water requirements for the lower water requirement scenario until 2030.

Once the EWRs are introduced, additional bulk water supply assets would be required to meet the upper water requirement scenario until 2030. The present system yield would be adequate to meet the water requirements for the lower water requirement scenario until 2030 even with the introduction of the EWRs.

Central to the selection of additional bulk water supply assets is the manner in which WTWs will be used and be developed as well as the way in which BCM will develop and manage its distribution system. In the event of the Umzonyana WTW being the sole or main potable water purification installation, dams in the Keiskamma River or in its tributaries would be the most advantageous. If the Umzonyana and Nahoon WTWs are to be developed in tandem, dams in the Nahoon, Gonubie and possibly in the Kwelera rivers would be the most beneficial. A priority intervention in the strategy is to determine the most advantageous water treatment arrangement for the Lower Buffalo Scheme.

Suggestions are made in this report regarding the possible reduction in the upper water requirement by not including in the ABWSS, areas that are currently outside the area of supply of the ABWSS and by restricting allocations for irrigation. Also, the system yield could be increased by operating the Maden, Rooikrantz, Laing, Bridle Drift and Nahoon dams at an assurance of supply of 90% as an interim measure (as is happening at present).

The existing system yield at 98% assurance of supply should be adequate to meet the upper water requirement scenario until around 2013 without the successful implementation of the WC/WDM interventions that BCM has in hand and without the introduction of additional areas or irrigation into the ABWSS. The successful implementation of the WC/WDM interventions that BCM has in hand should enable the additional areas to be introduced without having to augment the supply before 2013. Relaxation of the assurances of supply from the Maden, Rooikrantz, Laing, Bridle Drift and Nahoon dams could extend this period by another 5 years or so provided the EWRs are not introduced.

A comparison of the scenarios enables the earliest date by when the benefit of an intervention or an asset is required to be determined. These dates in turn determine the latest dates by when studies/investigations into the interventions/assets must begin.

While the DST shows when interventions are required and by when investigations/studies should start, the dates relate to the scenarios that have been analysed. Certain interventions and surface water assets are so critical that it will be prudent for studies into them to start earlier than the dates identified through the analysis of the eleven scenarios. Advisable study start dates for these interventions and surface water assets are given.

In addition to the water quantity analysis provided by the DST, it is also necessary to introduce water quality interventions. To this end, proposals are made for water quality interventions and when studies/investigations into them should commence.

ES9 THE RECONCILIATION STRATEGY FOR THE ABWSS (CHAPTER 10)

The strategy is the selection of the interventions and potential surface water supply assets that would contribute to addressing the largest number of scenarios analysed by the DST as well as those issues raised by stakeholders during the course of the study.

The strategy covers a number of elements related to the options. They are:

- the earliest date by which each intervention or asset is required;
- the advisable or latest date by which the study/investigation for each intervention or asset creation should start;
- what would "trigger" the study/investigation;
- the responsible stakeholder for the study/investigation for each intervention or asset and
- the priority assigned to the study/investigation for each intervention or asset.

Emphasis of the strategy is on the studies/investigations to enable the benefits of the desired interventions/assets to be attained at the earliest date required by the scenarios analysed during the study.

The strategy is in tabular form and is divided into 9 categories as summarised in the table below.

Categories	No. of Interventions/ Assets	Priority No. of Interventions/ Assets		
		High	Medium	Low
WC and WDM interventions	18	9	5	4
Return flow of treated wastewater to enhance the yields of dams	2	2		
Use of treated wastewater (for domestic, industrial or irrigation purposes)	4	1	2	1
Surface water asset creation	9	5	2	2
Groundwater asset creation	1		1	
Water quality improvements	13	10	1	2
EWRs	2	1	1	
Mitigation of risk	2	1		1
Institutional/management arrangements	8	8		

Monitoring of the strategy through the indicators is viewed as essential to identify the "triggers" timeously.

Key interventions and surface water assets are listed and priority actions for 2008 and 2009 are given. The key interventions and priority actions are summarised in the section that follows.

KEY INTERVENTIONS AND ASSET CREATION

KIA1 PURPOSE OF HIGHLIGHTING THE KEY INTERVENTIONS AND ASSET CREATION OPTIONS

The strategy in Chapter 10 sets out the interventions and additional surface water as well as groundwater assets that will enable the water requirements to be reconciled with the available water up to 2030.

Certain of the interventions and asset creation options are key to the implementation of the strategy. Without those interventions and asset creation options, the strategy cannot be implemented or the implementation will be only partially successful. Also, the interventions and decisions regarding the creation of assets tend to be interdependent, with the key ones preceding the less critical ones. The key interventions and asset creation options are set out below.

KIA2 WC/WDM INTERVENTIONS THAT BCM HAS IN HAND

BCM currently has four interventions in hand, while a further four interventions are required to make BCM's interventions successful and sustainable.

The interventions that BCM has in hand are:

- the installation of domestic water meters, particularly for the "deemed-to-use" households (ie households that pay a fixed amount each month irrespective of the quantity of water they use during the month);
- pressure reduction in water reticulation networks;
- the installation of area meters and
- development and use of a management information system.

The interventions that are necessary to make BCM's interventions successful, are:

- an annual water audit;
- enhancement of meter, billing and debtor management;
- improvements to the user education programme and
- a structured response to issues related to water use and cost recovery.

These eight interventions are the most cost effective water use efficiency measures and could account for 50% of the potential reduction in water requirements due to WC/WDM interventions.

KIA3 OTHER WATER USE EFFICIENCY MEASURES

Water infrastructure asset management undertaken in a structured manner in accordance with best-practice manuals recently introduced into South Africa will reduce conveyance and distribution losses.

Interventions are proposed to reduce water requirements through the use of water efficient type sanitation systems, support to households (particularly registered indigent households) and public bodies to maintain water use installations as well as to improve the monitoring of the quality of construction of water installations. These interventions are less cost effective than the ones BCM currently has in hand, but all contribute towards water use efficiency as well as to reducing the water requirements.

Similar interventions should be introduced by ADM for the other Local Municipalities (LMs) for which it is the Water Service Authority (WSA).

KIA4 CONNECTIONS FROM THE WRIGGLESWADE TRANSFER SCHEME

The most critical asset creation activity is the protection of the water courses into which water from the Wriggleswade Transfer Scheme is discharged as well as the construction of the connections from the transfer scheme to WTWs so that water can be transferred from the Wriggleswade Dam to the various parts of the ABWSS when that water is needed.

The yield from the Wriggleswade Dam has been taken into account when determining the system yield.

Currently the Maden, Rooikrantz and Bridle Drift dams are being operated at assurances of supply less than 90% and reliance is placed, therefore, on the water from the Wriggleswade Dam. There is a risk that the water in the Wriggleswade Dam will not be readily available on a sustainable basis to augment the supply to the Maden, Rooikrantz, Laing and Bridle Drift dams when it is required.

The connections from the Wriggleswade Transfer Scheme to the WTWs must be completed as soon as possible.

KIA5 WATER DISTRIBUTION TO WSAs

The operation of the ABWSS as a system is dependent upon a clear definition of where the water from the Wriggleswade Dam is required, how the water will reach the WTWs and the circumstances under which water will be transferred between the five schemes that make up the ABWSS.

A proposal for the operation of the system with a view to optimising the use of water supply, distribution and treatment assets is made in Chapter 7. Relevant stakeholders need to agree as a matter of urgency on the manner in which the water from the Wriggleswade Dam will be distributed so that the necessary distribution infrastructure from the Wriggleswade Transfer Scheme to WTWs can be planned, designed and constructed.

Linked to this aspect is a decision that is required as to whether BCM will treat all the water for the Lower Buffalo Scheme at a single WTW (the Umzonyana WTW) or whether the water will be treated at both the Umzonyana and Nahoon WTWs. The latter could play an increasingly important role of supplying potable water to the northern parts of East London and the coastal area to the north east of East London. This decision impacts upon the way water from the Wriggleswade Transfer Scheme will be distributed, the future of the Nahoon WTW and the selection of the most cost effective surface water assets for investigation.

KIA6 WATER PRICING

Water pricing and the determination of charges between stakeholders is an aspect that could act either in favour of or against the ABWSS being operated as a system. The issues surrounding water pricing are described in Chapter 7 and a recommendation is made to improve the manner in which costs can be recorded and shared more transparently than is currently the case.

Linked to water pricing is the manner in which charges are levied for storage that is provided by one stakeholder for the benefit of another stakeholder. An example is the manner in which DWAF is compensated for providing storage in the Wriggleswade Dam for the benefit of ADM and BCM.

It is critical that the issues surrounding water pricing, as well as the storage and supply of bulk water, are addressed.

KIA7 SERVICE DELIVERY AGREEMENTS

While there are agreements between parties, they do not cover all the aspects required to manage the ABWSS as a system and for the true cost of water to be taken into account. SDAs are urgently required between the parties to cover aspects such as “rules of engagement” between the parties, the quantity of water to be supplied by one party to another, the costs of the water and the method of calculating the price of the water, the conditions governing the provision of an asset by one party for the benefit of another, the manner in which assets of each party can be optimized, responsibility for the augmentation of assets and the recourse that a party will have in the event of another party failing to fulfil its obligations.

The existing agreements need to be reviewed and be included in comprehensive SDAs in a manner that will attain equity amongst the stakeholders and that will enable the ABWSS to be operated as a system.

KIA8 ECOLOGICAL WATER REQUIREMENTS

The EWRs for different ecological categories are set out in Chapter 3 for the various river reaches in the area of supply of the ABWSS. The implications of the introduction of the EWRs on the need for the creation of surface water assets are shown in scenarios 9 to 11 in Chapter 9.

Also, the options for the use of treated wastewater emanating from Potsdam, Mdantsane and Reeston, are strongly influenced by the extent to which the treated wastewater will be allocated to meeting the EWR requirements in part or in whole in the Buffalo River downstream of the Bridle Drift Dam.

Decisions are required as a matter of urgency regarding the ecological categories that will be adopted for each river reach, the manner in which and the time when the EWR will be introduced as well as the extent to which treated wastewater will be released to the rivers in order to meet the EWRs.

Investigations into options for the use of treated wastewater and for the creation of surface water assets are dependent upon these decisions. The decisions also influence the potential yields of the dams and the manner in which the ABWSS would be operated as a system.

The EWR for the estuary of the Nahoon River and the extent to which the run-of-river flow can meet the EWR are uncertain at this time and could have a significant impact on the water available from the Nahoon River for other uses. A study is required into the estuarine reserve requirement and a measuring weir and gauging station at the estuary are necessary to measure the flow regime.

KIA9 WATER QUALITY

The best manner in which to maintain or improve the quality of water in the rivers is by addressing pollution at the source of the pollution. This applies to the water quality aspects of the EWRs as well as the quality of the raw water that is treated for domestic and industrial purposes.

Water quality management targets and objectives have been proposed in the past for the river reaches in the ABWSS. Modelling is urgently required to finalise the water quality management targets and objectives in order to finalise the EWRs, to define discharge parameters with which the WWTWs that discharge treated wastewater to the rivers in the ABWSS must comply and to set criteria for the management of diffuse pollution sources such as sewerage networks, agricultural runoff, solid waste management and settlements along watercourses.

Interventions for water quality improvement must be added to relevant interventions for WC/WDM and for infrastructure asset management.

KIA10 YIELD OF THE SYSTEM

The yield of the system, which has been adopted for the scenarios described in Chapter 9, has been taken at 98% assurance of supply. The ABWSS is currently at risk due to the quantities of water being abstracted from the Maden, Rooikrantz and Bridle Drift dams, without the certainty that water from the Wriggleswade Dam can be safely transferred on a sustainable basis when the need arises.

A decision is required as to the process that will be adopted to operate the ABWSS at an assurance of supply of 98%. To this end, operating rules for each dam and for the ABWSS as a whole must be determined in the first update of the strategy, while the analysis of the ABWSS, which was done by means of the Water Resources Planning Model (WRPM) must be updated to reflect the operating arrangements for the ABWSS agreed to by the stakeholders.

KIA11 INCLUSION INTO THE ABWSS OF ADDITIONAL AREAS REQUIRING SUPPLY

Stakeholders have indicated that there is a need to supply water from the ABWSS to areas outside the current area of supply of the ABWSS. The areas are the coastal zones and associated rural settlements to the north east and south west of East London and the rural settlements in the vicinity of Kei Road, Bhisho and Stutterheim (known as the Amahlati South Water Supply Scheme).

The latter scheme will abstract water from the Wriggleswade Transfer Scheme for treatment at the Kei Road WTW and would automatically become part of the ABWSS. The other two areas could be supplied with water from the ABWSS or through the more expensive option of desalinating seawater.

A decision is urgently required as to whether or not the coastal areas will be supplied with bulk water from the ABWSS and if so when as well as how the supply would be provided. This decision has a material influence on decisions regarding the surface water assets that need to be investigated, the manner in which bulk water will be delivered to and from WTWs and the potential use of treated wastewater emanating from the East Bank and Gonubie WWTWs.

KIA12 WATER FOR IRRIGATION

Water made available for irrigation from the dams in the ABWSS would have a notable influence on the manner in which water is distributed to users as well as on the surface water assets that would have to be constructed.

Decisions regarding the extent to which water from the dams and rivers in the ABWSS would be made available for irrigation are urgent as the decisions influence the manner in which water from the Wriggleswade Transfer Scheme will be distributed, which new surface water assets would have to be investigated and by when such investigations/studies should start.

KIA13 STUDIES FOR THE CREATION OF SURFACE WATER ASSETS

Through the analysis in Chapter 7 of the manner in which the ABWSS can be operated as a system and the scenario-analysis in Chapter 9, seven surface water assets have been identified as being worthy of further investigation.

The ones that should receive priority attention and by when the investigations should be started, are dependent on decisions taken in respect of matters outlined above, particularly the manner in which the EWRs would be introduced, how water would be distributed to and within the WSAs, inclusion or otherwise of additional areas into the area of supply of the ABWSS and the extent to which water would be made available for irrigation.

Time is of the essence for the decisions to be taken so that the potential surface water assets that need to be studied can be agreed upon.

KIA14 GROUNDWATER PILOT INVESTIGATION

The extent to which groundwater can be integrated into the ABWSS is uncertain at this time. Present indications are that groundwater sources are limited in the ABWSS.

Potential aquifers have been identified along the Nahoon River, one of which has been recommended for a pilot investigation to evaluate the aquifer as a potential source of water for the ABWSS and to determine the potential for the conjunctive use of surface and groundwater. Should the results of the pilot investigation prove favourable, the further development of groundwater as a component of the ABWSS could follow.

KIA15 MONITORING

The scenarios summarised in Chapter 9 show the impact of water requirements and interventions to reduce water requirements as well as the use of treated wastewater upon the need for the creation of new surface water assets.

Stakeholders face the risk of creating assets prematurely or with excessive capacity. They also face the risk of water requirements exceeding the quantity of water available.

Monitoring water requirements and water availability in the light of population change, the implementation of interventions and the creation of assets is a central part of the implementation of the strategy in order to take remedial measures timeously or to amend the strategy during the regular (possibly annual) update of the strategy.

Monitoring of each indicator by the most appropriate stakeholder, coupled with remedial measures, are central to the management of the strategy and to maintain the strategy's relevance.

KIA16 OPERATING THE ABWSS AS A SYSTEM

Currently the ABWSS is not operated as a system. Also, the disparate interests of stakeholders have a negative effect on the ABWSS being operated as a system.

Much emphasis is placed in the proposals on the ABWSS being operated as a system with a view to the advantageous use of the assets of each stakeholder and to limit the extent to which additional assets are required in order to balance the water requirements and the water that is available.

A priority of the bodies that will be established to manage the implementation of the strategy must be to address the issues that work against the ABWSS being operated as a system.

KIA17 STRATEGY STEERING AND OPERATIONS CO-ORDINATION COMMITTEES

The key interventions and asset creation proposals identified in the study and summarised above, coupled with the current fragmentation of the institutional arrangement, require one or more bodies to take custodianship of the strategy; to oversee the implementation, monitoring and updating of the strategy and to facilitate/co-ordinate the decision making/implementation process.

Alternative management arrangements have been considered and the following two committees have been selected by stakeholders:

- Amatole System Strategy Steering Committee (ASSSC) and
- Amatole System Operations Co-ordination Committee (ASOCC)

The ASSSC would be the custodian of the strategy, and would oversee the strategy, its implementation, its relevance, as well as its periodic updating.

The ASOCC would facilitate/co-ordinate inter-stakeholder relations where necessary, would assist stakeholders to operate the ABWSS as a system and would co-ordinate the activities between stakeholders at an operational level.

The two committees need to be established as a matter of urgency and a Professional Service Provider (PSP) should be appointed to provide technical assistance and support to the two committees.

KIA18 PRIORITY ACTIONS

The strategy in Chapter 10 sets out the advisable/latest study start dates. Those that are required to start during 2008 and 2009 are the foundation of the strategy and are summarised in the table below.

Latest Study Start Date	Category	Intervention/Asset	Responsible Stakeholder
2008	Water Conservation and Water Demand Management (WC/WDM) and Water Quality (WQ)	Develop and apply a management information system (MIS)	ADM and BCM
	WC/WDM	Reduce pressure in water reticulation networks	ADM and BCM
	WC/WDM	Determine water efficient sanitation systems that are acceptable to users for inclusion in sanitation improvement programmes	ADM and BCM
	Return flow (RF) and use (U) of treated wastewater	Determine the best way in which treated wastewater from all the WWTWs can be utilised	ADM, AW, BCM and DWAF
	Surface Water Assets (SWA)	Complete the connections from the Wriggleswade Transfer Scheme (has started)	DWAF
	SWA	Possible transfer of water from the Sandile and Binfield Park dams (in tributaries of the Keiskamma River) to the Buffalo River	DWAF
	SWA	Potential dam in the Keiskamma River at Ravenswood Farm	DWAF
	SWA	Potential dam in the Keiskamma River at Thornwood Farm	DWAF
	SWA	Potential dam in the Nahoon River at Stone Island Farm	DWAF
	SWA	Determine and agree the best way to distribute the water from the Wriggleswade Transfer Scheme	ASOCC
	Water quality (WQ)	Improve solid waste disposal (has started)	ADM and BCM
	WQ	Enforce development controls along the rivers and watercourses in the ABWSS	ADM and BCM
	WQ	Reduce phosphates and total dissolved solids (TDS) returned by WWTWs and industries to the rivers in the ABWSS (partly in hand)	ADM, BCM and DWAF

Latest Study Start Date	Category	Intervention/Asset	Responsible Stakeholder
2008	WQ	Set and agree the quality parameters for the EWR and the water quality objectives for the rivers in the ABWSS	DWAF
	WQ	Model the ABWSS to ascertain the impacts of and requirements for specific interventions to maintain or preferably to improve the quality of water in the rivers and streams of the ABWSS	DWAF
	Ecological Water Requirement (EWR)	Finalise the water quantity for each EWR and when the EWR should be introduced	DWAF
	EWR	Construct a weir and a gauging station just upstream of the Nahoon estuary	DWAF
	Mitigation of Risk (MoR)	Investigate and evaluate a single source of supply of potable water for East London, Mdantsane, Reeston and the coastal areas from the Umzonyana WTW compared with a dual source of supply of potable water from the Umzonyana and the Nahoon WTWs	BCM
	Institutional/ Management arrangements (I and M)	Convert the Steering Committee for this study (The Development of a Reconciliation Strategy for the ABWSS) into a body that will manage the implementation of the strategy (the ASSSC) and strengthen the ASOCC	ADM, AW, BCM, and DWAF
	I and M	Resolve the disagreements concerning water pricing, subsidisation and the manner in which water tariffs are determined	ADM, AW, BCM and DWAF
	I and M	Select the most favourable option for the ownership, operation and management of assets in the ABWSS. (Removal of shortcomings in the current arrangement seems to be the most practicable option at this stage)	ADM, AW, BCM and DWAF
	I and M	Align the population growth scenarios with those of the IDP	ADM, BCM and DWAF
	I and M	Determine when and if the coastal areas to the north east and south west of East London need to be incorporated into the ABWSS to enable the service delivery requirements of BCM and ADM to be met	ADM and BCM
	I and M	Determine the extent to which provision should be made for irrigation water and when licences could/should be issued	DWAF
	I and M	Adopt a 90% assurance of supply for dams from which water is abstracted for domestic and industrial purposes as a temporary measure (already happening) until the results of the interventions are known or until the benefits of interventions as well as of the creation of bulk water supply assets can be realised. Retain a 98% assurance of supply for the ABWSS as a whole	ASOCC
2009	WC/WDM	Undertake an annual water audit	ADM and BCM
	WC/WDM	Enhance effective meter reading, billing and debtor control	ADM and BCM

Latest Study Start Date	Category	Intervention/Asset	Responsible Stakeholder
2009	WC/WDM	Strengthen the structured response in respect of default in water payment or excessive use of water	ADM and BCM
	WC/WDM	Install area water meters	ADM and BCM
	WC/WDM and WQ	Enhance support to users to maintain water, sanitation and sewerage installations	ADM and BCM
	WC/WDM and WQ	Enhance the water and sanitation education programmes	ADM and BCM
	SWA	Potential dam in the Gqunube River at Groothoek/Waterfall	DWAF
	WQ	Improve solid waste collection and refuse/waste picking in open spaces	ADM and BCM
	WQ	Improve wastewater treatment at the 10 WWTWs to meet the river water quality objectives	ADM and BCM
	I and M	Agree on the best way to operate the ABWSS as a system, monitor the ABWSS, apply the WRPM and establish operating rules	ADM, ASOCC, AW, BCM and DWAF

CHAPTER 1
Introduction

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1 INTRODUCTION

1.1 BACKGROUND TO THE STUDY

In order to effectively and efficiently manage the water resources of the Amatole sub-region and to confidently establish the allocation as well as the water use requirements into the future, many water-related aspects of the Amatole environment need to be considered. This study addresses the key issues and formulates a reconciliation strategy (the strategy) by combining reconciliation options (options) aimed at meeting the increasing water requirements from the Amatole Bulk Water Supply System (ABWSS).

Within this study emphasis has been placed on current and future urban, rural and agricultural water requirements; the availability of water; existing and future infrastructure; the ecological water requirement (EWR) for alternative categories, as well as both institutional and water pricing concerns.

Water requirements in the ABWSS arise from domestic (urban and rural), industrial and agricultural uses, with the bulk of the requirements being a result of domestic use. The ABWSS provides water for urban, rural and agricultural users in the catchments of the Buffalo, Nahoon and Upper Kubusi rivers. The water in these catchments can be augmented from the Kubusi River via the Wriggleswade Transfer Scheme, which is yet to be made operational. The ABWSS supplies Buffalo City in the main, but also users in the Amathole District Municipality (ADM) as well as irrigators along the Buffalo, Gubu, Kubusi and Nahoon rivers.

The Local Municipalities (LMs) supplied with water from the ABWSS are:

- Amahlati;
- Buffalo City (BCM) and
- Ngqushwa.

By far the greatest part of the study area is within the jurisdiction of BCM.

The internal strategic perspective (ISP) study, which was undertaken by the Department of Water Affairs and Forestry (DWAF) in 2004, indicated that the area supplied by the ABWSS could be short of water soon after 2012. Furthermore, water is provided to users through several supply schemes, which are not fully integrated into a system. The purpose of the strategy, therefore, is to:

- develop options which, when combined, will provide a strategy to ensure an adequate supply of water for the users in the designated area up to 2030 and to enable the ABWSS to be operated as a system;

- identify interventions and bulk water supply assets, which water resources managers can implement to balance water requirements and water availability;
- identify dates by which studies for the interventions and assets should commence and
- identify monitoring indicators which will enable water resources managers to gauge the success of the strategy so that corrective action can be taken timeously.

As the ABWSS and neighbouring catchments have been intensively studied over many years, there is a wealth of information available. The purpose of this study was not to repeat the work already done, but to review its suitability and applicability in the light of changed circumstances, such as the requirements of the National Water Act (36 of 1998), as well as to determine the water requirements up to 2030 in the area supplied by the ABWSS.

During the preparation of this report, the use of the terms “water demands” and “water requirements” were discussed. For the purposes of this investigation, the terms are used interchangeably. There has also been discussion on the spelling of Amatola, Amatole and Amathole. The following is adopted:

- Amatola Water when referring to the organisation;
- Amathole District Municipality and
- Amatole for all other purposes.

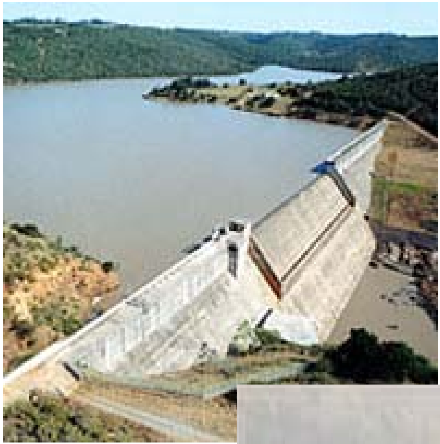
1.2 OVERVIEW OF THE AMATOLE BULK WATER SUPPLY SYSTEM

The study area is shown in Figure 1.1 and the ABWSS is shown schematically in Figure 1.2. There are 4 dams in the Buffalo River (Maden, Rooikrantz, Laing and Bridle Drift), one dam in the Nahoon River (Nahoon), one dam in the Gubu River (Gubu) and one dam in the Kubusi River (Wriggleswade). Except for Bridle Drift and Maden dams, all the dams belong to DWAF and are operated by Amatola Water (AW). Bridle Drift and Maden dams are owned and operated by BCM.

A picture of each dam is shown in the collage on the next page.


Maden Dam

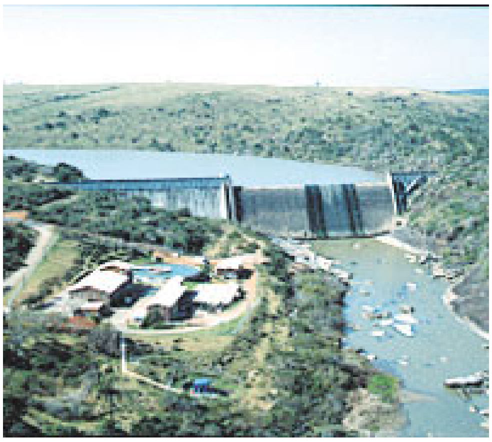
Nahoon Dam



Rooikrantz Dam

Gubu Dam

Bridle Drift Dam



Laing Dam

Wriggleswade Dam Spillway

Maden and Rooikrantz dams supply the towns of King William's Town and Bhisho. The supplies are augmented from Laing Dam in times of below average rainfall. Both sources also serve peri-urban areas and rural settlements in the vicinity of King William's Town/Bhisho as well as the Zwelitsha plant of Da Gama Textiles.

Laing Dam also provides water to the industrial area of Berlin as well as to a number of urban, peri-urban and rural areas.

Nahoon Dam supplies water for the residential areas of Potsdam and Mdantsane, the East London plant of Da Gama Textiles (currently partially operating), the newly developing residential area of Reeston and the rural settlement of Newlands.

Bridle Drift Dam is the main source of water supply for East London and nearby coastal towns/resorts.

Infrastructure exists for the transfer of water from the Kubusi River to either or both the Buffalo and Nahoon rivers. Transfers are made from the Wriggleswade Dam through its associated tunnel and canals. A conduit is being planned to protect the upper reaches of the KwaNkwebu River (a tributary of the Yellowwoods River that is in turn a tributary of the Buffalo River). Investigations are in hand to provide crossings over the natural water course into which water from the Wriggleswade Transfer Scheme is to be discharged. Only once these works are completed, will transfers be effected as planned.

Gubu Dam is used to regulate flows along the Gubu and Upper Kubusi rivers, as well as for the supply to Stutterheim and the scheduled irrigation area along the Kubusi River from the confluence of the Gubu and Kubisi rivers to the Wriggleswade Dam.

Water can also be transferred from the Wriggleswade Dam to the Gqunube River although this is not a main function of the scheme. Transfer can be effected via an overflow/diversion upstream of the canal conveying water to the Buffalo and Nahoon rivers.

The Wriggleswade Transfer Scheme is shown schematically in Figure 1.3. The transfer scheme feeds into the Buffalo River upstream of Laing Dam, which enables more than half of the river, as well as the Laing and Bridle Drift dams, to benefit. The transfer scheme feeds into the Nahoon River close to the head-waters, which enables most of the river and the Nahoon Dam to benefit. Similarly, water can be transferred to the Gqunube River near the head-waters which benefits most of this river. The Sandile Dam in a tributary of the Keiskamma River currently supplies potable water to Dimbaza in Buffalo City and adjoining rural settlements.

The individual sources of supply and the areas they serve are inter-connected but they are not being operated as a system. A manner in which this can be affected to the benefit of most stakeholders, together with options for the development and integration of additional supply systems, are outputs of this study.

1.3 PHILOSOPHY OF THE STUDY

The study has as its focus to :

- timeously identify interventions which can be implemented and the creation of bulk water supply assets that would need to be constructed by stakeholders in order to ensure that the availability of water and its distribution in bulk do not become limiting factors for social and economic development while sustaining the social and biophysical environment and
- identify and propose institutional arrangements which would enable the ABWSS to be operated as a system.

The study is a process whereby scenarios of water requirements and options to address these requirements are developed with stakeholders, who will be responsible to manage the scenarios as well as to implement options.

The most advantageous options, comprising interventions and the creation of bulk water supply assets identified during this study, are combined into a strategy to effect the reconciliation of water availability and requirements. The remaining options are not discarded, but are held in reserve for incorporation should amendments to the strategy be necessary over time. Adoption of one or more of these options held in reserve could arise from changes in circumstances, or if the actual water requirements differ from the selected water requirement scenarios, or if the options which are selected do not have the expected results.

The strategy derived from this study is a living process that continues beyond this study through a process of monitoring selected indicators in order to ascertain where deviation occurs between the strategy and reality so that corrective measures can be taken timeously.

The focus of the study is the area currently supplied by the ABWSS. Stakeholders require, however, that areas outside of the current supply area of the ABWSS (particularly the coastal zones to the north east and south west of East London), should also be taken into account. The possible supply of water to these areas is handled in the study as an option.

Figure 1.1 Locality Map of Key Focus Area

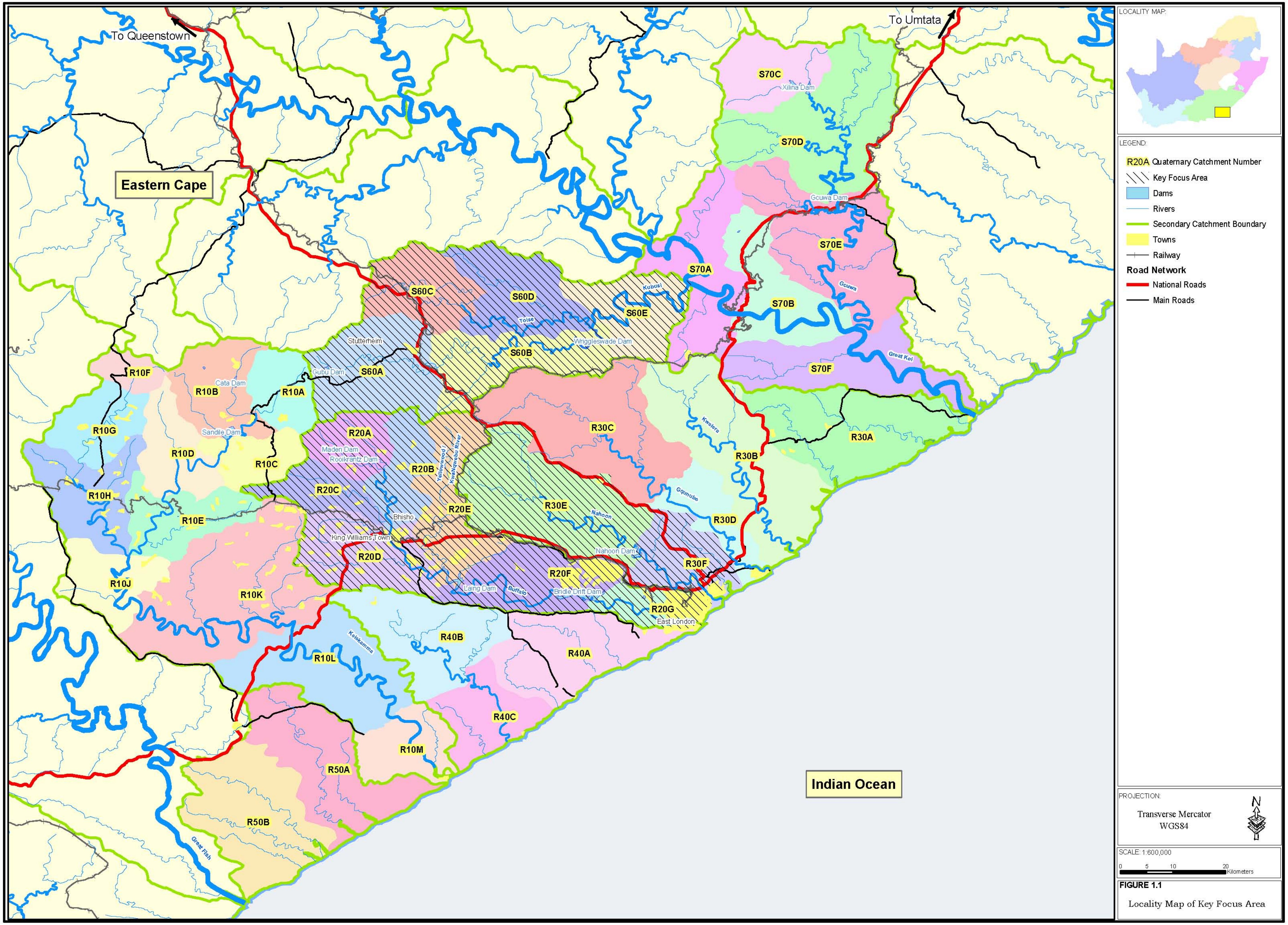


Figure 1.2 Schematic Representation of the Study Area

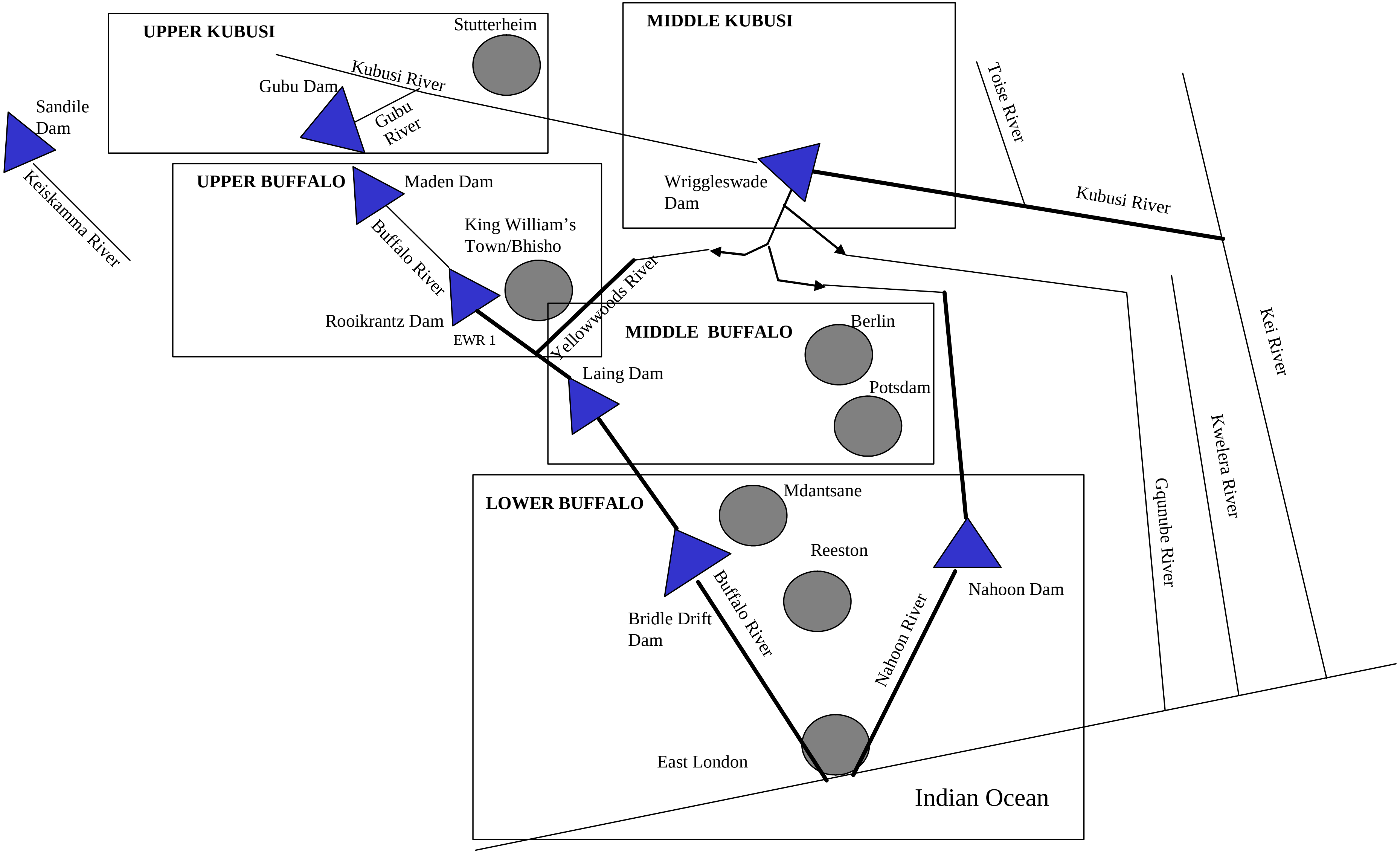
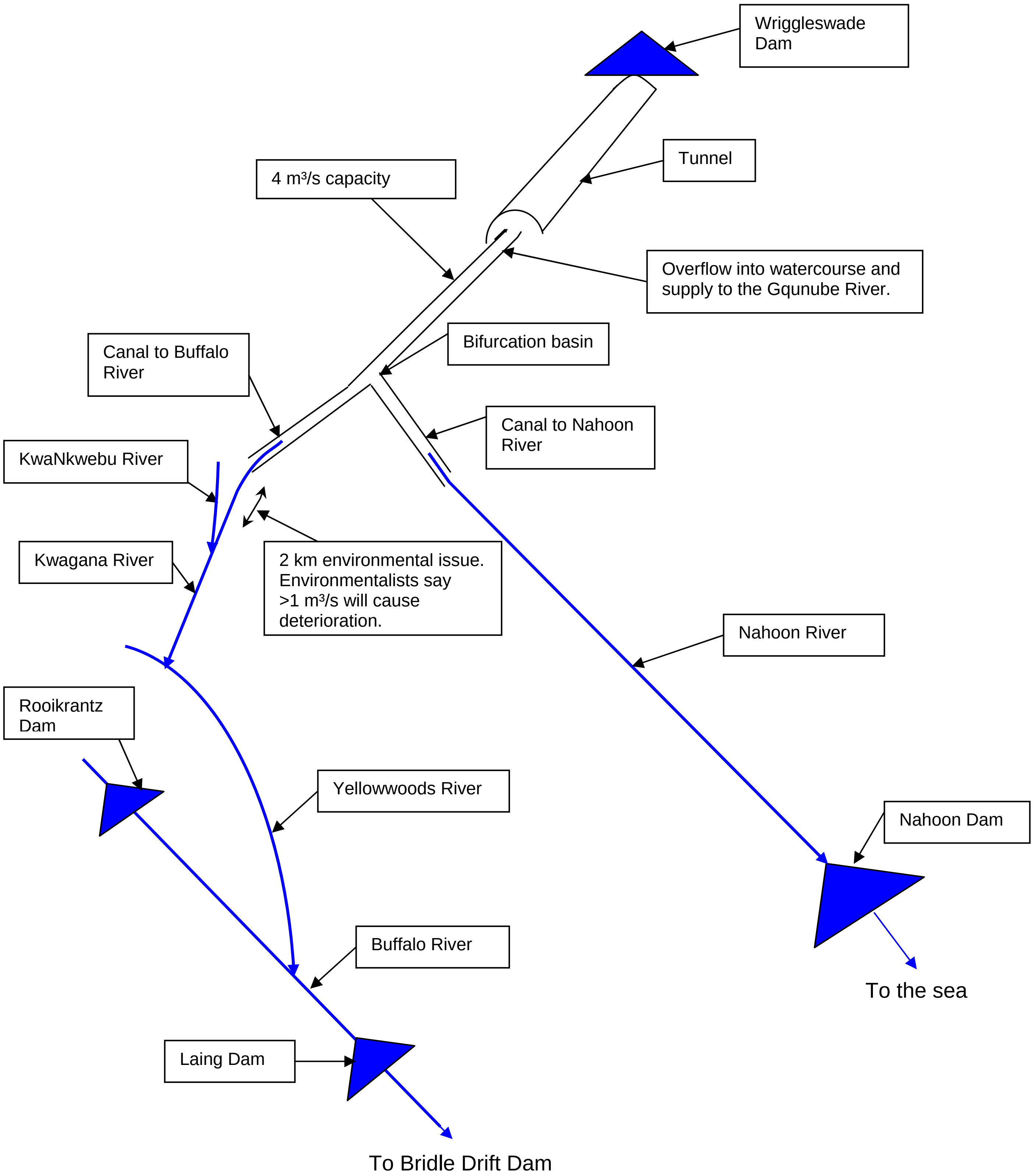


FIGURE 1.2:

SCHEMATIC REPRESENTATION OF THE STUDY AREA

Figure 1.3 Schematic Arrangement of the Wriggleswade Transfer Scheme



1.4 METHOD ADOPTED FOR THE STUDY

As the integration of management and further development of the ABWSS to operate as a system for mutual benefit of stakeholders is a goal to which this assignment contributes, the views and agreement of key stakeholders were sought with respect to current water-related issues within the study area, the most favourable options, the selection of options, the development of the strategy as well as the timing and sequence of implementation.

Meetings with stakeholders were thus held. The information that was collected was used to identify the most favoured scenarios and options for inclusion in the strategy as well as those options to be held in reserve for implementation should actual circumstances differ over time from the scenarios adopted for the development of the strategy.

Deliberations at Study Project Management Committee, Working Group and Steering Committee meetings that were held during the study were based on reviews of existing reports, new investigations and input from stakeholders, which were presented to delegates in the form of discussion documents in advance of each meeting.

Minutes of a key Project Management Committee meeting as well as the records of Working Group and Steering Committee meetings are set out in Appendices 1.1 to 1.10 in Volume 2 of this report.

1.4.1 Phases of the Study

The study was undertaken in two phases as follows:

Phase 1 : Introduction to the Study and Inception Phase

In August 2004, prior to commencement of the study, DWAF organised a key stakeholder information meeting in East London during which the purpose of the study was discussed. Representatives of DWAF, Buffalo City Municipality, Amatola Water, irrigators, industry and the Provincial Department of Economic Affairs, Environment and Tourism attended the meeting.

The concept of developing a reconciliation strategy was well received, with the proviso that cognisance is taken of the actual or perceived needs of stakeholders and that attention be given to those aspects most likely to yield value for money coupled with a sound return for the effort required.

The introductory meeting was followed by DWAF appointing a Professional Service Provider (PSP) team (referred to hereinafter as the Planning Team) and work on the Inception Phase commenced in January 2005.

This part of the study consisted of consultation with key stakeholders and initial review of existing studies/proposed interventions to ascertain the aspects upon which this investigation should focus. The output from the Inception Phase was an Inception Report, which set out the actual or perceived needs, possible augmentation assets, the areas of focus for the study and the scope of work for the rest of the assignment.

Several versions of the Inception Report were produced, culminating in the Inception Report only being finalised in March 2006. Substantive issues in the report were agreed on in July 2005 after which work on Phase 2 for the development of the strategy began.

Phase 2 : Development of the Strategy

This phase consisted of the execution of the tasks identified in the Inception Phase. Central to the investigation are the determination of scenarios of water availability and water requirements, the identification of options that need to be combined to obtain reconciliation and to form the strategy and those options which are held in reserve, the monitoring indicators as well as management/institutional arrangements necessary for the ABWSS to be managed as a system.

The strategy is intended to convert the ABWSS from one in which supply/ requirements/uses are managed as separate or loosely integrated schemes into an integrated system, managed as a unit to the benefit of stakeholders, able to supply water to Buffalo City and its surrounds well into the future at an acceptable assurance of supply and of acceptable quality.

This assignment included formulating and agreeing options with key stakeholders to optimise the ABWSS and to develop the strategy with respect to the studies for interventions and assets that would balance future requirements with the supply of water in bulk.

The studies for the options and their subsequent implementation when they are required will be contracted by the stakeholders responsible for the options as separate assignments.

This assignment focussed on scenarios of water availability; population change and water requirements; review of the water balance; the measures stakeholders could take to manage the requirements (demand-side interventions) as well as to augment the supply of water (supply-side interventions and asset creation) throughout the water cycle; optimisation of the existing system and the manner in which the ABWSS could be integrated into a system for the development/management of the available water resources to the mutual benefit of stakeholders.

The ABWSS has been developed over many decades in five water supply areas (referred to in previous studies and in this study as “schemes”), as shown diagrammatically in Figure 1.2. The five schemes can be described broadly as:

- the Upper Buffalo supplied from the Maden and Rooikrantz dams;
- the Middle Buffalo supplied from the Laing Dam;
- the Lower Buffalo supplied from the Bridle Drift and Nahoon dams;
- the Upper Kubusi supplied from the Gubu Dam and
- the Middle Kubusi from which water can be supplied to the Upper, Middle and Lower Buffalo schemes via the Wriggleswade Transfer Scheme.

The schemes are not all discrete. Water can be transferred between some of them.

The focus of the study is to provide options for the bulk supply of water at an appropriate quantity and quality and to integrate the five schemes to operate as a single system.

In developing options and scenarios, consideration has been given to those activities which result in physical assets and those activities which improve water resources management and which reduce water requirements but which do not require or result in physical assets.

The term ‘asset’ is used where physical bulk raw water supply assets are created. The term, ‘intervention’ is used where physical bulk raw water supply assets are not created.

The focus was upon four groups of interventions/assets in order to obtain a comprehensive set of options. The groups comprise those interventions/assets which are:

- currently being implemented;
- currently being planned or designed;
- required to meet intermediate needs and which have relatively short gestation/implementation periods and

- required to meet long-term needs and which have lengthy gestation/implementation periods.

Throughout the process, attention was given to selecting options that have a sound relationship between cost/effort and benefit as well as those that provide value for money.

1.4.2 Site Visit

A site visit was held on 9 and 10 February 2005. Participants were from DWAF's Pretoria, King William's Town, East London and Cradock offices; representatives of Amatola Water and the PSP. The site visit started with a briefing session at Nahoon Dam. The schedule followed on the first day, in order to familiarise the study team with the ABWSS, was as follows:

- Nahoon Dam;
- Bridle Drift Dam;
- Buffalo River (view water hyacinth);
- Laing Dam;
- Da Gama Textiles' irrigated area at Zwelitsha;
- Rooikrantz Dam (via King William's Town);
- Maden Dam;
- Wriggleswade Dam (via Stutterheim) including the tunnel inlet structure;
- outlet from the Wriggleswade tunnel into the transfer canal which can convey water to the bifurcation feeding the Buffalo and Nahoon rivers and
- bifurcation at the end of the Wriggleswade Canal/Tunnel (near Kei Road).

On the second day a Project Management Committee meeting was held with those who had attended the site visit, during which matters of importance and concern were discussed. Key issues to which the study should give attention were identified. The minutes of the meeting are included in this report as Appendix 1.1 and are summarised below.

The investigation should focus on the system for the Amatole Sub-region (as shown in the shaded key focus area in Figure 1.1), which can be defined as bulk water supply assets/interventions to meet the needs of the catchment of the Buffalo and Nahoon rivers in particular. The transfer of water from the Wriggleswade Dam is an integral part of this system.

The supply areas in the remainder of the ADM area, supplied from the Gqunube, Keiskamma, Kwelera and Great Kei rivers, should be taken into account as far as they impact on or are required to augment the supplies in the catchments of the Buffalo and Nahoon rivers.

The supply areas on the Kubusi River and its tributaries in the adjoining Lower Great Kei catchment should be taken into account as far as they impact upon the transfer of water from the Wriggleswade Dam through the transfer infrastructure.

Potential areas of supply along the coast between the Keiskamma and Great Kei rivers were to be considered in the event of these areas being supplied from the Buffalo or Nahoon rivers.

Those present at the meeting further concluded that a general public participation programme for the study was not practicable. Instead, it was decided that the key stakeholder group would be enlarged and this group would be invited to two meetings per year. The main purposes of the meetings were to solicit input regarding progress of the study and the manner in which the concerns of the key stakeholders were being addressed.

Following the site visit and the meeting on 9 and 10 February 2005, a number of the key stakeholders as well as others were visited. During these visits emphasis was placed on obtaining relevant information and on ascertaining the stakeholders' major concerns.

1.4.3 Stakeholder Concerns

There are common concerns as well as specific concerns related to individual stakeholders. This study focussed on common concerns. A summary of the concerns raised, together with possible methods to address the concerns, are set out in Appendix 1.11.

The concerns of stakeholders can be grouped into three main categories as listed below.

Governance

Stakeholders felt that parties are not working sufficiently well together owing to the governance structure, fragmentation of functions, lack of unanimity of roles, pricing arrangements, issues surrounding service delivery agreements (SDAs) and absence of a macro strategy for the management of the bulk water supply services. There existed a view that DWAF should assume a greater leadership role.

Finance

It was felt that financial arrangements impact negatively on the ABWSS being operated as a system owing to actual or perceived inequities in tariffs, water revenues being used for purposes other than water services, as well as inadequate funds being available for the implementation of Water Demand Management (WDM), Water Conservation (WC), sewerage rehabilitation initiatives and the augmentation of wastewater treatment facilities.

Water availability, quality and use

An overall water balance was required, together with a strategy for the allocation of water of appropriate quantity and quality to each Water Services Provider (WSP), each Water Services Authority (WSA) and to irrigators of water. The need for operating rules for the ABWSS was also established.

This study takes into account the three categories of concern outlined above. Suggestions are made for interventions for the further development and management/operation of the bulk water supply infrastructure in the ABWSS as a system that is capable of meeting expected water requirements over the next 25 years.

1.4.4 Stakeholder Workshop of 20 April 2005

A stakeholder workshop of the enlarged stakeholder group was held on 20 April 2005. Prior to the meeting, a starter document was made available to stakeholders and a record of proceedings was sent to stakeholders on 13 May 2005. The latter document is reproduced in Appendix 1.2. The starter document, augmented by presentations, formed the basis of discussions at the workshop.

The purpose of the workshop was to obtain consensus on the main concerns of stakeholders identified during the data collection and preliminary analysis part of the inception phase of the study with a view to reaching agreement on the issues upon which the study must focus.

Salient aspects of the record of proceedings were the following:

- substantive agreement was reached on the method by which water requirement scenarios are to be determined;
- projection horizons are to be 2010, 2020 and 2030;
- consideration is to be given to the implications of desalination for proposed coastal developments which are not connected to the bulk water supply system;

- consideration is to be given to the implications of the West Bank marine outfall in East London on the use of wastewater;
- the study is to be integrated with the statutory plans prepared by the municipalities and the Provincial Government of the Eastern Cape and
- the manner in which key concerns of stakeholders could be addressed during the course of this study was identified.

1.4.5 Presentation to DWAF Managers on 10 June 2005

The findings of the Inception Phase of the study were presented to DWAF managers on 10 June 2005. Valuable comments were received, particularly with respect to the identification and use of options, the development of scenarios for water requirements and the formulation of a monitoring procedure. The comments were incorporated into both the Inception Report and the Final Report.

1.4.6 Verification Working Meeting of 4 November 2005

Information on key aspects related to the study was collected during the Inception Phase of the study and views of the stakeholders were sought. The information and views were not consistent. It became necessary to verify and to try to attain consensus on the 16 key aspects set out below.

1. Current (2005) population estimate.
2. Population growth scenarios up to 2030.
3. Densification and/or significant land use changes up to 2030.
4. Current (2005) water requirements.
5. Water requirement scenarios up to 2030.
6. The water requirement planning scenario.
7. Indicators which can be used and measured annually by WSPs, WSAs and DWAF to monitor actual water requirements.
8. Proposals and interventions for WC and WDM with the associated capital and recurrent costs.
9. The expected impact of WC and WDM on the projected water requirements.
10. Proposals and interventions for the use of treated wastewater with the associated capital and recurrent costs, when such interventions are expected to

be undertaken, the quantities of wastewater which are expected to be used and the environmental consequences of the use of the wastewater.

11. The expected impact of the use of water on the water requirement planning scenario.

12. Proposals, interventions and/or measures to reinstate water quality or to reduce deterioration in water quality, with the associated capital and recurrent costs and the quantities of water expected to be affected by the proposals, interventions and/or measures.

13. Proposals and interventions for the adoption of desalination with the associated capital and recurrent costs.

14. The expected impact of desalination of water on the water requirements from fresh water sources.

15. Pricing arrangements which will assist in integrating the supply from the dams, as well as from possible future dams, into an overall system.

16. Improvements which can be made in the governance arrangements for the bulk supply of water.

Prior to the verification working meeting, a discussion document for use at the meeting was distributed to stakeholders.

After the working verification meeting, the discussion document was enhanced by adding to it a record of the comments and views expressed at the meeting and by highlighting the implications of the verification process for the strategy. The enhanced discussion document is reproduced in Appendix 1.3.

Salient aspects of the document are:

- adopt 2001 population census data for the area covered by the study (subsequently amended);
- adopt the planning team's population growth scenario as the low growth scenario, with BCM's least growth scenario from its Water Services Development Plan (WSDP) being taken for the high growth scenario (subsequently amended);
- adopt population growth as the basis for determining water requirements in the absence of definitive proposals for densification as well as for significant land-use changes;
- adopt full waterborne sanitation for all households for the high water requirement scenario, while the current proportion of non-waterborne sanitation

relative to the total domestic sanitation would be adopted for the low water requirement scenario;

- adopt the 2005 industrial water use, together with the estimate of water requirement for the Industrial Development Zone (IDZ) in East London as the low water requirement scenario for industrial development, with the high water requirement being the 2005 industrial water use, estimated need of the IDZ, together with the requirements of 3 significant industries in respect of which applications have been received by BCM in the recent past. Adopt the intermediate scenario as being the estimated 2005 industrial water use, the needs of the IDZ together with 50% of the quantities applied for in respect of the three significant industries (subsequently amended);
- provide for industrial development in the Lower Buffalo, but consider an option in the event of industrial developments taking place in the Middle or Upper Buffalo;
- do not account separately from the residential water requirement scenarios for commerce, tourism and administration;
- adopt a conveyance loss of 30% of the water supplied to the WSAs together with an allowance in respect of abstraction, treatment and delivery to the WSA for all supply areas (subsequently amended);
- adopt the allocation of water from the dams on the Gubu, Kubusi and Nahoon rivers as being agricultural requirements (subsequently amended);
- adopt the planning team's scenarios for water requirements, subject to amendments arising from the verification process;
- adopt the planning team's proposed indicators with minor modifications and the addition of water oxygen levels in the dams. Existing management information systems can accommodate the indicators;
- propose WC and WDM measures, together with achievable reductions in water requirements;
- propose wastewater use measures, together with realistic scenarios of reductions in raw water requirements;
- propose measures to improve water quality or to reduce deterioration in water quality;
- consider desalination of sea water as an option for the augmentation of bulk water supplies to BCM and possibly for coastal developments within the ADM;
- evaluate the pricing components of BCM and AW with a view to formulating an option to address actual or perceived differences and
- the Amatole System Co-ordination Committee (ASCC) and the Planning Team would work together to address matters of governance.

1.4.7 Steering Committee Meeting No 1 of 21 February 2006

A Steering Committee (SC) consisting of stakeholders, together with senior managers of DWAF responsible for water resource planning and management, was established to provide strategic input into the study.

The first SC meeting was held on 21 February 2006, prior to which discussion documents were distributed to stakeholders. The documents consisted of a progress report, the enhanced document prepared as a result of the verification working meeting of 4 November 2005, outlined above, and the proposed contents of the final strategy report. Salient aspects discussed at the SC meeting and their implications for the study were noted and sent to stakeholders. The notes are reproduced in Appendix 1.4.

Matters of importance from the notes are:

- amend the salient aspects noted in the discussion document of the verification working meeting of 4 November 2005 as follows:
  - take into account the demographic scenarios being prepared by BCM and its consultants;
  - account for natural growth, migration and the impact of HIV/AIDS in the population growth scenarios where relevant data is available, in a manner which would enable variations in these growth components to be monitored;
  - include population growth, migration and HIV/AIDS indicators in the monitoring indicators where relevant data is available;
  - extend the study area to include coastal developments either side of East London;
  - amend domestic water requirement categories slightly;
  - investigate irrigation water requirements further and change the terminology used for this component;
  - investigate the need to include non-water related indicators;
  - take desalination into account as an option and
  - reconcile the differences in the manner in which BCM and AW calculate the cost of potable water.

The contents and format of this final report reflect comments from stakeholders with respect to the draft table of contents (as well as of comments received subsequently).

1.4.8 Steering Committee Meeting No 2 of 29 August 2006

The second SC meeting was held on 29 August 2006, prior to which a discussion document was distributed to stakeholders. The document contained the notes of SC meeting No 1 of 21 February 2006; a progress report; water availability and water requirement scenarios; options for WC/WDM, treated wastewater use and the management of the strategy as well as revisions to the proposed structure of the report. Salient aspects discussed at the SC meeting and their implications for the study were noted and sent to stakeholders. The notes (to which is attached a document from BCM verifying its inputs) are reproduced in Appendix 1.5.

Matters of importance from the notes are:

- a proposal to delay the reconciliation of the differences in the manner in which BCM and AW calculate the cost of water until there is greater clarity on scenarios and options was rejected;
- the report is to include an outline of the method used to determine the Ecological Water Requirements (EWR);
- in the light of a hut count conducted by BCM's Water Branch from aerial photography taken in 2001, as well as from variances which might exist between the data available from demographers engaged by BCM and those of the Planning Team, further reconciliation of the population figures was required;
- water requirements for current areas outside of the area of supply of the ABWSS, and the manner in which the water requirements could be met, would be handled as options;
- the previously accepted water loss allowances would be amended as follows:

- reticulation losses	- 30%;
- losses in conveyances from WTWs to points of supply of reticulations in WSAs (including allowance for unauthorised water connections)	- 5% to 12% (depending on distance);
- losses in conveyance of water from dams to points of abstraction of raw water and treatment at WTWs	- 5% to 10% (depending on distances between dams and WTWs as well as the extent of re-cycling of process water);

- the previously accepted water requirement for industrial use would be amended as follows:
  - low scenario:- The 2005 industrial water use together with 25% of the estimated potable water requirement for the IDZ;

- intermediate scenario:- The 2005 industrial water use together with 50% of the estimated potable water requirement for the IDZ;
- high scenario:- The 2005 industrial water use together with 75% of the estimated potable water requirement for the IDZ and
- the requirement for treated wastewater as a source of bulk water for the IDZ would be reviewed in the light of the scenarios outlined above;

- a proposal should be made in the strategy that water licenses for irrigation be limited to the compensation water released at present from the dams in the Buffalo, Nahoon, Gubu and Kubusi rivers together with run-of-river flow to meet the requirements of the scheduled area in the upper Kubusi, which cannot be supplied from the compensation flow from the Gubu Dam;
- the interventions for WC, WDM and the use of treated wastewater were viewed as reasonable subject to refinement of the figures and timelines used in the discussion document;
- consideration was to be given to the additional WC/WDM interventions set out below:
  - reductions in water loss/use at public facilities, particularly public and communal toilets;
  - flow reduction and rectification interventions where there is excessive use at households, particularly at registered indigent households, with a view to water use being maintained within the limits of the free basic water allocation;
  - amendments to the consumer tariff structure, if necessary/beneficial, particularly for industrial water users;
  - a "working for water" type intervention to improve and maintain public as well as private water use fittings, particularly for indigent households;
  - reduction of losses in conveyance of water from dams to WTWs, particularly in respect of the reach from Bridle Drift Dam to the Umzonyana WTW;
  - the possible use of "pour-flush" type waterborne sanitation systems in place of full flush systems;
  - inclusion in the water use education programme for greater attention to be given to decision makers and
  - improvements in monitoring the quality of construction of water use installations, with adequate provision for corrective measures to be taken where appropriate;
- consideration was to be given to the need for a measuring weir at or close to the Nahoon estuary to monitor the need or otherwise for the introduction of

water from external sources to supply part of the Estuarine Flow Requirement (EFR);

- proposals were to be made for a statutory committee or body, established in terms of the National Water Act, together with the necessary support structures, to manage the implementation of the strategy. The committee or body should have the ability to attain compliance with regulations and
- "rules of engagement" between stakeholders should be provided for in the institutional arrangements.

1.4.9 Presentation to DWAF Managers on 20 September 2006

The findings of the study were presented to DWAF Managers. There were discrepancies between the findings of previous studies and those in this study. As a result, the Planning Team was instructed to look into the following requirements:

- appropriate yields without return flows, were to be determined so that different yields and variations in return flows can be considered as options;
- the differences in yields and EWRs determined by the Planning Team and those in the Amatole Water Resources Systems Analysis (AWRSA) needed to be checked and the causes for differences explained;
- the EWRs and their application needed to be critically assessed;
- emphasis was no longer to be placed upon establishing an "intermediate scenario". The upper and lower limits arising from the scenarios were to be considered, with options (interventions and asset creation) being selected to meet the upper water requirement scenario and the lower water requirement scenario. The combinations of options, which best suit both eventualities, could form the basis of the strategy which is selected and
- a selection matrix (subsequently referred to as the "Decision Support Tool (DST)" developed by the Reconciliation Strategy Team for the Western Cape), was to be adopted by all teams preparing reconciliation strategies.

The record of requirements arising from the presentation and discussions is included in Appendix 1.6.

1.4.10 Working Meeting on 13 March 2007

The working meeting was held to obtain views of stakeholders on the first draft of Chapters 1 to 7 of the final report and to get stakeholders' guidance on matters that will assist the Planning Team to formulate scenarios and the strategy.

Copies of the draft Chapters 1 to 7 as well as an analysis of the manner in which AW, BCM and DWAF calculate the cost of water were forwarded to stakeholders before the working meeting. Preliminary analysis of scenarios evaluated by means of the DST were presented at the meeting.

The record of key matters considered at the meeting is contained in Appendix 1.7, while requests from stakeholders and decisions that were taken as a result of the meeting are:

- the DST is available to stakeholders to assist them in planning and marketing their water management interventions;
- the Planning Team was requested to reconsider the desirability of reflecting yield values without return flows as well as describing the study area by schemes rather than by sub-catchments (this was subsequently done and the conclusion was reached that it is preferable to retain the descriptions and analyses except for return flows from the Upper and Middle Buffalo schemes as well as from the Upper Kubusi Scheme, the return flow being included as part of the system yield);
- the principle of apportioning different assurances of supply to different dams was accepted, provided the assurance of supply of the ABWSS as a whole is adequate;
- a proposal to ascertain groundwater potential by means of a pilot project at a possible aquifer in the Nahoon River catchment was accepted;
- the population growth and industrial development scenarios with the associated water requirements were accepted;
- there was no objection to the inclusion of Amahlati South, the coastal area north east of East London and the coastal area south west of East London as options when evaluating options and formulating scenarios;
- return flows to enhance the yields of dams should be viewed as the primary option for treated wastewater emanating from the Upper and Middle Buffalo schemes as well as from the Upper Kubusi Scheme;
- the focus on wastewater use should be in the Lower Buffalo Scheme so as to reduce the potential loss of water from the ABWSS to the sea;
- two additional risks are to be added namely:
  - risk of failure of assurance of supply and
  - risk of investing unnecessarily in the creation of new assets;
- there is no agreement regarding the operation of the ABWSS as a system;
- a process of institutional reform in the water sector involving ADM, Chris Hani District Municipality and BCM as well as AW has recently started. This will necessitate the continuation of the existing institutional arrangement for the next 2 to 5 years at least;

- the previous decision of the Steering Comittee, that a statutory body should be formed to manage the ABWSS and the implementation of the strategy arising from this study, should be reconsidered. A suitable steering committee should be adequate. A statutory body could be a "fall-back" institutional arrangement in the event of the voluntary association of stakeholders (governed by appropriate agreements) being inadequate;
- consideration should be given to maintaining the current method of operation of the ABWSS (by scheme rather than as a system) as an option;
- it was agreed that the Amatole System Co-ordination Committee (ASCC) would convene to develop a standardised method of costing purified bulk water by line-item as well as to establish what should be included in each line item and
- in the absence of comment from delegates regarding a strategy for the ABWSS, the Planning Team would adopt the options and scenarios outlined in Chapters 3 to 7 of the draft final report when preparing the remainder of the report. Further comment was solicited, but the Planning Team did not receive further suggestions/proposals.

1.4.11 13th Amatole System Co-ordination Committee Meeting held on 15 May 2007

The meeting was convened to obtain :

- an understanding of the methods adopted by stakeholders when pricing bulk water supplies;
- greater alignment between stakeholders with regard to the manner in which cost/pricing of bulk water is to be determined;
- agreement on the expenses, which should be taken into account when determining the cost/pricing of bulk water;
- agreement on the manner in which line items should be calculated and
- a clear understanding of obstacles which might prevent greater alignment of cost/pricing of bulk water and what can be done to remove the obstacles.

Two documents covering the cost of bulk water and line items used by AW, BCM and DWAF to determine the costs, were forwarded to stakeholder representatives before the meeting.

In the event, it was not possible to address all the issues outlined above and the meeting was structured to cover:

- key concerns/givens, opportunities for improvement and suggestions for improvement as voiced by stakeholder representatives;
- consistency of recording costs and
- the way forward.

The views of stakeholder representatives were recorded in notes of the proceedings of the meeting, which are reproduced in Appendix 1.8. The views are summarised as follows:

- greater transparency between stakeholders regarding the method of calculating costs/pricing is possible and could foster greater understanding between stakeholders;
- cross subsidisation should be more clearly reflected in line items upon which costs/pricing are based;
- the impacts on cost/pricing of the under-utilisation of assets need attention. One possibility is to "mothball" the WTW at Nahoon Dam and supply raw water from the dam to the Umzonyana WTW. An investigation into the desirability of such a course of action is to be included in the strategy arising from this study. An alternative is to fully utilize and possibly augment the Nahoon WTW to obtain the best benefit from the asset;
- the annual revaluation of bulk water supply assets owned by DWAF results in the difference between costs/pricing calculated by DWAF/AW and the costs calculated by BCM to widen;
- BCM abstracts as much water as it can from Bridle Drift Dam. BCM views that water as the least expensive water, as well as being the source over which BCM has control;
- BCM is sensitive to the price of raw and purified water as a result of BCM's fragile and narrow income base;
- due to the multiplicity of WTWs in the ABWSS, the benefits of scale are not being realised;
- DWAF is obliged to charge for raw water in accordance with the National Pricing Policy. Return on assets (RoA) is included as the social opportunity cost of the investment in bulk water assets. The proceeds from RoA are returned to municipalities;
- currently, there is no agreement or agreed price for water from the Wriggleswade Dam, nor is there a joint decision-making forum to decide when and how water will be drawn from the ABWSS and
- currently there is significant under-recovery by DWAF of water which is available in the ABWSS as a result of DWAF's assets.

Suggestions for improvement made by stakeholder representatives and the way forward are outlined below:

- existing WTWs should be fully utilised before developing further WTWs, taking into account the need to "mothball" WTWs if necessary to realise the advantage of scale;

- the method of determining the costs/pricing of bulk water should be declared and should be scheme specific with the actual costs shown. Any costs of cross-subsidisation, RoA and any other non-cost related items which affect the pricing of water should be shown separately;
- agreements must be finalised with respect to payment for assets made available by one stakeholder for the benefit of another stakeholder and the manner in which water will be released from DWAF's dams to meet the stakeholders' requirements in order to limit/remove the under-recovery of costs and
- a template was tabled which could form the basis for consistency amongst the stakeholders in recording costs/pricing of bulk water. The template, reflecting amendments that stakeholder representatives at the meeting required, is contained in Appendix 1.8.1.

1.4.12 Presentation to DWAF's Managers on 29 June 2007

A presentation of progress of the study was made to DWAF Managers. The Planning Team was requested to take the following into account:

- prepare and show the scenarios for the ABWSS as a whole;
- the assurance of supply is to be 98% for the system as a whole. A reduction in assurance of supply would be viewed as an interim measure only until appropriate interventions or creation of surface water supply assets can be implemented;
- the EWR calculations were to be checked (subsequently done);
- the implications of allowing for changes in the quantities of the return flows and for the use of treated wastewater to mirror the changes in the scenarios of wastewater treated at WWTWs was to be investigated (subsequently done but it proved difficult to apply variable return flows in the DST) and
- consider the implications of delaying the introduction into the ABWSS of the Amahlati South Rural Water Supply Scheme, the coastal area to the north east of East London and the coastal area to the south west of East London.

The notes of requirements arising from the presentation are included in Appendix 1.9.

1.4.13 Steering Committee Meeting No 3 of 8 November 2007

The third SC meeting was held on 8 November 2007, prior to which Draft No 2 of the Final Report and a proposal for a steering committee as well as an operations co-ordinating committee (subsequently amended) were distributed to stakeholders. Salient aspects discussed at the SC meeting were recorded and sent to stakeholders. A record of the proceeding has been reproduced in Appendix 1.10.

Matters of importance from the record of proceedings are:

- WC/WDM and the use of treated wastewater are critical elements in balancing water requirements and water availability and studies to effect their implementation should start without delay;
- priority needs to be given to putting the Wriggleswade Transfer Scheme into full operation;
- decisions on major capital works should be delayed until there is greater clarity on the need for such works, but studies into the favourable options should commence where necessary;
- monitoring of the water balance is important so as to identify interventions and the need for additional surface water assets timeously;
- it could be beneficial to take into account a possible groundwater source to the west of BCM in the vicinity of Chalumna in the catchment of the Keiskamma River;
- a strategy steering committee (referred to as the Amatole System Strategy Steering Committee (ASSSC)) and an operations co-ordination committee (referred to as the Amatole System Operations Co-ordination Committee (ASOCC)) should be formed to manage the strategy and to co-ordinate the operation of the ABWSS respectively;
- stakeholders to participate in the ASSSC and ASOCC were identified and
- stakeholder representatives on the Steering Committee for the Reconciliation Strategy Study undertook to assist DWAF in presenting the findings of the study to senior decision makers.

1.5 PARTICIPANTS/STAKEHOLDERS IN THE STUDY

Stakeholders associated with this study and those within the Amatole Sub-region were consulted. Representatives of the organisations who have participated in one or more of the stakeholder meetings, are presented in Appendix 1.12.

1.6 MONITORING AND EVALUATION OF THE STRATEGY

DWAF has in mind that the strategy will be monitored and updated regularly, possibly as frequently as annually. The intention is to compare the scenarios used in developing the strategy and in identifying the options against what actually happens.

Monitoring will be undertaken by stakeholders in the normal course of managing their water and sewerage operations. To this end, indicators have been identified to measure the most critical aspects of water availability, water requirements and water management measures aimed at ensuring supply, reducing water requirements and maintaining water quality.

The indicators, per supply scheme, together with the stakeholder who should be responsible for each indicator, are set out in Chapter 8. The intention is that the data from the stakeholders would be readily available for the regular updates of the strategy.

These monitoring indicators are contained within or can be introduced into ADM's, AW's, BCM's and DWAF's existing or proposed management information systems.

1.7 DECISION SUPPORT TOOL

DWAF commissioned the development of a Decision Support Tool (DST) to assist stakeholders to reach decisions as well as to evaluate and to graphically display various water requirement/demand-side interventions together with supply-side asset creation scenarios.

The DST was prepared for the Western Cape Reconciliation Strategy and was subsequently customised and used for the Reconciliation Strategy for the Amatole Bulk Water Supply System.

The DST was applied to various scenarios to meet the upper and lower water requirement scenarios. Appropriate interventions and asset creation options were identified as showing promise and dates by when studies for the interventions and asset creation projects need to commence were identified.

The scenarios, results from the DST and a brief description of the DST are contained in Chapter 9.

1.8 FUTURE REVIEWS/UPDATES OF THE STRATEGY

The intention is that only critical elements of this report will be reviewed annually. To this end salient figures from the body of this report are contained in the DST so as to limit the extent to which all parts of the study need to be revisited. The DST also provides a means by which the monitoring results can be tracked. The consequences of interventions and the need, if any, for asset creation can be vividly illustrated to decision makers.

1.9 STRUCTURE OF THE REPORT

Chapters 1 and 2 form the introduction and background to the study.

Chapter 3 describes the water resources component covering the hydrology, yields of dams and of the system, Ecological Water Requirements (EWR) and the reduction in stream-flow due to invasive alien plants (IAP) and afforestation. A section on potential groundwater resources is also included as is a comment on rainwater harvesting.

Chapter 4 deals with the population changes and scenarios of water requirements for domestic, industrial and irrigation uses.

Chapter 5 proposes interventions and potential asset creation options to reduce water requirements and to increase the quantity as well as quality of bulk water.

Chapter 6 briefly considers risks which might apply to the ABWSS.

Chapter 7 contains suggestions for improvements to the institutional arrangements governing the operation of the ABWSS as a system together with an analysis of current water pricing. Recommendations are made for improvement.

Chapter 8 lists indicators which should be monitored to measure the success or otherwise of interventions as well as to indicate when further interventions are required or when bulk water supply assets need to be created.

Chapter 9 contains the scenarios that have been analysed by means of the DST, together with a list of interventions and assets which should be studied as well as dates by when the studies must commence.

Chapter 10 contains the strategy emanating from the study.

Where relevant, the chapters are supported by appendices. For ease of reference, each Appendix is numbered so as to clearly reflect the chapter which it supports and upon which it amplifies. The appendices are contained in a separate volume from the main text of the report.

The main text of the report is contained in Volume 1, while the appendices are in Volume 2. Where an appendix is too large to be printed in hard-copy, reference is made to the compact disk (CD), which contains the appendix. The contents of each volume are stored on a separate CD.

CHAPTER 2
Previous Studies

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2 PREVIOUS STUDIES

2.1 SCHEDULE OF STUDIES CONSULTED

2.1.1 Relevant Information

Refer to Appendix 2 for relevant reports which have been consulted.

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3 CURRENT WATER AVAILABILITY

3.1 SURFACE WATER HYDROLOGY

3.1.1 Review of Streamflow Gauges

DWAF was of the view that a physical review of key gauges would be beneficial.

At the beginning of November 2005, selected streamflow gauges in the Amatole study area were visited with members of the DWAF Regional Office in Cradock, who operate the gauges. The gauges reviewed were chosen based on DWAF's suggestions. The aim of the visit was to assess the condition of the flow measurement stations in order to evaluate their suitability for the provision of realistic data for this and other studies. The full report based on this visit is reproduced in Appendix 3.1. The 16 streamflow gauges visited are listed in Table 3.1.

Table 3.1 Streamflow gauges visited in November 2005

Gauge No.	River	Place name	Catchment area (km^2)	Station open/closed	Condition of gauge
S6H001	Kubusi	Stutterheim	90	Open	Acceptable
S6H002	Kubusi	Hammerhead	488	Closed	Acceptable
S6H003	Toise	Forkroad	215	Open	Acceptable
S6H004	Gubu	Gubu Dam (d/s)	24	Open	Acceptable
S6H005	Kubusi	Wriggleswade Dam (d/s)	448	Open	Acceptable
R3H001	Gqunube	Outspan	500	Open	Acceptable
R3H003	Nahoon	Farm 305	473	Open	Acceptable
R2H001	Buffalo	Pirie Main Forest Reserve	29	Open	Acceptable
R2H005	Buffalo	King William's Town	411	Open	Acceptable
R2H006	Mgqakwebe	Msenge Ridge	119	Open	Acceptable
R2H007	Zele	Braunschweig	82	Closed	Not acceptable
R2H008	Quengcwe	Braunschweig	61	Open	Acceptable
R2H009	Ngqokweni	Sheshegu	103	Open	Acceptable
R2H011	Yellowwoods	Fort Murray	197	Closed	Not acceptable
R2H015	Yellowwoods	Fort Murray	198	Open	Acceptable
R2H027	Buffalo	Mhlabati	1160	Open	Acceptable

With few exceptions, the records for the streamflow gauges in the Amatole study area are sufficiently accurate to be used as input for analysis models.

Three gauges have been closed; two (R2H007 and R2H011) because conditions make the measurements unreliable. Gauge S6H002 is situated a few kilometres downstream of the Wriggleswade Dam. After completion of the dam and the weir downstream of the dam (Gauge No. S6H005, which measures spills and releases into the Kubusi River), the site S6H002 became redundant. Furthermore, leakage had occurred underneath the weir at Gauge No. S6H002, and an island upstream of the weir on the right bank had influenced high flows recorded by this gauge. For these reasons the gauge was closed. Gauge No. R2H015 has replaced Gauge No. R2H011 so there is no need to reinstate the latter gauge.

Generally the gauges have been maintained, but in some cases silt has built up and reeds have started growing. This will impact on flow measurement. Silt and the consequent proliferation of reeds are general problems with all gauging stations. DWAF's Hydrometry Division has a regular maintenance programme for all stations to improve accuracy of gauging. Unfortunately, owing to financial and human resources constraints, these sites are only maintained approximately every second year, whereas annual maintenance is desirable.

The results of the rainfall-runoff modelling indicate that streamflow gauging in the study area is adequate. No new gauges are proposed, except one in the Nahoon River as close to the estuary as possible, to monitor the Estuarine Flow Requirement (EFR).

3.1.2 Review of Existing Hydrological Analyses

Surface water hydrology of the area has previously been intensively studied, in particular in the Amatole Water Resources Systems Analysis (AWRSA) of 1995, from which the hydrological reports have been obtained. Correspondence with an author of the reports clarified the details of the analysis, which was performed using the Pitman rainfall-runoff model, calibrated at selected flow gauging stations, and taking historical land-use development into account using the SHELL model. The calibrated Pitman model was then used to generate naturalised monthly streamflow time sequences.

The Amatole Sub-region was divided into the following 5 catchments :

- Toise;
- Kubusi;
- Buffalo;
- Gqunube and
- Nahoon.

Streamflow time series were generated for the 72-year period 1920 to 1991 and later extended to 1995.

Network diagrams were obtained showing the Water Resources Yield Model (WRYM) network. The diagrams are reproduced in Appendix 3.2. The analysis was compared to a number of other sources, namely:

- the Water Resources 1990 Study (WR90);
- the Water Resources Simulation Model (WRSM2000) naturalised flows extended up to 2003 and
- an analysis done as part of this study up to Rooikrantz Dam and the EWR Site No 1 in the Buffalo River.

The results are shown in Appendix 3.3.

3.1.2.1 Enhanced WRSM2000 Hydrological Analysis

A great deal of liaison has taken place with the Consulting Engineers who prepared the AWRSA and its associated WRYM (Ninham Shand) to obtain hydrological and system analysis information. The spreadsheet in Appendix 3.3 was set up to compare natural inflows from the sources used, namely the WR90, WRYM and WRSM2000 analyses as well as Table 2.5 of the Inception Report (based on analysis done by Ninham Shand).

The total natural flow (columns O and Q of the spreadsheet, titled 'Comparison of Ninham Shand WRYM and SSI's WRSM2000 incremental natural inflows' in Appendix 3.3) and the WR90 study (column I in Appendix 3.3) showed a reasonably close correlation (207 Mm^3/a for Ninham Shand's WRYM system, 205 Mm^3/a for WRSM2000 and 219 Mm^3/a for WR90). The breakdown into catchments gave some considerably larger variations. This can possibly be ascribed to the system being divided slightly differently in the first two analyses and that the three analyses were carried out on different record periods.

In order to review the work done in the AWRSA and to extend the hydrology up to the 2003 hydrological year, the WRSM2000 system was set up for natural flows. A five-year overlap in the natural flow time series was examined and appreciable differences were found. Difficulty was also experienced in obtaining information about what land-use data had been used in previous analyses. It was therefore decided that it would be best to undertake a completely independent review, i.e. to use WRSM2000 natural flow and land-use for the entire record period. The rainfall analysis was carried out using the DWAF Rainfall Information Management System (IMS) to extend the data to the 2003 hydrological year. Land-use data was obtained from the Water Situation Assessment Model (WSAM) database and the WR90 appendices.

The WRSM2000 network for natural flows (see Appendix 3.4) was therefore extended to include land use and observed flows. The system was calibrated at a number of gauges shown in Appendix 3.5. Table 3.2 gives a summary of the observed and simulated flows at the various gauges.

Table 3.2 Simulated Versus Observed Streamflows at Various Gauged Points

Location of gauge	Gauge	River	Record period	Comment	Observed flow (Mm³/a)	Simulated flow (Mm³/a)
Upstream of Maden Dam	R2H001	Buffalo	1947-2003		8.41	7.50
Upstream of Rooikrantz Dam	R2R002	Buffalo	1951-2003		13.38	11.00
Tributary of Buffalo, downstream of Rooikrantz Dam	R2H008	Quencwe	1946-2003		6.35	8.67
Tributary of Buffalo, downstream of Rooikrantz Dam	R2H007	Zele	1947-1981	Gauge appears to be inaccurate	6.47	3.61
Tributary of Buffalo, downstream of Rooikrantz Dam	R2H012	Mgqukwebe	1960-1996	Gauge appears to over record flow as downstream gauge ties up well	4.30	1.62
Tributary of Buffalo, downstream of Rooikrantz Dam	R2H006	Mgqukwebe	1948-2003		8.81	8.60
Downstream of the Buffalo/Mgqakwebe confluence	R2H009	Ngqokweni	1947-2003	Gauge appears to be inaccurate	3.17	8.83
Downstream of the Buffalo/Mgqakwebe confluence	R2H005	Buffalo	1947-1950	Gauge divided into 2 records	41.70	37.60
Downstream of the Buffalo/Mgqakwebe confluence	R2H005_2	Buffalo	1954-2003		30.15	35.76
Downstream of the Buffalo/Ngqokweni confluence	R2H010	Buffalo	1950-2003		30.96	44.04
Tributary of Buffalo	R2H015	Yellowwoods	1987-2003	Gauge appears to be inaccurate	12.75	8.39
Just upstream of Laing Dam	R2R001	Buffalo	1949-2003		57.68	54.73
Downstream of Laing Dam	R2R003	Buffalo	1968-2003		81.50	79.99
Upstream of Gubu Dam	S6R001	Kubusi	1971-2003		4.04	4.14
Downstream of Gubu Dam	S6H004	Kubusi	1971-2003		3.87	3.68
Upstream of Wriggleswade Dam	S6H001	Kubusi	1946-2003		14.86	14.06
Upstream of Wriggleswade Dam	S6H005	Kubusi	1988-2003		34.74	38.07
Downstream of Wriggleswade Dam	S6H002	Kubusi	1946-1994		35.60	41.98
Tributary of the Kubusi	S6H003	Toise	1963-2003		14.87	12.47
Upstream of the Nahoon Dam	R3R001	Nahoon	1966-2003		31.58	34.49

Following the successful calibration, the calibration parameters were used in the system without man-made influences to determine the naturalised flows which were required as input for the WRYM model. The naturalised flows that were calculated are summarised in Table 3.3.

Table 3.3 Naturalised Streamflow Hydrology

Name	Catchment Ref No.	Mean Annual Runoff (Mm^3/a)	
		WRSM2000 (1920 – 2003) Hydrological Year	AWRSA WRYM (1920 – 1995) Hydrological Year
Bridle	12	21.49	17.19
Buff	2	8.16	5.60
Gubu	20	5.56	5.38
Kubu	16	16.60	16.33
Lkubu	17	4.81	1.62
Maden	1	12.82	13.48
Mgqa	3	8.78	8.75
Mgqak	10	1.61	5.08
Naho1	14	28.26	36.18
Naho2	15	1.48	1.26
Ngqu	6	8.78	8.84
Quen	5	10.11	10.94
Rooi	13	4.47	4.54
Tois1	18	17.69	16.75
Tois2	19	1.54	1.42
Tshabo	11	2.60	3.35
Wriggl1	22	3.17	2.76
Wriggl2	21	32.05	27.01
Yell1	8	4.19	5.12
Yell2	9	2.72	3.32
Yell3	7	3.56	4.38
Zele	4	4.60	7.53
TOTAL		**205.05**	**206.83**

While the comparison differed significantly for some streamflow gauges, the overall totals compared favourably. The WRSM2000 total naturalised flow was calculated as 205.05 million m^3/a for the period 1920 to 2003 and the AWRSA's flow was calculated as 206.83 million m^3/a for the period 1920 to 1995.

3.2 PREPARATION OF THE YIELD MODEL

A system model for the whole Amatole supply area was obtained from the consultants responsible for the AWRSA. This model served as a basis for setting up separate models for the Buffalo, Nahoon and Kubusi river systems so that the yields for a range of operating scenarios could be determined for each of the water supply components. This section summarises and/or describes the hydrological time series, EWRs and the three system models that were set up to determine the yield from the various water supply components that make up the ABWSS.

3.2.1 Streamflow time series

The time series required for the WRYM are:

- incremental streamflow;
- catchment irrigation;
- afforestation use and
- catchment rainfall.

These time series were prepared using the WRSM2000 model set up for the Amatole sub-catchments from 1920 to 2003 hydrological years. The sub-catchment time series information is summarised in Table 3.4.

Table 3.4 Sub-Catchment Time Series Summary

Sub-catchment (filename)[1]	Catchment reference number[2]	Mean annual runoff (.inc)	Afforestation usage (.aff)	IAP usage (.irr)	Mean annual precipitation (.ran)
		M m^3/a			(mm)
Bridle	12	21.49	0.46	1.95	679
Buff	2	8.16	0.49	0.91	796
Gubu	20	5.56	1.24	0.44	908
Kubu	16	12.74	2.67	1.01	893
Lkubu	17	4.81	0.00	0.00	732
Maden	1	12.82	5.48	0.00	1407
Mgqa	3	8.78	0.47	1.51	805
Mgqak	10	1.61	0.10	0.00	805
Naho1	14	28.26	0.07	0.00	670
Naho2	15	1.49	0.00	0.00	670
Ngqu	6	8.78	0.00	0.00	574
Quen	5	10.12	0.61	0.97	1017
Rooi	13	4.47	1.38	0.38	1106
Tois1	18	17.69	3.89	2.91	674
Tois2	19	1.54	0.00	0.00	674
Tshabo	11	2.61	0.16	0.45	661

Sub-catchment (filename)[1]	Catchment reference number[2]	Mean annual runoff (.inc)	Afforestation usage (.aff)	IAP usage (.irr)	Mean annual precipitation (.ran)
		M m^3/a			(mm)
Wriggl1	22	3.17	0.00	0.00	732
Wriggl2	21	32.05	10.52	3.88	732
Yell1	8	4.19	0.63	1.87	661
Yell2	9	2.72	0.00	0.00	661
Yell3	7	3.56	0.00	0.00	661
Zele	4	4.60	0.38	0.78	701

1 The sub-catchment names are the filenames used in the hydrology. The filename extensions for the various hydrology files are shown in brackets.
2 The catchment reference number is the position of the data for the respective hydrology in the WRYM parameter file.

3.2.2 Ecological Reserve

3.2.2.1 EWR information

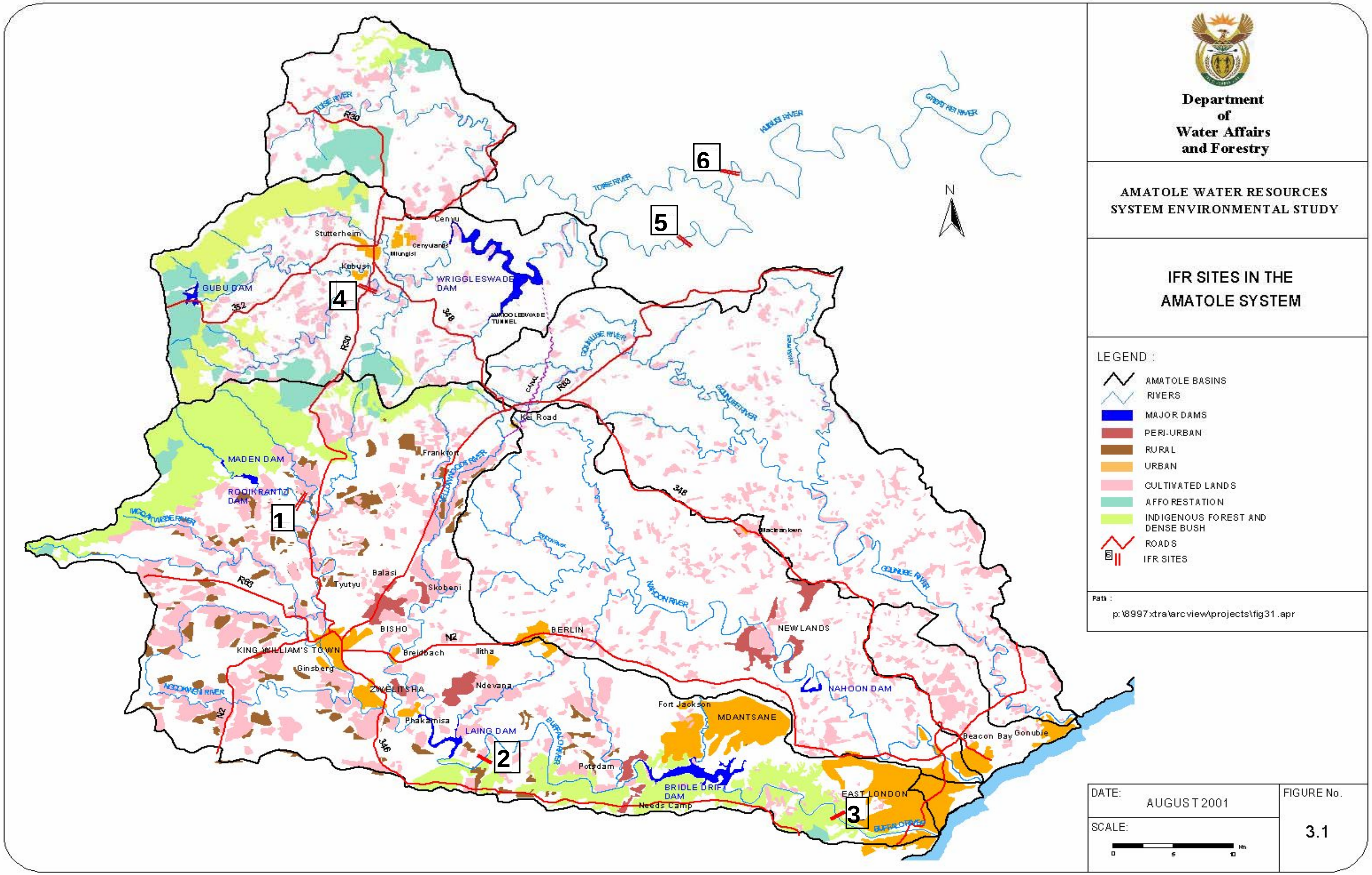
The location of the sites at which EWRs were determined for the AWRSA is shown in Figure 3.1 which comes from the Ninham Shand report "Amatole Water Resources System, Environmental Study, Summary Report", DWAF report number P R000/00/31/01, published in September 2001.

The system model included EWRs located downstream of Rooikrantz, Laing and Bridle Drift dams in the Buffalo River and two downstream of the Wriggleswade Dam in the Kubusi River. In all cases the EWR sites are located some distance downstream of the dams.

The EWR information was supplied as a WRYM "F14" data file and not in the form of the standard output from the Desktop Reserve Model (. rul files). In the F14 data file each EWR is specified as 12 monthly duration curves. These duration curves, for each EWR, are related to 12 monthly duration curves for a user-selected set of incremental inflows.

The incremental inflow duration curves in the F14 data file were revised using updated hydrology prepared as part of this study so that the system model could be used to assess the impact of the EWRs on yield. The results of simulation analyses to assess the EWRs supplied with the system model showed that the average annual requirement for the EWRs downstream of the Wriggleswade and Bridle Drift dams was 5.2 and 10.5 percent of the natural runoff respectively. These percentages are very low for ecological category C EWRs (the category proposed for the reaches of the rivers by the Directorate : Resource Directed Measures [RDM]) and do not correspond with the percentages in the Ninham Shand report. However, it is understood that changes were made to the EWR downstream of Bridle Drift Dam because the river is already degraded and the recommended category is higher than the present state.

Figure 3.1 Location of EWR sites in the Amatole Catchment



It is understood that the EWR downstream of the Wriggleswade Dam was also reduced because inflow from tributaries will make up the requirement before it is needed.

The Directorate: RDM did preliminary Reserve determinations at five locations, two in the Keiskamma River and one each in the Yellowwoods, Nahoon and Kwelera rivers. The two Reserve determinations in the Keiskamma River and the one in the Yellowwoods River were done at a level of Rapid III. The remaining two determinations in the Nahoon and Kwelera rivers were done at a level of Rapid I. A review of EWR site 1 in the Buffalo River was carried out as part of this study with the revision of the hydrology. The revised hydrology was used to generate an EWR at site 1. The results showed that the EWR is realistic and could be accepted. (For the full report see Appendix 3.3.1)

The Yellowwoods EWR site is located just upstream of Bhisho where control over flows is limited. The information was used to generate an EWR in the Yellowwoods just upstream of the confluence with the Buffalo River. Capping flows for the Yellowwoods River will be required to regulate transfers from the Wiggleswade Dam to the Buffalo River. These flows will be specified by the Directorate: RDM together with the Directorate: National Water Resource Planning (NWRP) when operating rules are developed for the transfers.

3.2.3 EWRs Used in this Study

Because there was uncertainty about the EWRs supplied in the system model developed for the AWRSA, it was decided to generate EWRs using the Desktop Reserve Model with updated hydrology, based on the information available on the ecological categories as determined during the intermediate study. EWRs were generated downstream of each dam in the system. EWRs were generated with full EWR floods and with the flood peaks reduced to conform to release constraints at the dams.

The EWRs presented in this report conform to the EWRs that are proposed by DWAF. However, it must be noted that they are based on procedures that have been modified and improved in subsequent EWR studies and that there is a recommendation that a specialist team be appointed to review the Amatole EWRs. The review should also include the ecological consequences when the specified EWRs can't be met due to system constraints.

3.2.3.1 Rooikrantz EWR

Rooikrantz Dam is located in the Buffalo River and commands a catchment of 51 km^2. The ecological category (EC) proposed by the Directorate: RDM (the proposed EC) for the EWR site downstream of Rooikrantz Dam is C. The results from the Desktop Reserve Model with full EWR floods supplied and with floods capped at 1.5 m^3/s are summarised in Table 3.5 and Table 3.6 respectively.

Table 3.5 Rooikrantz EWR EC = C (full floods)

```
Desktop Version 2, Printed on 03/08/2006
Summary of IFR estimate for: Rooi EWR Generic Name
Determination based on site specific parameters from SPATSIM database.

Annual Flows (Mill. cu. m or index values):
MAR                =   16.423
S.Dev.             =    8.619
CV                 =    0.525
Q75                =    0.228
Q75/MMF            =    0.167
BFI Index          =    0.317
CV(JJA+JFM) Index =    3.519

ERC = C

Total IFR          =    3.286 (20.01 %MAR)
Maint. Lowflow     =    1.495 ( 9.10 %MAR)
Drought Lowflow    =    0.482 ( 2.93 %MAR)
Maint. Highflow    =    1.791 (10.91 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.557	0.627	0.420	0.042	0.018	0.066	0.108
Nov	0.902	1.185	0.507	0.059	0.025	0.232	0.291
Dec	0.683	0.783	0.428	0.055	0.021	0.049	0.104
Jan	0.512	0.645	0.471	0.050	0.011	0.043	0.093
Feb	0.643	0.779	0.500	0.060	0.008	0.055	0.115
Mar	0.907	0.911	0.375	0.068	0.011	0.097	0.165
Apr	0.639	0.754	0.455	0.063	0.018	0.066	0.130
May	0.309	0.503	0.609	0.044	0.018	0.000	0.044
Jun	0.190	0.357	0.727	0.033	0.014	0.000	0.033
Jul	0.213	0.473	0.829	0.029	0.012	0.000	0.029
Aug	0.308	0.917	1.112	0.031	0.013	0.032	0.063
Sep	0.400	0.569	0.548	0.036	0.015	0.044	0.080

Table 3.6 Rooikrantz EWR EC = C (floods capped at 1.5 m^3/s)

```
\        Desktop Version 2, Printed on 08/08/2006
Summary of IFR estimate for: Rooi EWR Generic Name
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):
MAR                =   16.423
S.Dev.             =    8.619
CV                 =    0.525
Q75                =    0.228
Q75/MMF            =    0.167
BFI Index          =    0.317
CV(JJA+JFM) Index =    3.519

ERC = C

Total IFR          =    2.786 (16.96 %MAR)
Maint. Lowflow     =    1.495 ( 9.10 %MAR)
Drought Lowflow    =    0.485 ( 2.95 %MAR)
Maint. Highflow    =    1.291 ( 7.86 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.557	0.627	0.420	0.042	0.018	0.066	0.108
Nov	0.902	1.185	0.507	0.059	0.025	0.070	0.129
Dec	0.683	0.783	0.428	0.055	0.021	0.049	0.104

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Jan	0.512	0.645	0.471	0.050	0.011	0.043	0.093
Feb	0.643	0.779	0.500	0.060	0.008	0.055	0.115
Mar	0.907	0.911	0.375	0.068	0.011	0.068	0.136
Apr	0.639	0.754	0.455	0.063	0.018	0.066	0.129
May	0.309	0.503	0.609	0.044	0.018	0.000	0.044
Jun	0.190	0.357	0.727	0.033	0.014	0.000	0.033
Jul	0.213	0.473	0.829	0.029	0.012	0.000	0.029
Aug	0.308	0.917	1.112	0.031	0.013	0.032	0.063
Sep	0.400	0.569	0.548	0.036	0.015	0.044	0.080

3.2.3.2 Laing EWR

Laing Dam is located in the Buffalo River downstream of the Yellowwoods confluence. The dam commands a catchment of 913 km^2. The proposed EC for the river downstream of Laing Dam is C. The outlet capacity of the dam is 4 m^3/s. The default flows for category C in the Desktop Reserve Model were adjusted so that the EWR corresponded with the proposed EWR downstream of Laing Dam. The results for full floods and capped floods are summarised in Table 3.7 and Table 3.8 respectively.

Table 3.7 Laing EWR EC = C (full floods)

```
Desktop Version 2, Printed on 28/02/2007
Summary of IFR estimate for: Laing EWR Generic Name
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):
MAR               =   59.168
S.Dev.            =   41.233
CV                =    0.697
Q75               =    0.912
Q75/MMF           =    0.185
BFI Index         =    0.330
CV(JJA+JFM) Index =    4.039

ERC = C

Total IFR         =   15.435 (26.09 %MAR)
Maint. Lowflow    =   10.825 (18.30 %MAR)
Drought Lowflow   =    2.368 ( 4.00 %MAR)
Maint. Highflow   =    4.610 ( 7.79 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.699	2.194	0.482	0.230	0.055	0.197	0.427
Nov	3.676	7.172	0.753	0.736	0.184	0.629	1.365
Dec	2.757	3.671	0.497	0.460	0.110	0.045	0.505
Jan	1.805	2.230	0.461	0.359	0.083	0.047	0.406
Feb	2.046	2.593	0.524	0.331	0.074	0.290	0.621
Mar	2.924	3.677	0.469	0.708	0.175	0.561	1.269
Apr	1.995	2.906	0.562	0.488	0.120	0.000	0.488
May	1.085	2.102	0.723	0.294	0.064	0.000	0.294
Jun	0.757	1.617	0.824	0.055	0.005	0.000	0.055
Jul	0.841	1.972	0.876	0.092	0.005	0.000	0.092
Aug	1.555	6.028	1.447	0.184	0.009	0.000	0.184
Sep	1.401	2.609	0.719	0.184	0.018	0.000	0.184

Table 3.8 Laing EWR EC = C (floods capped at 4 m^3/s)

```
Desktop Version 2, Printed on 28/02/2007
Summary of IFR estimate for: Laing EWR Generic Name
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):
MAR               =   59.168
S.Dev.            =   41.233
CV                =    0.697
Q75               =    0.912
Q75/MMF           =    0.185
BFI Index         =    0.330
CV(JJA+JFM) Index =    4.039

ERC = C

Total IFR         =   13.284 (22.45 %MAR)
Maint. Lowflow    =   10.825 (18.30 %MAR)
Drought Lowflow   =    2.368 ( 4.00 %MAR)
Maint. Highflow   =    2.458 ( 4.15 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   1.699   2.194   0.482    0.230   0.055     0.181     0.411
 Nov   3.676   7.172   0.753    0.736   0.184     0.240     0.976
 Dec   2.757   3.671   0.497    0.460   0.110     0.045     0.505
 Jan   1.805   2.230   0.461    0.359   0.083     0.047     0.406
 Feb   2.046   2.593   0.524    0.331   0.074     0.200     0.531
 Mar   2.924   3.677   0.469    0.708   0.175     0.232     0.940
 Apr   1.995   2.906   0.562    0.488   0.120     0.000     0.488
 May   1.085   2.102   0.723    0.294   0.064     0.000     0.294
 Jun   0.757   1.617   0.824    0.055   0.005     0.000     0.055
 Jul   0.841   1.972   0.876    0.092   0.005     0.000     0.092
 Aug   1.555   6.028   1.447    0.184   0.009     0.000     0.184
 Sep   1.401   2.609   0.719    0.184   0.018     0.000     0.184
```

3.2.3.3 Bridle Drift EWR

Bridle Drift Dam is downstream of Laing Dam in the Buffalo River. It commands a catchment of 1176 km^2. The proposed EC for the river downstream of Bridle Drift Dam is C. The capacity of the outlet is 5 m^3/s. The results from the Desktop Reserve Model for full and capped floods are shown in Table 3.9 and Table 3.10 respectively.

Table 3.9 Bridle Drift EWR EC = C (full floods)

```
Desktop Version 2, Printed on 21/02/2007
Summary of IFR estimate for: Bridle EWR Generic Name
Determination based on site specific parameters from SPATSIM database.
Annual Flows (Mill. cu. m or index values):
MAR               =   85.924
S.Dev.            =   66.663
CV                =    0.776
Q75               =    1.150
Q75/MMF           =    0.161
BFI Index         =    0.295
CV(JJA+JFM) Index =    4.280

ERC = C

Total IFR         =   16.657 (19.39 %MAR)
Maint. Lowflow    =    6.967 ( 8.11 %MAR)
Drought Lowflow   =    2.089 ( 2.43 %MAR)
Maint. Highflow   =    9.689 (11.28 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : E.Cape
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	2.807	4.663	0.620	0.209	0.082	0.329	0.537
Nov	5.315	10.915	0.792	0.293	0.112	1.279	1.572
Dec	3.587	4.997	0.520	0.256	0.098	0.227	0.483
Jan	2.224	2.804	0.471	0.216	0.034	0.230	0.446
Feb	2.584	3.408	0.545	0.239	0.021	0.274	0.513
Mar	4.090	5.728	0.523	0.268	0.030	0.454	0.723
Apr	2.896	4.343	0.578	0.247	0.050	0.316	0.563
May	1.675	3.770	0.840	0.193	0.076	0.000	0.193
Jun	1.082	2.421	0.863	0.168	0.067	0.000	0.168
Jul	1.297	3.312	0.953	0.162	0.065	0.000	0.162
Aug	2.693	10.955	1.519	0.200	0.079	0.317	0.517
Sep	2.459	4.783	0.750	0.204	0.080	0.278	0.482

Table 3.10 Bridle Drift EWR EC = C (floods capped at 5 m^3/s)

```
Desktop Version 2, Printed on 21/02/2007
Summary of IFR estimate for: Bridle EWR Generic Name
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):
MAR               =   85.924
S.Dev.            =   66.663
CV                =    0.776
Q75               =    1.150
Q75/MMF           =    0.161
BFI Index         =    0.295
CV(JJA+JFM) Index =    4.280

ERC = C

Total IFR         =   12.414 (14.45 %MAR)
Maint. Lowflow    =    6.970 ( 8.11 %MAR)
Drought Lowflow   =    2.095 ( 2.44 %MAR)
Maint. Highflow   =    5.443 ( 6.33 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : E.Cape
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	2.807	4.663	0.620	0.209	0.082	0.226	0.435
Nov	5.315	10.915	0.792	0.293	0.112	0.233	0.526
Dec	3.587	4.997	0.520	0.256	0.098	0.226	0.482
Jan	2.224	2.804	0.471	0.216	0.034	0.226	0.442
Feb	2.584	3.408	0.545	0.239	0.021	0.250	0.489
Mar	4.090	5.728	0.523	0.268	0.030	0.226	0.494
Apr	2.896	4.343	0.578	0.247	0.050	0.233	0.480
May	1.675	3.770	0.840	0.193	0.076	0.000	0.193
Jun	1.082	2.421	0.863	0.168	0.067	0.000	0.168
Jul	1.297	3.312	0.953	0.162	0.065	0.000	0.162
Aug	2.693	10.955	1.519	0.200	0.079	0.226	0.426
Sep	2.459	4.783	0.750	0.204	0.080	0.233	0.437

The EWRs for ECs of C/D and D were also determined for input in assessing the impact on the yield from Bridle Drift Dam. The results from the Desktop Reserve Model for these ECs with full floods and floods capped at 5 m^3/s are shown in Table 3.11 to Table 3.14

Table 3.11 Bridle Drift EWR EC = C/D (full floods)

```
Desktop Version 2, Printed on 21/02/2007
Summary of IFR estimate for: Bridle EWR Generic Name
Determination based on site specific parameters from SPATSIM database.

Annual Flows (Mill. cu. m or index values):
MAR               =   85.924
S.Dev.            =   66.663
CV                =    0.776
Q75               =    1.150
Q75/MMF           =    0.161
BFI Index         =    0.295
CV(JJA+JFM) Index =    4.280

ERC = C/D

Total IFR         =   13.578 (15.80 %MAR)
Maint. Lowflow    =    4.933 ( 5.74 %MAR)
Drought Lowflow   =    2.089 ( 2.43 %MAR)
Maint. Highflow   =    8.645 (10.06 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : E.Cape

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   2.807   4.663   0.620    0.148   0.082     0.293     0.441
 Nov   5.315  10.915   0.792    0.205   0.112     1.141     1.347
 Dec   3.587   4.997   0.520    0.180   0.098     0.203     0.383
 Jan   2.224   2.804   0.471    0.153   0.034     0.205     0.358
 Feb   2.584   3.408   0.545    0.169   0.021     0.245     0.414
 Mar   4.090   5.728   0.523    0.189   0.030     0.405     0.594
 Apr   2.896   4.343   0.578    0.174   0.050     0.282     0.456
 May   1.675   3.770   0.840    0.137   0.076     0.000     0.137
 Jun   1.082   2.421   0.863    0.120   0.067     0.000     0.120
 Jul   1.297   3.312   0.953    0.116   0.065     0.000     0.116
 Aug   2.693  10.955   1.519    0.142   0.079     0.282     0.425
 Sep   2.459   4.783   0.750    0.145   0.080     0.248     0.393
```

Table 3.12 Bridle Drift EWR EC = C/D (floods capped at 5 m^3/s)

```
Desktop Version 2, Printed on 21/02/2007
Summary of IFR estimate for: Bridle EWR Generic Name
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):
MAR               =   85.924
S.Dev.            =   66.663
CV                =    0.776
Q75               =    1.150
Q75/MMF           =    0.161
BFI Index         =    0.295
CV(JJA+JFM) Index =    4.280

ERC = C/D

Total IFR         =   10.245 (11.92 %MAR)
Maint. Lowflow    =    4.931 ( 5.74 %MAR)
Drought Lowflow   =    2.095 ( 2.44 %MAR)
Maint. Highflow   =    5.314 ( 6.18 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : E.Cape

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   2.807   4.663   0.620    0.148   0.082     0.226     0.374
 Nov   5.315  10.915   0.792    0.205   0.112     0.233     0.438
 Dec   3.587   4.997   0.520    0.180   0.098     0.203     0.383
 Jan   2.224   2.804   0.471    0.153   0.034     0.205     0.358
 Feb   2.584   3.408   0.545    0.169   0.021     0.245     0.414
 Mar   4.090   5.728   0.523    0.189   0.030     0.226     0.415
 Apr   2.896   4.343   0.578    0.174   0.050     0.233     0.407
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
May	1.675	3.770	0.840	0.137	0.076	0.000	0.137
Jun	1.082	2.421	0.863	0.120	0.067	0.000	0.120
Jul	1.297	3.312	0.953	0.116	0.065	0.000	0.116
Aug	2.693	10.955	1.519	0.142	0.079	0.226	0.368
Sep	2.459	4.783	0.750	0.145	0.080	0.233	0.378

Table 3.13 Bridle Drift EWR EC = D (full floods)

```
Desktop Version 2, Printed on 21/02/2007
Summary of IFR estimate for: Bridle EWR Generic Name
Determination based on site specific parameters from SPATSIM database.

Annual Flows (Mill. cu. m or index values):
MAR               =   85.924
S.Dev.            =   66.663
CV                =    0.776
Q75               =    1.150
Q75/MMF           =    0.161
BFI Index         =    0.295
CV(JJA+JFM) Index =    4.280

ERC = D

Total IFR         =   10.769 (12.53 %MAR)
Maint. Lowflow    =    2.712 ( 3.16 %MAR)
Drought Lowflow   =    2.089 ( 2.43 %MAR)
Maint. Highflow   =    8.057 ( 9.38 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : E.Cape
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	2.807	4.663	0.620	0.082	0.082	0.273	0.355
Nov	5.315	10.915	0.792	0.112	0.112	1.064	1.175
Dec	3.587	4.997	0.520	0.098	0.098	0.189	0.287
Jan	2.224	2.804	0.471	0.084	0.034	0.191	0.276
Feb	2.584	3.408	0.545	0.093	0.021	0.228	0.321
Mar	4.090	5.728	0.523	0.103	0.030	0.378	0.480
Apr	2.896	4.343	0.578	0.095	0.050	0.263	0.358
May	1.675	3.770	0.840	0.076	0.076	0.000	0.076
Jun	1.082	2.421	0.863	0.067	0.067	0.000	0.067
Jul	1.297	3.312	0.953	0.065	0.065	0.000	0.065
Aug	2.693	10.955	1.519	0.079	0.079	0.263	0.342
Sep	2.459	4.783	0.750	0.080	0.080	0.231	0.311

Table 3.14 Bridle Drift EWR EC = D (floods capped at 5 m^3/s)

```
Desktop Version 2, Printed on 21/02/2007
Summary of IFR estimate for: Bridle EWR Generic Name
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):
MAR               =   85.924
S.Dev.            =   66.663
CV                =    0.776
Q75               =    1.150
Q75/MMF           =    0.161
BFI Index         =    0.295
CV(JJA+JFM) Index =    4.280

ERC = D

Total IFR         =    7.908 ( 9.20 %MAR)
Maint. Lowflow    =    2.715 ( 3.16 %MAR)
Drought Lowflow   =    2.095 ( 2.44 %MAR)
Maint. Highflow   =    5.193 ( 6.04 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : E.Cape
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	2.807	4.663	0.620	0.082	0.082	0.226	0.308
Nov	5.315	10.915	0.792	0.112	0.112	0.233	0.345
Dec	3.587	4.997	0.520	0.098	0.098	0.189	0.287
Jan	2.224	2.804	0.471	0.084	0.034	0.191	0.275
Feb	2.584	3.408	0.545	0.093	0.021	0.228	0.321
Mar	4.090	5.728	0.523	0.103	0.030	0.226	0.329
Apr	2.896	4.343	0.578	0.095	0.050	0.233	0.328
May	1.675	3.770	0.840	0.076	0.076	0.000	0.076
Jun	1.082	2.421	0.863	0.067	0.067	0.000	0.067
Jul	1.297	3.312	0.953	0.065	0.065	0.000	0.065
Aug	2.693	10.955	1.519	0.079	0.079	0.226	0.305
Sep	2.459	4.783	0.750	0.080	0.080	0.231	0.311

3.2.3.4 Gubu EWR

Gubu Dam is located in the Gubu River, a tributary of the Kubusi River and commands a catchment of 23 km^2. The proposed EC for the river downstream of Gubu Dam is C/D. The capacity of the outlet is 1.8 m^3/s, which is more than the maximum flood peak determined using the Desktop Reserve Model. Accordingly, the EWR was determined for the full flood scenario only. These results are shown in Table 3.15 .

Table 3.15 Gubu EWR EC = C/D (full floods)

```
Desktop Version 2, Printed on 28/02/2007
Summary of IFR estimate for: Gubu EWR Generic Name
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):
MAR               =    5.282
S.Dev.            =    2.144
CV                =    0.406
Q75               =    0.133
Q75/MMF           =    0.302
BFI Index         =    0.429
CV(JJA+JFM) Index =    2.358

ERC = C/D

Total IFR         =    0.770 (14.58 %MAR)
Maint. Lowflow    =    0.404 ( 7.64 %MAR)
Drought Lowflow   =    0.262 ( 4.96 %MAR)
Maint. Highflow   =    0.366 ( 6.93 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	0.152	0.158	0.389	0.010	0.006	0.012	0.022
Nov	0.263	0.300	0.440	0.014	0.009	0.021	0.035
Dec	0.225	0.190	0.315	0.014	0.009	0.010	0.024
Jan	0.204	0.181	0.330	0.014	0.009	0.012	0.026
Feb	0.248	0.204	0.340	0.017	0.011	0.015	0.032
Mar	0.291	0.239	0.307	0.018	0.011	0.047	0.065
Apr	0.193	0.160	0.321	0.016	0.011	0.012	0.028
May	0.104	0.105	0.378	0.013	0.009	0.000	0.013
Jun	0.074	0.060	0.312	0.011	0.007	0.000	0.011
Jul	0.073	0.117	0.596	0.009	0.006	0.000	0.009
Aug	0.083	0.177	0.800	0.009	0.006	0.004	0.013
Sep	0.107	0.132	0.474	0.009	0.006	0.007	0.016

3.2.3.5 *Wriggleswade EWR*

The Wriggleswade Dam is in the Kubusi River and commands a catchment of 447 km^2. The release capacity from the dam is 9 m^3/s. The EWR site is some distance downstream of the dam. However, the yield model was not set up for the downstream catchment. An EWR was determined for a site immediately downstream of the dam so that the yield model would release proportionately the contribution from the dam to meet the immediate downstream EWR. The EWRs were determined using the Desktop Reserve Model for the proposed EC of C as well as for an EC of C/D and an EC of D for scenarios with full floods and floods capped at 9 m^3/s. The results are shown in Table 3.16 to Table 3.21.

Table 3.16 Wriggleswade EWR EC = C (full floods)

```
Desktop Version 2, Printed on 26/02/2007
Summary of IFR estimate for: Wriggle EWR Generic Name
Determination based on site specific parameters from SPATSIM database.

Annual Flows (Mill. cu. m or index values):
MAR               =   54.505
S.Dev.            =   23.754
CV                =    0.436
Q75               =    2.033
Q75/MMF           =    0.448
BFI Index         =    0.533
CV(JJA+JFM) Index =    1.941

ERC = C

Total IFR         =   12.573 (23.07 %MAR)
Maint. Lowflow    =    8.034 (14.74 %MAR)
Drought Lowflow   =    4.211 ( 7.73 %MAR)
Maint. Highflow   =    4.539 ( 8.33 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   1.392   1.227   0.329    0.212   0.110     0.113     0.325
 Nov   2.465   3.104   0.486    0.261   0.137     0.261     0.522
 Dec   2.111   1.710   0.303    0.255   0.134     0.126     0.382
 Jan   1.885   1.422   0.282    0.256   0.134     0.137     0.393
 Feb   2.224   1.624   0.302    0.296   0.156     0.164     0.460
 Mar   2.727   2.490   0.341    0.303   0.161     0.606     0.909
 Apr   2.164   1.738   0.310    0.303   0.160     0.189     0.491
 May   1.452   1.177   0.303    0.272   0.144     0.000     0.272
 Jun   1.128   0.670   0.229    0.256   0.134     0.000     0.256
 Jul   1.013   1.060   0.391    0.228   0.118     0.000     0.228
 Aug   1.090   1.947   0.667    0.211   0.109     0.060     0.271
 Sep   1.138   1.145   0.388    0.209   0.108     0.070     0.279
```

Table 3.17 Wriggleswade EWR EC = C (floods capped at 9 m^3/s)

```
Desktop Version 2, Printed on 26/02/2007
Summary of IFR estimate for: Wriggle EWR Generic Name
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):
MAR               =   54.505
S.Dev.            =   23.754
CV                =    0.436
Q75               =    2.033
Q75/MMF           =    0.448
BFI Index         =    0.533
```

```
CV(JJA+JFM) Index =    1.941

ERC = C

Total IFR         =   12.038 (22.09 %MAR)
Maint. Lowflow    =    8.036 (14.74 %MAR)
Drought Lowflow   =    4.212 ( 7.73 %MAR)
Maint. Highflow   =    4.003 ( 7.34 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD      CV      Maint.  Drought    Maint.    Maint.
 Oct   1.392   1.227   0.329    0.212   0.110     0.113     0.325
 Nov   2.465   3.104   0.486    0.261   0.137     0.261     0.522
 Dec   2.111   1.710   0.303    0.255   0.134     0.126     0.381
 Jan   1.885   1.422   0.282    0.256   0.134     0.137     0.393
 Feb   2.224   1.624   0.302    0.296   0.156     0.164     0.460
 Mar   2.727   2.490   0.341    0.303   0.161     0.406     0.709
 Apr   2.164   1.738   0.310    0.303   0.160     0.189     0.492
 May   1.452   1.177   0.303    0.272   0.144     0.000     0.272
 Jun   1.128   0.670   0.229    0.256   0.134     0.000     0.256
 Jul   1.013   1.060   0.391    0.228   0.118     0.000     0.228
 Aug   1.090   1.947   0.667    0.211   0.109     0.060     0.271
 Sep   1.138   1.145   0.388    0.209   0.108     0.070     0.279
```

Table 3.18 Wriggleswade EWR EC = C/D (full floods)

```
Desktop Version 2, Printed on 26/02/2007
Summary of IFR estimate for: Wriggle EWR Generic Name
Determination based on site specific parameters from SPATSIM database.

Annual Flows (Mill. cu. m or index values):
MAR               =   54.505
S.Dev.            =   23.754
CV                =    0.436
Q75               =    2.033
Q75/MMF           =    0.448
BFI Index         =    0.533
CV(JJA+JFM) Index =    1.941

ERC = C/D

Total IFR         =   10.326 (18.94 %MAR)
Maint. Lowflow    =    6.185 (11.35 %MAR)
Drought Lowflow   =    4.211 ( 7.73 %MAR)
Maint. Highflow   =    4.141 ( 7.60 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD      CV      Maint.  Drought    Maint.    Maint.
 Oct   1.392   1.227   0.329    0.162   0.110     0.103     0.266
 Nov   2.465   3.104   0.486    0.201   0.137     0.238     0.439
 Dec   2.111   1.710   0.303    0.197   0.134     0.115     0.312
 Jan   1.885   1.422   0.282    0.197   0.134     0.125     0.322
 Feb   2.224   1.624   0.302    0.228   0.156     0.149     0.378
 Mar   2.727   2.490   0.341    0.234   0.161     0.553     0.788
 Apr   2.164   1.738   0.310    0.234   0.160     0.172     0.406
 May   1.452   1.177   0.303    0.210   0.144     0.000     0.210
 Jun   1.128   0.670   0.229    0.197   0.134     0.000     0.197
 Jul   1.013   1.060   0.391    0.175   0.118     0.000     0.175
 Aug   1.090   1.947   0.667    0.162   0.109     0.055     0.216
 Sep   1.138   1.145   0.388    0.159   0.108     0.064     0.224
```

Table 3.19 Wriggleswade EWR EC = C/D (floods capped at 9 m^3/s)

```
Desktop Version 2, Printed on 26/02/2007
Summary of IFR estimate for: Wriggle EWR Generic Name
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):
MAR               =   54.505
S.Dev.            =   23.754
CV                =    0.436
Q75               =    2.033
Q75/MMF           =    0.448
BFI Index         =    0.533
CV(JJA+JFM) Index =    1.941

ERC = C/D

Total IFR         =    9.930 (18.22 %MAR)
Maint. Lowflow    =    6.183 (11.34 %MAR)
Drought Lowflow   =    4.212 ( 7.73 %MAR)
Maint. Highflow   =    3.747 ( 6.88 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.392	1.227	0.329	0.162	0.110	0.103	0.265
Nov	2.465	3.104	0.486	0.201	0.137	0.238	0.439
Dec	2.111	1.710	0.303	0.197	0.134	0.115	0.312
Jan	1.885	1.422	0.282	0.197	0.134	0.125	0.322
Feb	2.224	1.624	0.302	0.228	0.156	0.150	0.378
Mar	2.727	2.490	0.341	0.234	0.161	0.406	0.640
Apr	2.164	1.738	0.310	0.234	0.160	0.172	0.406
May	1.452	1.177	0.303	0.210	0.144	0.000	0.210
Jun	1.128	0.670	0.229	0.197	0.134	0.000	0.197
Jul	1.013	1.060	0.391	0.175	0.118	0.000	0.175
Aug	1.090	1.947	0.667	0.162	0.109	0.055	0.217
Sep	1.138	1.145	0.388	0.159	0.108	0.064	0.223

Table 3.20 Wriggleswade EWR EC = D (full floods)

```
Desktop Version 2, Printed on 26/02/2007
Summary of IFR estimate for: Wriggle EWR Generic Name
Determination based on site specific parameters from SPATSIM database.

Annual Flows (Mill. cu. m or index values):
MAR               =   54.505
S.Dev.            =   23.754
CV                =    0.436
Q75               =    2.033
Q75/MMF           =    0.448
BFI Index         =    0.533
CV(JJA+JFM) Index =    1.941

ERC = D

Total IFR         =    8.146 (14.94 %MAR)
Maint. Lowflow    =    4.211 ( 7.73 %MAR)
Drought Lowflow   =    4.211 ( 7.73 %MAR)
Maint. Highflow   =    3.934 ( 7.22 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.392	1.227	0.329	0.110	0.110	0.098	0.208
Nov	2.465	3.104	0.486	0.137	0.137	0.227	0.363
Dec	2.111	1.710	0.303	0.134	0.134	0.110	0.244
Jan	1.885	1.422	0.282	0.134	0.134	0.119	0.253
Feb	2.224	1.624	0.302	0.156	0.156	0.142	0.298
Mar	2.727	2.490	0.341	0.161	0.161	0.526	0.686
Apr	2.164	1.738	0.310	0.160	0.160	0.164	0.324

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
May	1.452	1.177	0.303	0.144	0.144	0.000	0.144
Jun	1.128	0.670	0.229	0.134	0.134	0.000	0.134
Jul	1.013	1.060	0.391	0.118	0.118	0.000	0.118
Aug	1.090	1.947	0.667	0.109	0.109	0.052	0.161
Sep	1.138	1.145	0.388	0.108	0.108	0.061	0.169

Table 3.21 Wriggleswade EWR EC = D (floods capped at 9 m^3/s)

```
Desktop Version 2, Printed on 26/02/2007
Summary of IFR estimate for: Wriggle EWR Generic Name
Determination based on defined BBM Table with site specific assurance rules.

Annual Flows (Mill. cu. m or index values):
MAR              =   54.505
S.Dev.           =   23.754
CV               =    0.436
Q75              =    2.033
Q75/MMF          =    0.448
BFI Index        =    0.533
CV(JJA+JFM) Index =   1.941

ERC = D

Total IFR        =    7.826 (14.36 %MAR)
Maint. Lowflow   =    4.212 ( 7.73 %MAR)
Drought Lowflow  =    4.212 ( 7.73 %MAR)
Maint. Highflow  =    3.615 ( 6.63 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole
```

Month	Natural Flows			Modified Flows (IFR)			
				Low flows		High Flows	Total Flows
	Mean	SD	CV	Maint.	Drought	Maint.	Maint.
Oct	1.392	1.227	0.329	0.110	0.110	0.098	0.208
Nov	2.465	3.104	0.486	0.137	0.137	0.227	0.364
Dec	2.111	1.710	0.303	0.134	0.134	0.110	0.244
Jan	1.885	1.422	0.282	0.134	0.134	0.119	0.253
Feb	2.224	1.624	0.302	0.156	0.156	0.142	0.298
Mar	2.727	2.490	0.341	0.161	0.161	0.406	0.567
Apr	2.164	1.738	0.310	0.160	0.160	0.164	0.324
May	1.452	1.177	0.303	0.144	0.144	0.000	0.144
Jun	1.128	0.670	0.229	0.134	0.134	0.000	0.134
Jul	1.013	1.060	0.391	0.118	0.118	0.000	0.118
Aug	1.090	1.947	0.667	0.109	0.109	0.052	0.161
Sep	1.138	1.145	0.388	0.108	0.108	0.061	0.169

3.2.3.6 Nahoon EWR

Nahoon Dam is in the Nahoon River and commands a catchment of 473 km^2. The outlet capacity of the dam is 12 m^3/s. The proposed EC is C. The maximum flood generated for on EC of C is less than 12 m^3/s (9.7 m^3/s) so only the full flood scenario was analysed. The results from the Desktop Reserve Model for an EC of C are shown in Table 3.22.

Table 3.22 Nahoon EWR EC = C

```
Desktop Version 2, Printed on 02/08/2006
Summary of IFR estimate for: Nahoon EWR Generic Name
Determination based on site specific parameters from SPATSIM database.

Annual Flows (Mill. cu. m or index values):
MAR               =   28.260
S.Dev.            =   31.957
CV                =    1.131
Q75               =    0.133
Q75/MMF           =    0.056
BFI Index         =    0.224
CV(JJA+JFM) Index =    6.371

ERC = C

Total IFR         =    5.119 (18.11 %MAR)
Maint. Lowflow    =    1.715 ( 6.07 %MAR)
Drought Lowflow   =    0.366 ( 1.29 %MAR)
Maint. Highflow   =    3.404 (12.05 %MAR)

Monthly Distributions (cu.m./s)
Distribution Type : Amatole

Month    Natural Flows           Modified Flows (IFR)
                                 Low flows    High Flows Total Flows
       Mean    SD      CV     Maint.  Drought    Maint.    Maint.
 Oct   1.196   3.229   1.008    0.066   0.018     0.148     0.213
 Nov   1.683   4.333   0.993    0.085   0.023     0.454     0.540
 Dec   0.759   1.432   0.704    0.059   0.011     0.068     0.127
 Jan   0.412   0.995   0.903    0.036   0.004     0.035     0.071
 Feb   0.570   1.178   0.853    0.040   0.000     0.053     0.093
 Mar   1.195   3.075   0.960    0.062   0.004     0.136     0.198
 Apr   0.987   2.469   0.966    0.061   0.015     0.118     0.179
 May   0.537   1.890   1.313    0.041   0.011     0.000     0.041
 Jun   0.381   1.498   1.517    0.033   0.009     0.000     0.033
 Jul   0.699   2.538   1.356    0.043   0.011     0.000     0.043
 Aug   1.131   5.082   1.678    0.060   0.016     0.141     0.201
 Sep   1.193   2.739   0.886    0.067   0.018     0.147     0.213
```

3.2.3.7 Nahoon Estuarine Requirement

The natural mean annual runoff (MAR) at the Nahoon Estuary is 40.2 Mm^3/a. The EFR in the yield model, used in previous work, is 20.34 Mm^3/a made up from 12 monthly values that are the same for each year and are not related to natural flow at the estuary. The monthly values together with the percentage of months in the simulated natural streamflow time series for the estuary equalled or exceeded the estuarine requirement are summarised in Table 3.23.

Table 3.23 EFR from Previous Yield Model Data File

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
EFR (Mm^3)	**3.18**	**1.59**	**2.54**	**2.22**	**1.91**	**0.95**	**0.95**	**0.32**	**1.27**	**1.59**	**1.91**	**1.91**
% months EFR exceeded in natural streamflow time series	25%	32%	32%	18%	23%	48%	42%	60%	6%	11%	11%	19%

In discussions with representatives of the Directorate: RDM it was agreed to modify the EFR and to relate the monthly requirement to natural flow at the estuary using information from the Ninham Shand report "Amatole Water Resources System, Environmental Study, Summary Report". The report gives the 90%, median and 10% exceeded EFR for each calendar month as listed in Table 3.24.

Table 3.24 Estuarine flow requirement

	EFR (Mm^3)											
EFR % exceeded	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
90%	0.32	0.35	0.16	0.11	0.08	0.11	0.16	0.00	0.00	0.00	0.03	0.08
median	0.80	0.96	0.56	0.40	0.37	0.75	0.72	0.24	0.16	0.16	0.13	0.21
10%	7.61	11.78	7.42	5.95	5.57	11.38	4.96	0.67	0.40	0.46	0.59	1.69

Simulation analyses using this EFR showed that the annual average requirement is 13.49 Mm^3/a (33.6% of the natural MAR).

3.2.4 Amatole System models

The Amatole system comprises the Buffalo and Nahoon rivers as well as the Kubusi River down to the Wriggleswade Dam. A system analysis model was set up for each of these three rivers and was used to determine the historic as well as the probabilistic yields from the various reservoirs (dams) for a range of operating scenarios.

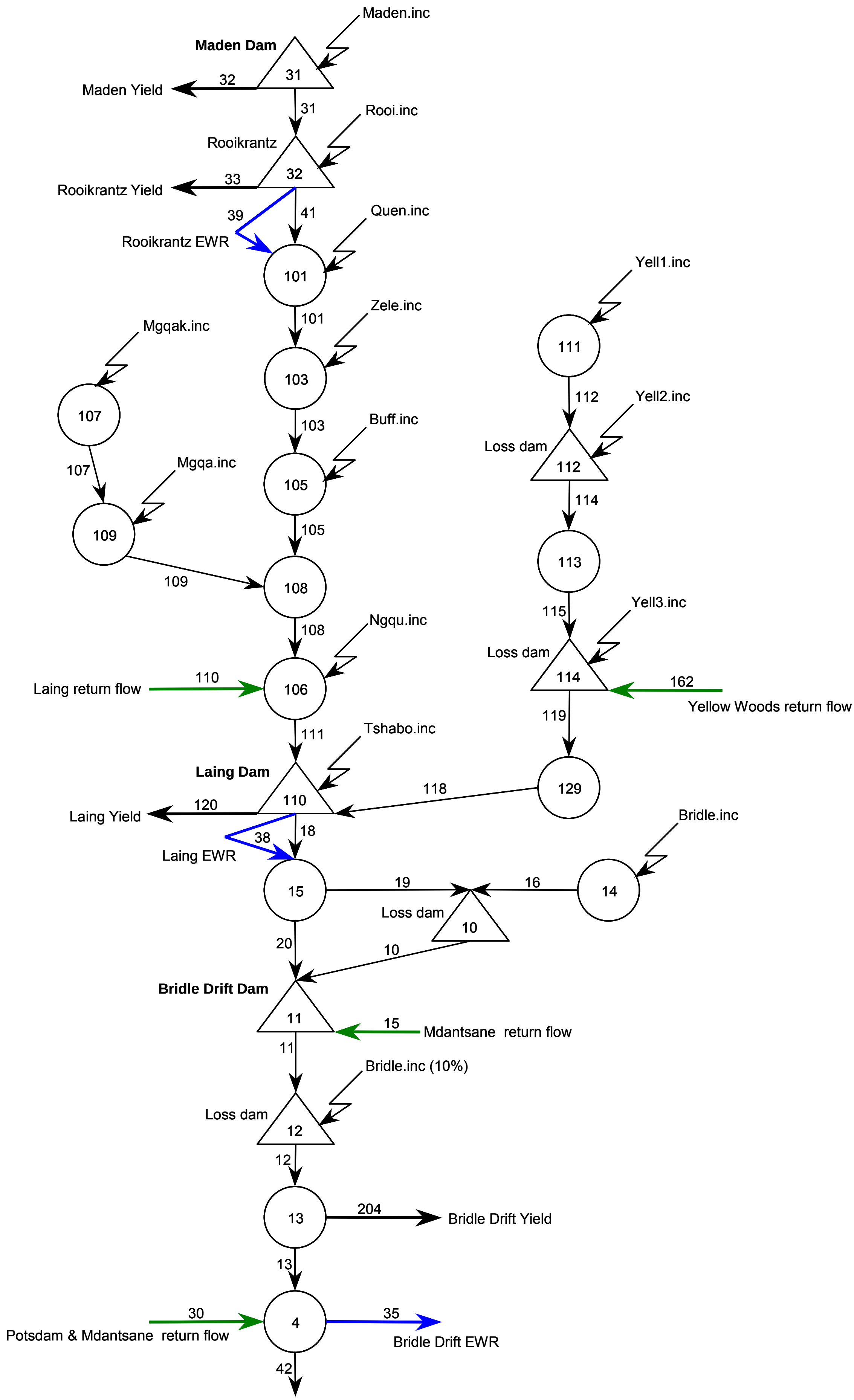
The WRYM, used for the system analyses, requires that the rivers and their tributaries be described by means of nodes and channels with penalties to prioritise supply to the users and from the various dams. Penalties were set so that ecological requirements were supplied in preference to supplying other users and also to ensure that abstractions from downstream dams would not impact on upstream dams.

The three models are described in the following sections.

3.2.4.1 Buffalo River Model

The Buffalo River contains four dams and is divided into the Upper (Maden and Rooikrantz dams), Middle (Laing Dam) and Lower Buffalo (Bridle Drift Dam) supply schemes. The system model shown in Figure 3.2 was set up to determine the historic firm yield and probabilistic yields from each of the dams in the system while the corresponding firm or probabilistic yield was abstracted from the upstream dams. To facilitate this the value of water in the dams was decreased from upstream to downstream and the penalties for under supply of the draft on each dam was set so that water would not be supplied from upstream dams. The model includes EWRs downstream of Rooikrantz, Laing and Bridle Drift dams and four return flows. Dams, which reflect losses from the system and which were included in the AWRSA model, were retained as "loss dams".

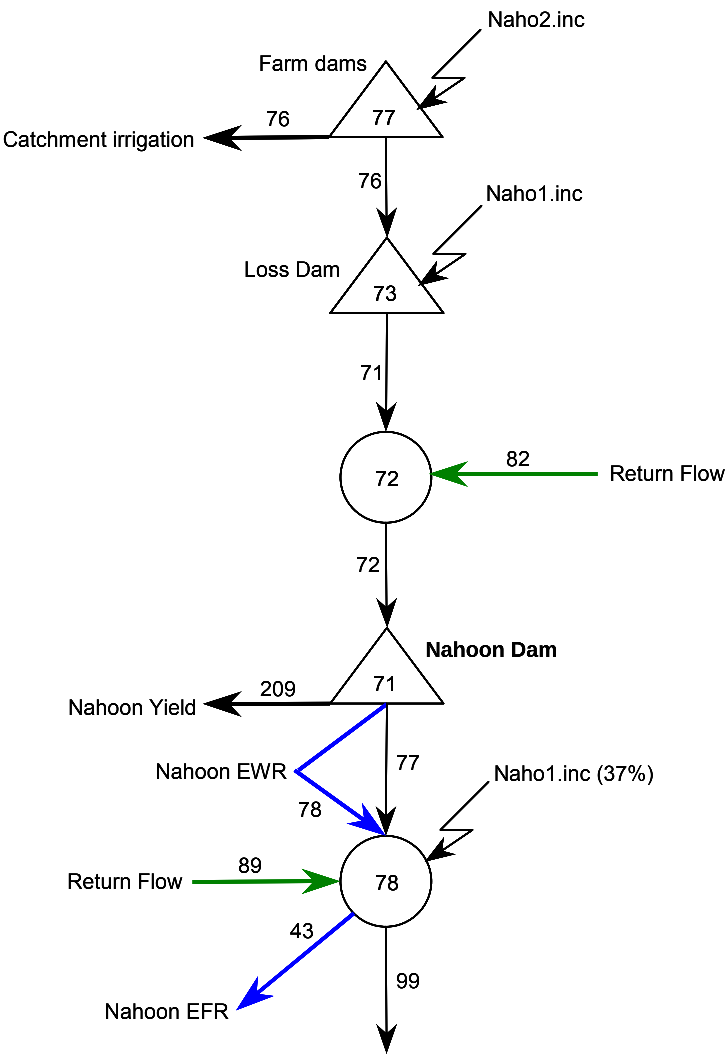
Figure 3.2 Buffalo River Model



3.2.4.2 Nahoon River Model

The Nahoon River contains one major dam (Nahoon Dam) which forms part of the Lower Buffalo supply scheme. River losses are catered for using a loss dam as used in the AWRSA model. There is an EWR downstream of Nahoon Dam and an EFR at the discharge to the sea. The model includes two return flows, one upstream of Nahoon Dam and one upstream of the estuary. The system diagram is shown in Figure 3.3.

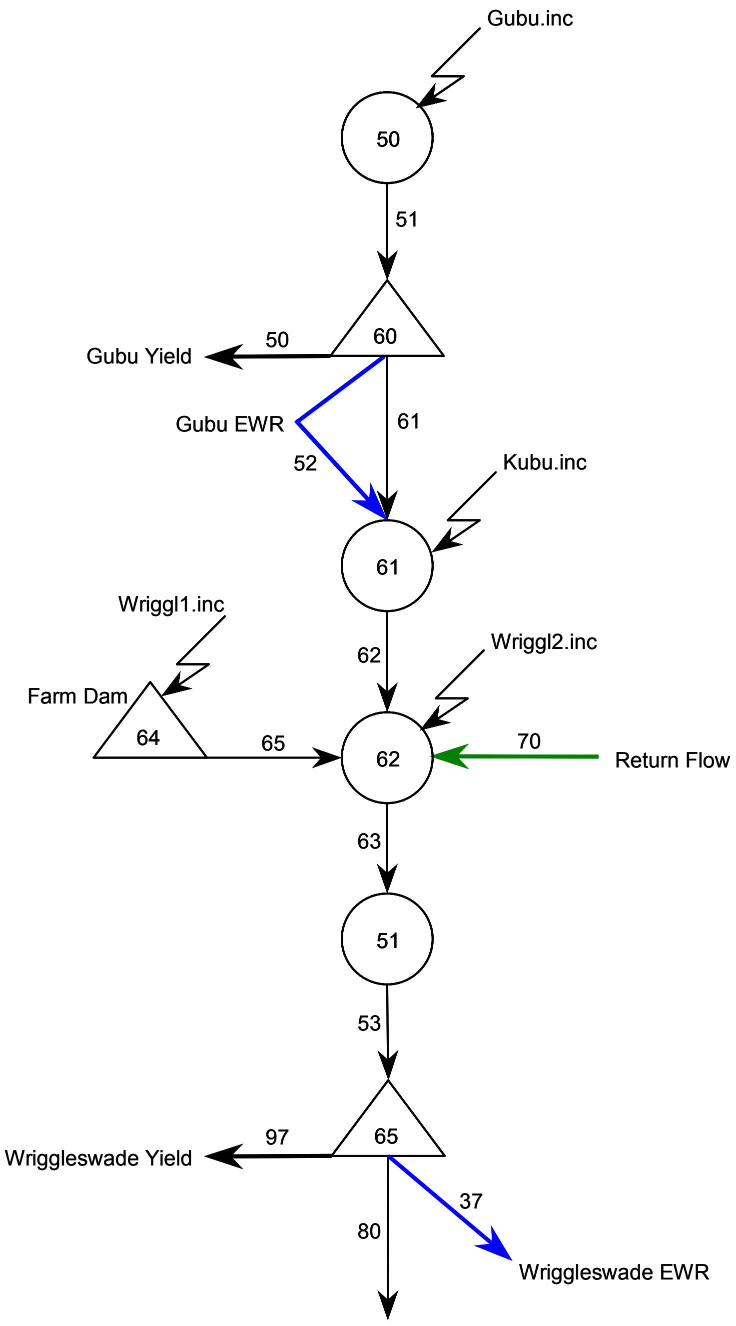
Figure 3.3 Nahoon River Model



3.2.4.3 Kubusi River Model

The Kubusi system comprises two major dams, the Gubu and Wriggleswade dams, and a grouped farm dam in the Wriggleswade incremental catchment. EWRs are located downstream of the Gubu Dam and of the Wriggleswade Dam. The system includes one return flow, upstream of the Wriggleswade dam. The system diagram is shown in Figure 3.4.

Figure 3.4 Kubusi River Model



3.2.5 Yield analysis

Analyses were done by simulation using the WRYM to determine historic firm yields and probabilistic yields from the various water supply components. Return flows vary with time and are dependent on the quantity of water supplied to users and the quantity of wastewater treated. Analyses were done to determine the relationship between return flow and yield. The results showed that the yield increased by 95% of the return flow. Knowing this the yield analyses were done with no return flows and return flows were treated as an augmentation intervention.

3.2.5.1 Historic Yield Analysis

The historic firm yield was defined as the draft that could be abstracted without any shortfalls during simulations using the historic inflow time series. Yields from the dams were determined without return flows for a range of scenarios. Analyses were done to assess the impact of changing the EWR classification on yield for some cases only. The results are summarised in Table 3.25. The ECs proposed by the Directorate: RDM are shown in bold in Table 3.25.

Table 3.25 Historic Firm Yield from the ABWSS Dams

Central Register Dam	Yield (Mm^3/a)						
	No EWR	Reduced flood EWR			Full flood EWR		
		C	C/D	D	C	C/D	D
Maden[1]	**0.35**	X[3]	X	X	X	X	X
Rooikrantz	2.86	**1.19**	X	X	**1.04**	X	X
Laing	14.44	**11.56**	X	X	**8.13**	X	X
Bridle Drift	24.61	**25.59**	26.32	27.26	**25.81**	26.98	28.14
Nahoon[2]	6.78	**2.00**	X	X	**2.00**	X	X
Gubu[2]	3.40	X	**2.56**	X	X	**2.56**	X
Wriggleswade	24.76	**17.25**	18.17	19.37	**16.53**	17.58	18.85

NOTES

1. No EWR is proposed for Maden Dam
2. The release capacities of the Gubu and Nahoon dams are sufficient to release full EWR floods so no reduced flood EWRs are required.
3. Historic firm yields were not calculated for the ECs marked with an X.

Historic analyses were done to determine the impact on yield of afforestation and of removing invasive alien plants (IAP). The results are summarised in Table 3.26 and Table 3.27 respectively.

Table 3.26 Impact of removing afforestation

Dam	Afforestation Area (Km^2)	Afforestation Water use (Mm^3/a)	Yield (Mm^3/a)			Add Yield as % of afforestation water use
			With afforestation	Without afforestation	Additional yield	
Maden	30	5.48	0.35	0.66	0.31	6%
Rooikrantz	14	6.86	1.04	3.30	2.26	33%
Laing	27	2.84	8.13	9.56	1.43	50%
Bridle Drift	4	0.50	25.81	26.28	0.47	94%
Gubu	5	1.24	2.56	3.53	0.97	78%
Wriggleswade	137	13.19	16.53	28.45	11.92	90%
Total	217	30.11	54.42	71.78	17.36	58%

The results show that the increased yield, if forests are removed, is not related directly to the afforestation water use but that other factors such as relative catchment and dam size also play a part.

Table 3.27 Impact of Removing Invasive Alien Plants (IAP)

Dam	IAP Area (Km^2)	IAP water use (Mm^3/a)	Yield (Mm^3/a)			Add Yield as % of IAP Water Use
			With IAP	Without IAP	Additional yield	
Rooikrantz	1	0.38	1.04	1.30	0.26	68%
Laing	10	6.49	8.13	12.85	4.72	73%
Bridle Drift	3	1.95	25.81	27.70	1.89	97%
Gubu	3	0.44	2.56	2.93	0.37	84%
Wriggleswade	78	4.89	16.53	20.73	4.20	86%
Total	95	14.15	54.07	65.51	11.44	81%

The results show a similar trend to afforestation, in that the increased yield is not related directly to the IAP water use.

3.2.5.2 Probabilistic Yield Analysis

Analyses were done using 201 stochastic sequences generated from the historic inflow time series to determine the yield at assurances of supply of 90, 95, 98, 99 and 99.5%. Probabilistic yields were determined without EWRs or return flows and with full as well as reduced flood EWRs. The results are summarised in Table 3.28, Table 3.29 and Table 3.30 respectively. In the analyses the 98% assurance yield was abstracted at upstream reservoirs. The yields from the Gubu and Nahoon dams for the full and reduced flood EWRs are the same because the outlets from these dams can release the full EWR floods.

Table 3.28 Probabilistic Yield with no EWRs Supplied

Dam	Yield (Mm^3/a) for assurance				
	90%	95%	98%	99%	99.5%
Buffalo River					
Maden	0.60	0.58	0.48	0.43	0.40
Rooikrantz	4.10	4.06	3.70	3.41	3.12
Laing	21.03	20.74	18.27	17.15	16.37
Bridle Drift	32.87	32.57	29.41	26.12	23.22
Total Buffalo	58.60	57.95	51.86	47.11	43.11
Nahoon River					
Nahoon	9.55	9.44	8.41	7.63	7.02
Total Nahoon	9.55	9.44	8.41	7.63	7.02
Kubusi River					
Gubu	3.05	3.03	2.87	2.73	2.64
Wriggleswade	34.75	34.48	31.80	29.79	28.68
Total Kubusi	37.80	37.51	34.67	32.52	31.32
TOTAL	105.95	104.90	94.94	87.26	81.45

Multiple ECs were only analysed for the two largest most downstream dams (i.e. Bridle Drift and Wriggleswade) because water released from these dams leaves the system whereas EWR releases from the upstream dam(s) impact on the yield of the downstream dam. The results are shown in Table 3.29 and Table 3.30.

Table 3.29 Probabilistic Yield with Reduced Flood EWRs Supplied

Dam	Yield (Mm³/a) for assurance														
	90%			95%			98%			99%			99.5%		
	EWR classification														
	C	C/D	D	C	C/D	D	C	C/D	D	C	C/D	D	C	C/D	D
Buffalo River															
Maden[1]	**0.60**			**0.58**			**0.48**			**0.43**			**0.40**		
Rooikrantz	**1.96**			**1.91**			**1.49**			**1.30**			**1.08**		
Laing	**14.33**			**14.16**			**12.54**			**11.35**			**10.45**		
Bridle Drift	**33.09**	34.27	35.16	**32.69**	33.85	34.78	**28.91**	29.80	30.95	**25.98**	26.71	27.66	**23.52**	24.28	25.30
Total Buffalo	49.98	51.16	52.05	49.34	50.50	51.43	43.42	44.31	45.46	39.06	39.79	40.74	35.45	36.21	37.23
Nahoon River															
Nahoon	**4.04**			**3.99**			**3.45**			**2.85**			**2.35**		
Total Nahoon	4.04			3.99			3.45			2.85			2.35		
Kubusi River															
Gubu		**2.25**			**2.24**			**2.11**			**1.99**			**1.91**	
Wriggleswade	**22.52**	23.69	25.20	**22.32**	23.48	24.94	**20.28**	21.32	22.49	**18.66**	19.63	20.81	**17.70**	18.65	19.84
Total Kubusi	24.77	25.94	27.45	24.56	25.72	27.18	22.39	23.43	24.60	20.65	21.62	22.80	19.61	20.56	21.75
TOTAL	78.79	81.14	83.54	77.89	80.21	82.60	69.26	71.19	73.51	62.56	64.26	66.39	57.41	59.12	61.33

NOTES

1 No EWR at Maden

2 ECs proposed by the Directorate: RDM shown bold

Table 3.30 Probabilistic Yield with Full Flood EWRs Supplied

Dam	Yield (Mm³/a) for assurance														
	90%			95%			98%			99%			99.5%		
	EWR classification														
	C	C/D	D	C	C/D	D	C	C/D	D	C	C/D	D	C	C/D	D
Buffalo River															
Maden[1]	**0.60**			**0.58**			**0.48**			**0.43**			**0.40**		
Rooikrantz	**1.22**			**1.20**			**0.97**			**0.73**			**0.55**		
Laing	**13.79**			**13.61**			**11.90**			**10.79**			**9.95**		
Bridle Drift	**31.76**	33.19	35.39	**31.35**	32.77	34.90	**27.40**	28.80	30.33	**24.34**	25.87	27.20	**22.06**	23.66	25.04
Total Buffalo	47.37	48.80	51.00	46.74	48.16	50.29	40.75	42.15	43.68	36.29	37.82	39.15	32.96	34.56	35.94
Nahoon River															
Nahoon	**4.04**			**3.99**			**3.45**			**2.85**			**2.35**		
Total Nahoon	4.04			3.99			3.45			2.85			2.35		
Kubusi River															
Gubu		**2.25**			**2.24**			**2.11**			**1.99**			**1.91**	
Wriggleswade	**21.81**	23.36	24.56	**21.60**	23.12	24.35	**19.61**	20.80	22.26	**18.16**	19.20	20.56	**17.21**	18.18	19.53
Total Kubusi	24.06	25.61	26.81	23.84	25.36	26.59	21.72	22.91	24.37	20.15	21.19	22.55	19.03	20.09	21.44
TOTAL	75.47	78.45	81.85	74.57	77.51	80.87	65.92	68.51	71.50	59.29	61.86	64.55	54.34	57.00	59.73

NOTES

1 No EWR at Maden

2 ECs proposed by the Directorate: RDM shown bold

3.3 GROUNDWATER POTENTIAL

Groundwater Consulting Services (Pty) Ltd (GCS) was commissioned as part of the study to conduct a literature review of groundwater data and to compile a consolidated report. The findings are summarised below. For the full report see Appendix 3.6.

The study area is almost exclusively underlain by secondary aquifers. Aquifers associated with dolerite intrusions, stratigraphic contacts, fractured sedimentary rocks, dune deposits and alluvium are present. There are no large-scale alluvial deposits adjacent to the rivers, thus there are no primary, unconfined aquifers of any significance within the study area.

The database which was established for this study contains data for a total of 1 007 boreholes, scattered relatively evenly throughout the area, as shown in Figure 3.5.

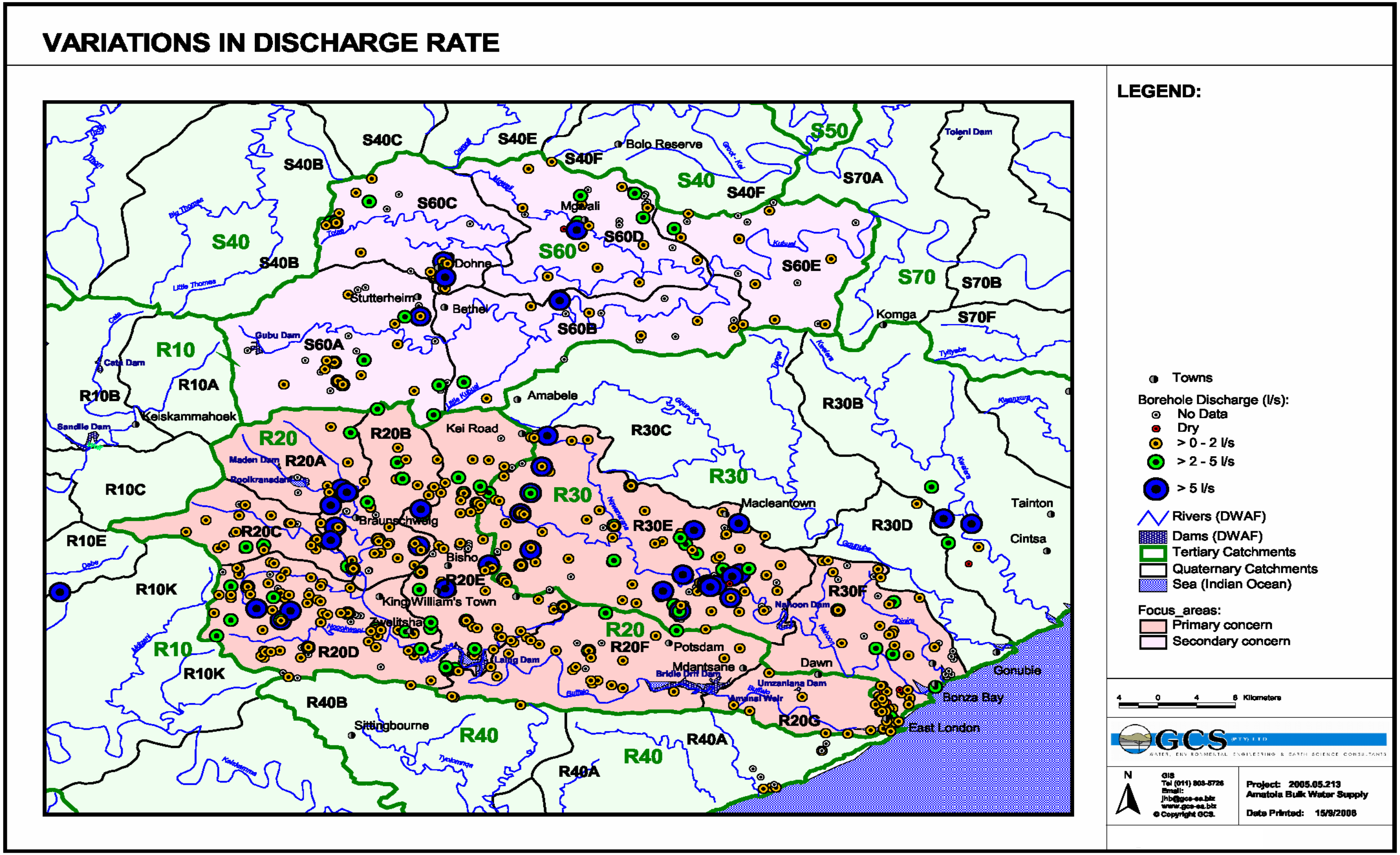
The area which was investigated is larger than the area supplied by the ABWSS, being 3 200 km^2, giving an overall borehole density of 1 borehole per 3 km^2.

Low yielding boreholes that discharge less than 2 ℓ/s make up 81% of all the boreholes in the study area, of which almost half have a yield of less than 0.3 ℓ/s. These are effectively dry, and should not be equipped even with a hand pump. Relatively high yielding boreholes (> 5 ℓ/s) make up between 0 and 11% for the different quaternary catchments, averaging 5% for the study area. Moderately yielding boreholes (2–5 ℓ/s) vary between 0 and 24%, averaging 14% for the whole study area. The distribution of the boreholes with their yields/discharge rates are shown pictorially in Figure 3.5.

The higher yielding boreholes frequently appear to have been sited adjacent to dolerite sills or dyke intrusions and/or fault lines, particularly the east–west trending dykes. The lower yielding and dry boreholes generally appear to have been sited where no structural features occur. The general trend is that the lithology that characterises the study area is not the controlling factor with regard to borehole yield. Rather, it is structural features such as dolerite dyke intrusions and faulting that affect borehole yield.

Hydrochemical data are scarce for the boreholes in the area. The most commonly used determinant is electrical conductivity, which is directly related to the concentration of total dissolved solids. There does not appear to be any correlation between water quality and water level or yield/discharge. The boreholes for which the most hydrochemical data are available are all monitoring boreholes for the East London Industrial Development Zone and various waste disposal sites. For this reason, as groundwater contamination can be expected in these areas, the water quality is frequently poor in these monitoring boreholes.

Figure 3.5 Variations in Groundwater Discharge Map



This data does not therefore represent the water quality as a whole. Where ambient groundwater quality is poor, the main salts of concern are generally sodium, chloride, calcium and potassium. Groundwater quality does not appear to have affected or prevented groundwater use.

The majority of boreholes have been drilled to supply domestic water, either for individual households or small villages. The very low yielding boreholes have not been equipped with pumps. In many cases the production boreholes are equipped with either wind pumps or hand pumps, and a small number are equipped with submersible or positive displacement (Mono) pumps, dependant on electrical or diesel power for their operation.

Owing to the scarcity of high yielding boreholes and the need for domestic water supplies, only a very small percentage of production boreholes are used for irrigation or stock watering. No large-scale irrigation supply schemes in the area are supplied from groundwater.

The limiting factor to the harvest potential in the study area is the effective storage of the aquifers. Rainfall recharge occurs regularly in most years but the recharge cannot all be absorbed into the aquifers owing to the low storage. This limits the quantity of groundwater that can be stored during the wet season to bridge abstraction during the drier season.

An average mean annual precipitation (MAP) of some 720 mm over the area and the chloride profile method, (namely the Vegter method, and the RECHARGE Excel spreadsheet) as well as the qualified guesses procedures (harvest potential and ACRU) were adopted to estimate the recharge of aquifers. The various methods yielded recharges varying from 1.7% to 6.3% of the MAP from which a conservative value of 2% of the MAP is proposed as the recharge value for use in determining yield. The result is that a potential recharge, and hence potential yield, for the area investigated was determined at 46 Mm^3/a.

Usually, if the Baseflow Index (ratio of the mean annual baseflow in a river divided by the total annual flow or mean annual runoff) is greater than 0.2 then a baseflow separation assessment is required. This value is given as the low maintenance flow, which is set for the EWR site. These values were not available.

In the absence of adequate historical data of the relationship between groundwater and surface water in the study area, the Herold's Baseflow Separation Method was used to estimate baseflow from groundwater to surface water. This was determined as 4.2 Mm^3/a.

The water available from groundwater sources is estimated, therefore, at

46.0 Mm^3/a – 4.2 Mm^3/a = 41.8 Mm^3/a.

3.3.1 Groundwater Reserve Requirements

3.3.1.1 Quantification of the Reserve

The groundwater Reserve is a volume of water required to sustain the Basic Human Needs (BHN) and aquatic ecosystems prior to any other considerations being made. Only once the groundwater has been allocated to these two important users, can further allocations be advised and implemented.

Allowance has been made for aquatic ecosystems through the EWRs for surface water. Consequently it should not be necessary to again make provision for that requirement.

The BHN Reserve is a function of the population within a particular area multiplied by a requirement of 25 litres/capita/day (ℓ/c/d). The population census of 2001 indicated the population at some 827 000 people. Of these people some 645 000 are taken into account in the allocations from the ABWSS, while the water requirement scenarios make provision for supplies for the population growth within the area of supply of the ABWSS. Also, population scenarios show a decline in population or a marginal growth, probably less than 5%, over the period covered by this study. Consequently, taking into account inaccuracies in population determination, allowance needs to be made in the reserve for some 180 000 people (827000 – 645 000) = 182 000 say 180 000, for whom the BHN is 1.6 Mm^3/a.

3.3.2 Groundwater Available

The groundwater, which is theoretically available for use, should be:

Groundwater Theoretically Available = Recharge – Baseflow – Basic Human Needs – use above the BHN of people outside the area of supply of the ABWSS.

Households outside of the area of supply of the ABWSS are largely “traditional” for which stakeholders have agreed an allowance of 60 ℓ/c/d should be made, which is 2.3 Mm^3/a more than the BHN of 1.6 Mm^3/a for the 180 000 people within the area investigated, but outside the area of supply of the ABWSS.

The water, which is theoretically available in respect of the study area, is set out in Table 3.31.

Table 3.31 Groundwater Theoretically Available

MAP (average)	720 mm/a
Recharge	46 Mm^3/a
Baseflow	4.2 Mm^3/a
BHN	1.6 Mm^3/a
Use above the BHN	2.3 Mm^3/a
Groundwater theoretically Available	37.9 Mm^3/a

Not all this theoretically available water is readily available to the people in the area covered by the ABWSS. Potential resources in the Upper and Middle Kubusi have been taken into account. Limited volumes make a transfer into a bulk system via the Wriggleswade Transfer Scheme unattractive.

Table 3.32 shows the groundwater estimate, which is theoretically available per scheme and per quaternary for the area of influence of this study.

Table 3.32 Estimate of Groundwater Theoretically Available per Scheme

Scheme/ Quaternary	Recharge = Yield = Discharge per Quaternary (Mm^3/a)	Baseflow per Quaternary (Mm^3/a)	Possible population for whom Basic Human Needs must be allowed as an environmental reserve (No.)	Basic Human Needs per Quaternary @ 25 ℓ/c/d (Mm^3/a)	Groundwater theoretically available per Quaternary (Mm^3/a)	Groundwater theoretically available per Scheme (Mm^3/a)
UPPER BUFFALO						9.2
R20A	0.9	0.2	8 000	0.1	0.6	
R20B	1.8	0.1	23 000	0.2	1.5	
R20C	1.1	0.1	9 000	0.1	0.9	
R20D	2.1	0.1	43 000	0.4	1.7	
R20E	4.8	0.1	20 000	0.2	4.5	
MIDDLE BUFFALO						19.5
R20F	5.2	0.2	0	0	5.0	
R30E	15.2	0.5	22 000	0.2	14.5	

Scheme/ Quaternary	Recharge = Yield = Discharge per Quaternary (Mm³/a)	Baseflow per Quaternary (Mm³/a)	Possible population for whom Basic Human Needs must be allowed as an environmental reserve (No.)	Basic Human Needs per Quaternary @ 25 ℓ/c/d (Mm³/a)	Groundwater theoretically available per Quaternary (Mm³/a)	Groundwater theoretically available per Scheme (Mm³/a)
LOWER BUFFALO						1.8
R20G	0.5	0.1	0	0	0.4	
R30F	2.0	0.2	44 000	0.4	1.4	
UPPER KUBUSI						3.1
S60A	4.8	1.6	11 000	0.1	3.1	
MIDDLE KUBUSI						
Not Applicable						
TOTAL	**38.4**	**3.2**	**180 000**	**1.7**		**33.6**

Collectively, the groundwater theoretically available within the area supplied by the ABWSS and in close proximity to the ABWSS is estimated at some 33.6 Mm^3/a.

While the groundwater theoretically available is significant, it is dispersed, aquifers appear to be limited and yields from boreholes to date have generally been low.

The integration of groundwater as a significant contributor to the ABWSS is likely to be by means of higher yielding boreholes, which have been taken to be greater than 5 ℓ/s.

Borehole yields vary amongst quaternaries. Also, the borehole yield data is not definitive due to different ways in which discharges have been measured.

The data indicates that some 5% of boreholes in the R20 quaternaries deliver more than 5 ℓ/s, with 9% of boreholes in the R30 quaternaries delivering more than 5 ℓ/s and 3% of boreholes in the S60 quaternaries delivering more than 5 ℓ/s.

Values are not readily available regarding the quantities which the higher yielding boreholes provide relative to the lower yielding boreholes.

While the higher yielding boreholes should deliver more water in proportion to the total, than the percentage of the number of higher yielding boreholes relative to the others, it would be conservative to adopt the same percentage for the purposes of analysis.

The groundwater theoretically available in several of the quaternaries is limited. The indications are that there is significant promise of naturally recharged groundwater in only 4 quaternary catchments, namely in the R20E, R20F, R30E and S60A quaternaries. The most promising quaternary appears to be R30E, along the Nahoon River, upstream of the Nahoon Dam as shown in Figure 3.5.

Taking the factors outlined above into account, the quantity of groundwater, which could be available to augment the ABWSS is as summarised in Table 3.33.

Table 3.33 Groundwater Availability

Scheme/Quaternary	Groundwater Theoretically Available Mm^3/a	Groundwater from Higher Yielding Boreholes Mm^3/a	Potential Recovery of Conveyance Losses Mm^3/a	TOTAL
UPPER BUFFALO				
R20E	4.5	0.2		0.2
MIDDLE BUFFALO				
R20F	5.0	0.2	-	0.2
R30E	14.5	1.2	0.1	1.3
LOWER BUFFALO				
Not Applicable				
UPPER KUBUSI				
S60A	3.1	0.1	-	0.1
MIDDLE KUBUSI				
Not Applicable				
TOTAL		**1.7**	**0.1**	**1.8**

The most promising area for the use of groundwater as a bulk source is in quaternary catchment R30E (the Middle Nahoon Catchment upstream of Nahoon Dam). Around two-thirds of the estimate of available groundwater is in that quaternary (1.2 Mm^3/a out of a total of 1.7 Mm^3/a), while a significant number of boreholes yielding more than 5 ℓ/s is also located there. The distribution of those boreholes (as shown in Figure 3.5) suggests there might be aquifers and there might be scope for the conjunctive use of surface and groundwater.

Seven areas of potential well-field development have been identified as shown on Figure 3.6 . Three of the areas are associated with the Kubusi River and its tributaries, while the remaining four areas are in the catchment of the Nahoon River. The latter are considered the most promising with respect to augmenting the ABWSS and were evaluated. Three of these areas of potential well-field development are in quaternary R30E and one is further downstream in quaternary R30F.

The alluvial deposits associated with the areas of potential well-field development are limited, but the areas are intersected by north east - south west trending structural features which should increase the probability of intersecting higher yielding, deeper aquifers.

The recharge/yield estimation methods outlined above have been used to estimate the groundwater available from the four areas of potential well-field development. The results are set out in Table 3.34.

Table 3.34 Estimate of Groundwater Available from Four Areas of Potential Well-Field Development in the Nahoon Catchment

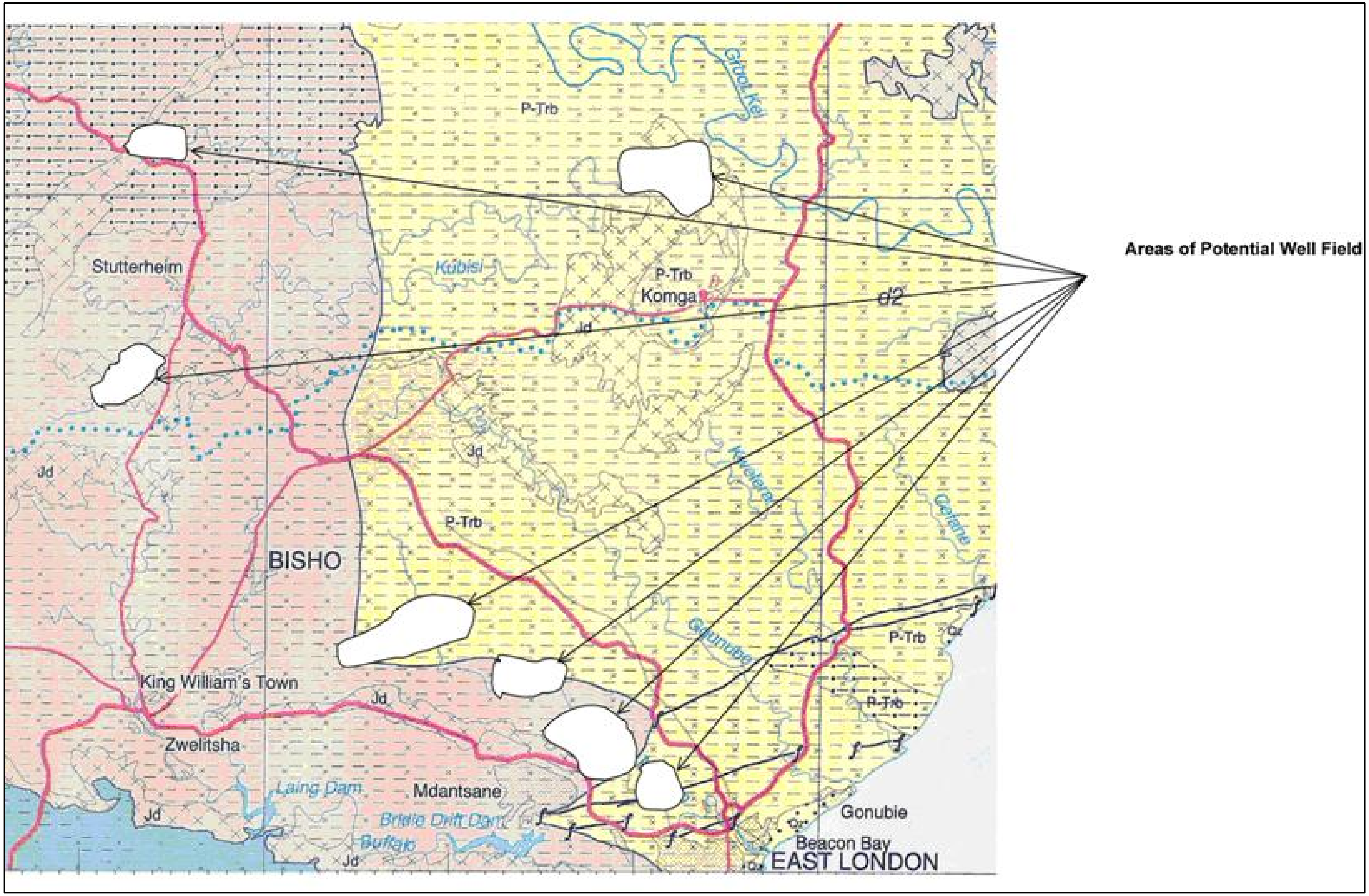
Potential Well Field Development	Approximate Area of Well Field km^2	Possible Yield Mm^3/a	Borehole Abstraction Rate ℓ/s
R30E – Upper	42	0.5	0 to 2
R30E – Middle	18	0.2	2 to 5
R30E – Lower	35	0.4	0 to 2
R30F – Upper	13	0.2	0 to 2

The results were subjected to an independent review by Mr Karim Sami, who concluded that by adopting a harvest potential method the possible yields could be up to 50% higher than those reflected in Table 3.34. The estimate of groundwater available as shown in Table 3.34 can be taken, therefore, as being realistic but possible conservative.

The most promising possibilities for aquifer development along the Nahoon River with the potential for conjunctive use of water discharged from the Wriggleswade Transfer Scheme, are downstream of where the Nkobongo River discharges into the Nahoon River. The water from the Wriggleswade Dam would be released to the Nkobongo River near Kei Road, from where the water would flow to the Nahoon River.

Three of the potential aquifers in quaternaries R30E and R30F (R30E–Middle, R30E-Lower and R30F-Upper) are downstream of the confluence of the Nkobongo and Nahoon rivers.

Figure 3.6 Areas of Potential Well Field Development



Possible aquifer R30F-Upper is below the Nahoon Dam and water released from the Wriggleswade Dam into the Nahoon River should not pass through the Nahoon Dam to augment the aquifer.

Possible aquifer R30E-Lower appears to be less permeable than aquifer R30E-Middle. Consequently, the best chances for the conjunctive use of groundwater and releases to the Nahoon River from the Wriggleswade Dam are at possible aquifer R30E-Middle. The possible yield from that source is estimated at some 0.2 Mm^3/a as shown in Table 3.34.

Stakeholders have expressed concern regarding water losses, which will occur when water is transferred through the Wriggleswade Transfer Scheme. The possibility of recovering some of that water through the replenishment of aquifers by means of the seepage water and abstraction of the groundwater for inclusion in the ABWSS, has been proposed as an option.

Not all the seepage water would be returned to the system. The quantity available for that purpose will depend upon factors such as the permeability of the soil, the nature of aquifers, if any, the locations of boreholes and the abstraction pattern relative to the seepage pattern. In the absence of definitive information, an increase of some 0.1 Mm^3/a in the yield of boreholes in the potential R30E-Middle aquifer could arise (see Table 3.33).

The resulting yield, could be around 0.3 Mm^3/a through the conjunctive use of groundwater and releases from the Wriggleswade Dam, but this would need to be proven in a detailed study. The potential for enhanced yields through the development of deep wells should be investigated at the same time.

3.4 RAINWATER HARVESTING

DWAF is actively engaged in promoting rainwater harvesting (RWH). A RWH pilot programme has been introduced in the Mzimvubu region of the Eastern Cape. The pilot programme has created a demand for the expansion of the project.

The current focus of the RWH programme is to increase the level of food security in resource poor households and to achieve the Millenium Development Goal 1a, namely to halve the number of people living with hunger by 2015.

The programme has the following main elements:

- intensified permaculture food production by households;

- run-on rainwater harvesting which leads rainfall run-off into gardens and into rainwater storage tanks and
- a 30 000-litre underground rainwater storage tank on the property of each participating household.

The tanks and the training of household members are financed by DWAF, through the programme as well as through Water User Associations or other approved legal entities.

Pamphlets outlining the programme are included in Appendix 3.7.

Rainwater has for many years been harvested from rooftops and this practice has the effect of reducing water requirements for garden watering.

The RWH for food security is unlikely to impact markedly on the ABWSS, while the extent to which RWH will add to the availability of water in the area of supply of the ABWSS is uncertain. Consequently, RWH has not been taken into account in the water availability scenarios investigated in this study. Consideration should be given, however, to promoting RWH as a means of reducing water requirements from the ABWSS.

CHAPTER 4

Current and Future Water Requirements

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4 CURRENT AND FUTURE WATER REQUIREMENTS

Evaluation of the current water use and future water requirements forms one of the core parts of the investigation. Much attention has been given to collecting, comparing and verifying data, as well as to obtaining alignment between the growth scenarios adopted by BCM and those proposed by the Planning Team.

The population change scenarios are set out in Appendix 4.1, while the calculation of the water requirement scenarios is shown in Appendix 4.2.

Water requirement scenarios have been formulated for domestic, industrial and irrigation uses.

The basis for the domestic water requirement scenarios is population change, linked to the nature of household demands for water. Industrial water requirement scenarios are based on the current use together with the water requirements for the IDZ. Irrigation water requirement scenarios focus mainly on compensation water from the dams in the ABWSS, together with water use recorded in DWAF's databases. Each use is handled in turn below, after consideration is given to population growth scenarios.

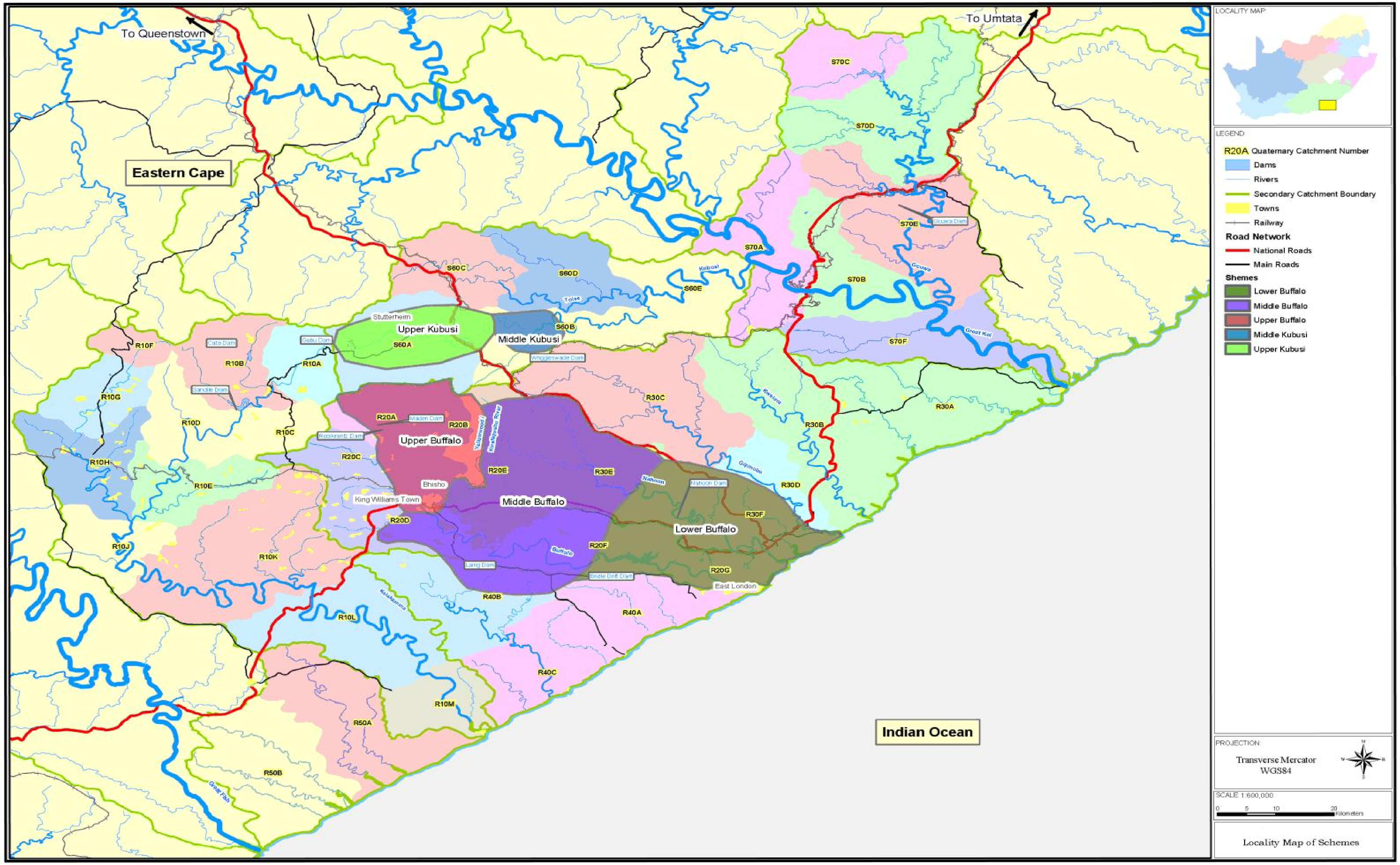
4.1 POPULATION GROWTH SCENARIOS

4.1.1 Population being considered

The population under consideration is that supplied with water from the ABWSS. The area of supply is illustrated on Figure 4.1. People who are not currently served by the ABWSS, but who might be supplied from the ABWSS in future, are taken into account by means of options that will require extensions to the ABWSS.

The area of supply of the ABWSS covers the parts of BCM served by the Upper, Middle and Lower Buffalo water supply schemes and parts of neighbouring local municipalities, namely the Amahlati LM (which includes Stutterheim) and the Ngqushwa LM.

Figure 4.1 Area of Supply of the ABWSS



4.1.2 Demographic Process

Three groups of demographers have prepared population growth scenarios. Two of the groups of demographers have been appointed by BCM's IDP Department and the third by DWAF's Directorate: Water Resource Planning Systems. BCM's demographic consultants have developed growth scenarios for high and low HIV/AIDS prevalence.

The results of the 2001 Census for each relevant Main and Sub-place serve as a basis for the population growth scenarios as was agreed at the Information Verification Working Meeting on 4 November 2005 and at the Steering Committee Meeting on 21 February 2006.

The population for each specific scheme was determined by grouping the Main-place and Sub-place polygons, as defined by the 2001 Census, enclosed within each scheme border.

Preliminary results of the demographic analysis undertaken on behalf of DWAF were made available to the Planning Team during the second half of 2005 and were presented at the Information Verification Working Meeting. The final results of the study were made available in 2006 and contained refinements with respect to the 2001 Census data, reflecting a population some 40 000 less in 2001 than the figures presented at the Information Verification Working Meeting. The lower figure corresponds with the independent analysis by the demographers commissioned by BCM's IDP Department and is taken, therefore, as being the more realistic figure. Consequently, the later scenario supersedes the Planning Team's scenario presented at the Information Verification Working Meeting.

The scenarios of the three demographers reflect the population of Buffalo City as having been some 702 000 people in 2001, not all of whom are supplied with water from the ABWSS.

The demographic analyses provided population projections up to 2025. The population numbers for 2030 were extrapolated for the purpose of this study by using the same growth rate as the previous time step between 2020 and 2025.

The method and the approach used by the demographers to arrive at the population growth scenario involved complex analysis and modelling, taking into account the most probable scenarios for natural growth, population migration patterns and the impact of HIV/AIDS. This method is similar to the approach, which the Steering Committee wished the Planning Team to adopt. However, due to complexity in the interrelationships, the Planning Team has not been able to disaggregate the growth scenarios to reflect separately (as requested by the Steering Committee):

- the natural growth of the population;
- migration and
- the impact of HIV/AIDS.

The natural growth is directly related to the fertility rates and the mortality rates, which in turn are impacted upon by various factors, such as the prevalence of HIV/AIDS. The migration patterns are in general more difficult to predict and are usually in response to a range of stimuli, including potential for employment opportunities, access to infrastructure and facilities (housing, education and health), security as well as family-related and cultural reasons. Since migration is a selective process in terms of sex, age as well as economic and social background, it ultimately leads to changes in the prevailing mortality and fertility rates at a regional level.

The demographic studies concluded that low natural growth would be experienced in the area of supply of the ABWSS. The general migration pattern is expected to involve gradual relocation of the rural population from within close proximity of the area of supply of the ABWSS to urban centres elsewhere in search of better employment and housing opportunities. In view of the limited scope for major economic development in the area, an influx of people is not foreseen.

The generalised sentiments are supported by research done for the State of the Cities Report for 2006. The research showed that between 2001 and 2006 the only urban centre in the Eastern Cape with a net in-migration of people was the Nelson Mandela Metropole. Indeed the Amathole District Municipality, within which most of the area supplied by the ABWSS falls, had a net out-migration of 4.89% over the period 2001 to 2006.

In the course of consultations with representatives of the BCM's Housing Department, information was obtained regarding planned housing projects proposed by the BCM Housing Policy Implementation Plan. In terms of the planned strategy, approximately 130 000 new housing units would be provided by the year 2020 and an additional 70 000 units could be developed at a later stage. The projections for housing needs contained in the Implementation Plan document were based on an estimated housing backlog of 75 000 units together with an additional 55 000 housing units needed to accommodate population growth by 2020, which corresponds to some 270 000 new residents. The population growth was attributed mainly to migration from the outlying rural areas outside of the BCM's area of jurisdiction, in search of employment opportunities and better access to services. This housing-needs scenario differs substantially from the population growth scenarios developed by the demographers and the migration pattern between 2001 and 2006 as outlined above, which predict that the future population within BCM would stabilise close to current levels or might even decline.

At the Information Verification Working meeting, it was concluded that the housing requirements are unlikely to be verified in the short term. As the current estimates of housing for new households are in excess of the needs generated by the population growth scenarios, housing projections have not been taken into account. The water requirement scenarios have been based on the population growth scenarios.

At the Information Verification Working Meeting, it was agreed that the low growth scenario of BCM's WSDP would be adopted as the upper growth scenario for the purpose of this study, extended by the Planning Team's scenario after 2015. At the Steering Committee meeting on 21 February 2006, the use of BCM's WSDP low growth scenario was not opposed.

During 2006 the Water Branch of BCM commissioned consulting engineers to count the number of dwellings in certain portions of the BCM's area of jurisdiction. The count was based on aerial photographs taken in 2001. The results were made available to the Planning Team at the Steering Committee Meeting on 29 August 2006.

The Planning Team's interpretation of the data derived from the dwelling count is that the population recorded in BCM as some 702 000 people in the 2001 census might be an undercount by around 19%. In that event the population in BCM would have been of the order of 835 000 people during 2001.

In order to accommodate the two population scenarios as at 2001 (the one based on the Census results and the other on the dwelling counts), both have been adopted for the population growth scenarios. For consistency the population growth scenarios generated by the three demographers have been applied to each of the two population figures (702 000 and 835 000 people in BCM) as at 2001. This process is considered more realistic than the growth projections used in the WSDP (which are an extrapolation of historic growth trends) and replaces the lower growth projection of the WSDP as a population growth scenario for the purposes of this study.

4.1.3 Population in the Area of Supply of the ABWSS

People within the area of jurisdiction of BCM are supplied with water from sources outside of the ABWSS, while communities in the Amahlati and Ngqushwa municipalities are provided with water from the ABWSS. The scenarios for the population served in each of the schemes for the lower and higher population scenarios in 2001 are summarised in Table 4.1.

Table 4.1 Scenarios for Population Served from the ABWSS in 2001

Scheme	Lower Population Scenario for 2001		Higher Population Scenario for 2001	
	Population in BCM	Population supplied by the ABWSS	Population in BCM	Population Supplied by the ABWSS
Upper Buffalo	52 574	72 473	61 000	86 243
Middle Buffalo	112 426	118 897	131 000	141 487
Lower Buffalo	428 740	428 740	510 000	510 201
Upper and Middle Kubusi	0	24 136	0	28 722
Total	593 740	644 246	702 000	766 653

4.1.4 Comparison of Population Growth Scenarios

The population growth scenarios developed by the demographers with the results of the 2001 Census as the basis and the population growth scenarios developed by the Planning Team by applying the same growth rates to the population estimated for 2001 from the dwelling count are shown in Table 4.2 below.

The population growth scenarios developed by the demographers are referred to as the "Lower Population Scenarios" and those population growth scenarios based on the dwelling count are referred to as the "Upper Population Scenarios".

Table 4.2 Population Growth Scenarios

	Lower			Upper		
	Census HIV High Impact	Census HIV Low Impact	Planning Team	Dwelling Count HIV High Impact	Dwelling Count HIV Low Impact	Dwelling Count Planning Team
2001	644 246	644 246	644 246	766 653	766 653	766 653
2005	632 247	645 048	675 027	752 374	767 607	799 655
2010	605 246	638 337	696 485	720 243	759 621	821 322
2015	567 230	624 765	702 623	675 004	743 470	825 166
2020	523 043	607 806	700 588	622 422	723 289	819 436
2025	482 299	591 307	692 227	573 935	703 655	813 747
2030	444 728	575 256	690 130	529 226	684 554	808 096

Notes:

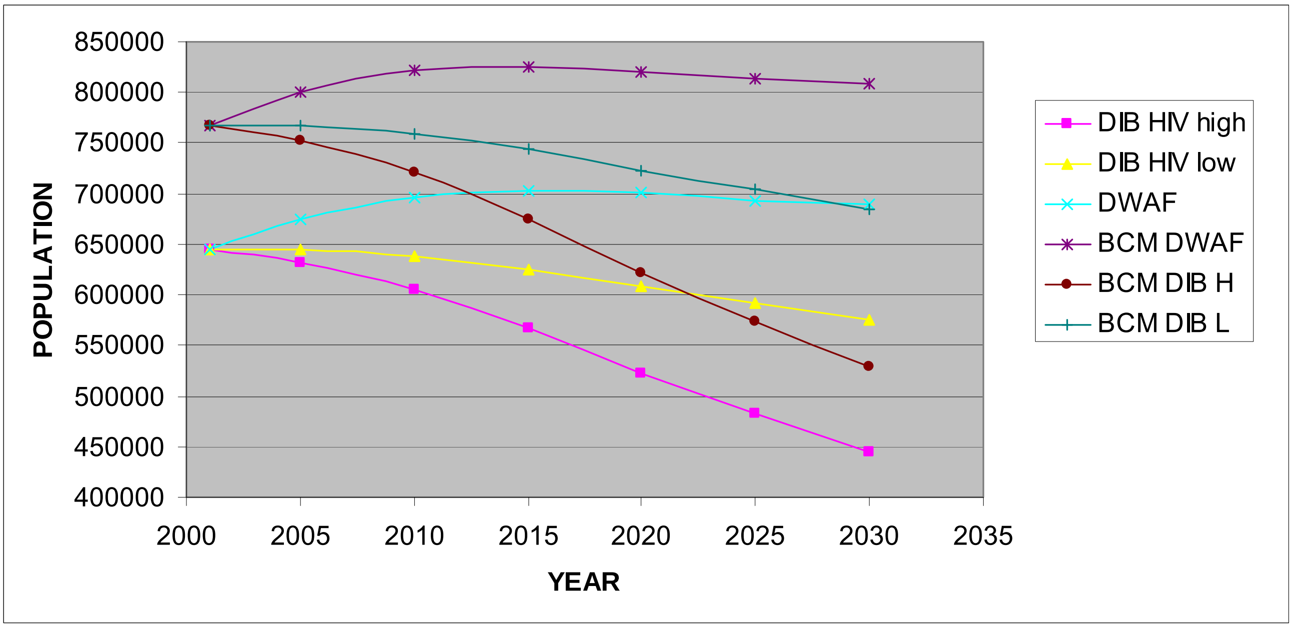
"Census": *Scenarios developed by the demographers engaged by BCM's IDP Department, based on the 2001 census (also referred to as DIB in Figure 4.2, being the acronym for the name of the demographic company which prepared the growth scenarios).*

"Planning Team": *Scenario developed by the Planning Team based upon the scenario developed by the demographers engaged by DWAF (also referred to as DWAF in Figure 4.2).*

"Dwelling Count": *Scenarios developed as a result of applying the scenarios developed by the demographers to the population scenario of the 2001 population derived from the dwelling count commissioned by the Water Branch of BCM (also referred to as "BCM" in Figure 4.2 to reflect the BCM dwelling count).*

The scenarios are shown graphically in Figure 4.2.

Figure 4.2 Population Growth Scenarios



4.1.5 Population Growth Scenarios by Schemes

The population growth scenarios are sub-divided in accordance with the 5 schemes to form the basis for the determination of domestic water requirements. The population scenarios for each scheme are shown in Table 4.3 to Table 4.8.

Table 4.3 2001 Census with High HIV Impact Scenario

(DIB HIV High)					
	Upper Buffalo	**Middle Buffalo**	**Lower Buffalo**	**Upper Kubusi**	**Total**
2001	72 473	118 897	428 740	24 136	644 246
2005	71 898	114 894	419 898	25 557	632 247
2010	69 713	108 364	400 430	26 739	605 246
2015	66 007	100 305	373 657	27 261	567 230
2020	61 299	91 483	343 032	27 228	523 043
2025	56 733	83 485	314 992	27 089	482 299
2030	52 571	76 481	288 721	26 956	444 728

Table 4.4 2001 Census with Low HIV Impact Scenario

(DIB HIV Low)					
	Upper Buffalo	**Middle Buffalo**	**Lower Buffalo**	**Upper Kubusi**	**Total**
2001	72 473	118 897	428 740	24136	644 246
2005	73 354	117 220	428 400	26 074	645 048
2010	73 524	114 286	422 322	28 201	638 337
2015	72 702	110 479	411 558	30 026	624 765
2020	71 233	106 309	398 623	31 641	607 806
2025	69 556	102 354	386 185	33 212	591 307
2030	68 001	98 928	373 460	34 867	575 256

Table 4.5 Planning Team's Scenario

(DWAF)					
	Upper Buffalo	**Middle Buffalo**	**Lower Buffalo**	**Upper Kubusi**	**Total**
2001	72 473	118 897	428 740	24 136	644 246
2005	76 763	122 668	448 310	27 286	675 027
2010	80 222	124 700	460 793	30 770	696 485
2015	81 762	124 247	462 846	33 768	702 623
2020	82 107	122 537	459 473	36 471	700 588
2025	81 427	119 823	452 097	38 880	692 227
2030	81 580	118 683	448 038	41 830	690 130

Table 4.6 Dwelling Count with High HIV Impact Scenario

(BCM DIB High)					
	Upper Buffalo	Middle Buffalo	Lower Buffalo	Upper Kubusi	Total
2001	86 243	141 487	510 201	28 722	766 653
2005	85 559	136 724	499 679	30 413	752 374
2010	82 958	128 954	476 511	31 820	720 243
2015	78 548	119 363	444 652	32 441	675 004
2020	72 946	108 865	408 208	32 402	622 422
2025	67 512	99 347	374 840	32 236	573 935
2030	62 559	91 012	343 578	32 077	529 226

Table 4.7 Dwelling Count with Low HIV Impact Scenario

(BCM DIB Low)					
	Upper Buffalo	Middle Buffalo	Lower Buffalo	Upper Kubusi	Total
2001	86 243	141 487	510 201	28 722	766 653
2005	87 291	139 492	509 796	31 028	767 607
2010	87 494	136 004	502 564	33 559	759 621
2015	86 515	131 470	489 754	35 731	743 470
2020	84 767	126 507	474 361	37 653	723 289
2025	82 771	121 801	459 561	39 522	703 655
2030	80 921	117 724	444 418	41 492	684 554

Table 4.8 Dwelling Count with Planning Team's Scenario

(BCM DWAF)					
	Upper Buffalo	Middle Buffalo	Lower Buffalo	Upper Kubusi	Total
2001	86 243	141 487	510 201	28 722	766 653
2005	90 935	145 316	531 080	32 324	799 655
2010	94 601	147 051	543 385	36 285	821 322
2015	96 022	145 917	543 570	39 657	825 166
2020	96 036	143 324	537 418	42 658	819 436
2025	95 721	140 858	531 462	45 705	813 747
2030	95 524	138 970	524 622	48 980	808 096

4.2 WATER REQUIREMENT SCENARIOS

The water requirement scenarios are influenced by not only population growth scenarios, but also by factors such as the domestic, industrial and irrigation uses, levels of service, as well as water use efficiency, all of which are determined in terms of volume and timing.

Invasive alien plants and afforestation have not been analysed as part of water requirement scenarios since these water uses were regarded rather as streamflow reduction activities affecting the yields of the water resources. The aspects relating to invasive alien plants and afforestation are addressed in the water resources analysis.

4.2.1 Water Loss for Domestic and Industrial Supplies

The proportion of water lost in the ABWSS during abstraction, treatment, conveyance, storage, distribution and use is not known as the suite of measurements is inadequate to reflect the losses with any degree of certainty.

At the Information Verification Working meeting views were expressed that it would be prudent to allow 30% of the water requirements for domestic and industrial uses to cover storage, conveyance and distribution losses, downstream of WTWs while a further undefined amount should be provided for losses in the process of abstraction from dams, conveyance to WTWs and purification of the water.

During the Steering Committee meeting on 29 August 2006 the matter of losses was again considered and the allowances for losses set out below were proposed:

- losses will differ for each of the supply areas;
- reticulation losses 30%;
- conveyance losses between WTWs and reticulation systems – as a guide 12% and
- conveyance losses between dams and WTWs (where conveyance is by means of run-of-river flow) and through the WTWs 10%.

The proposed losses were compared with records of AW and Stutterheim for water produced at and water sold from the WTWs at the Rooikrantz, Laing and Nahoon dams as well as at the WTWs managed by the Amahlati Municipality for Stutterheim. The average losses (as a percentage of water produced at the WTWs) from 2000/2001 to 2005/2006 were as set out in Table 4.9.

Table 4.9 Average Raw and Purified Water Losses from 2000/2001 to 2005/2006

Dam	Losses from the WTWs to Consumers %	Losses from the WTWs to Distribution Reservoirs %	Losses from the dam through the WTW %
Rooikrantz	24.7	-	10.4
Laing	20.9	-	3.7
Nahoon	-	4.4	4.8
Gubu		3.4	57.5 (of raw water imported) 38.9 (of raw water treated)

Similar data was not made available by BCM, but it would be reasonable to assume that the losses would be similar or less.

With the exception of the raw water losses for Stutterheim, the recorded values are lower than the allowance for losses proposed at the Steering Committee meeting of 29 August 2006, but they have greater foundation. The raw water losses at Stutterheim, particularly those through the WTW (the raw water treated), are excessive and should not be much more than those of the Rooikrantz WTW. Consequently the provisions for losses in respect of domestic and industrial water use have been adopted as set out in Table 4.10 .

Table 4.10 Provision for Losses

	Losses as % of Domestic and Industrial Water Requirements			
Scheme	Reticulation Losses	Conveyance between WTWs and Reticulation Systems	Dams to WTWs and through WTWs	TOTAL
Upper Buffalo	20	5	10	35
Middle Buffalo	15	6	4	25
Lower Buffalo	16	5	9	30
Upper Kubusi	15	4	16	35

4.2.2 Domestic and Industrial Water Requirements

4.2.2.1 Domestic Water Requirements

The domestic water requirements were calculated by adopting consumption figures applicable to the socio–economic categories set out below.

1.	Upper income	320 ℓ/c/d
2.	Middle income	200 ℓ/c/d
3.	Lower income formal	120 ℓ/c/d
4.	Lower income informal	25 ℓ/c/d
5.	Traditional	60 ℓ/c/d including allowance for limited gardening and livestock watering

These water requirements correspond well with the consumption figures adopted by BCM, albeit by means of a different characterisation.

The institutional, tourism and commercial water requirements were factored into the above domestic unit consumption figures.

National policy, underpinned by the Constitution of the Republic of South Africa, has a central thrust to improve sanitation services in parallel with enhanced water supply services. Consequently water allocations need to take into account the implications of changes in the level of service for sanitation.

There is increasing pressure from communities for waterborne sanitation in preference to dry sanitation systems. Also, the present trend in formal developments is to upgrade bucket and other dry sanitation systems to waterborne sanitation systems.

At the Information Verification Working Meeting, the view was expressed that the upper water requirement scenario would be based on all households being served by waterborne sanitation and that there would be a general increase in levels of service (LoS). The current mix of dry and waterborne sanitation systems would be adopted for the lower water requirement scenario. This approach has been adopted, with the minimum requirement of 120 ℓ/c/d being allowed for waterborne sanitation.

Logistics, cost and affordability dictate against the traditional settlements being provided with waterborne sanitation, while national policy is to upgrade or replace informal settlements with formal settlements during the planning horizon of this strategy. Hence the intermediate scenario can be taken as all households, other than traditional ones, having waterborne sanitation.

Water requirements were calculated taking cognisance of the different levels of water services at 2001 as indicated in the demographic analysis prepared under the guidance of DWAF. The three scenarios outlined above were then developed as follows:

- lower scenario — No change in the mix of LoS;

- intermediate scenario — Gradual increase in LoS for the population of informal settlements with the unit consumption of 25 ℓ/c/d increasing to 120 ℓ/c/d by 2025 and
- upper scenario — In addition to the increase in LoS for informal settlements to 120 ℓ/c/d, as per the intermediate scenario, the LoS of the population currently served at 120 ℓ/c/d will gradually increase to 200 ℓ/c/d by 2025.

The water requirement scenarios for domestic use are shown in Table 4.11 to Table 4.16 in respect of the Upper, Middle and Lower Buffalo schemes as well as for the Upper and Middle Kubusi schemes combined. Emphasis is placed in this study on the lower and upper scenarios. Consequently in each case, they are shown first in the tables, followed by the intermediate scenario.

Note that based on the above definitions for any particular catchment, the "intermediate water requirement" may be lower than the "lower water requirement" (this occurs in the Middle Buffalo Scheme). In total (for all four catchments), however, the "lower water requirement" will be less than the "intermediate water requirement" which will be less than the "higher water requirement".

Table 4.11 Domestic Water Requirements - Census with High HIV Impact Scenario

	Upper Buffalo			Middle Buffalo			Lower Buffalo			Upper Kubusi			Total		
	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a
2005	4.65	4.65	4.65	7.44	7.44	7.44	30.58	30.58	30.58	2.67	2.67	2.67	45.34	45.34	45.34
2010	4.51	5.12	4.94	6.99	7.07	6.85	29.05	32.32	30.28	2.90	3.02	2.95	43.45	47.53	45.02
2015	4.28	5.42	5.06	6.45	6.60	6.19	27.02	33.09	29.30	3.06	3.28	3.16	40.81	48.38	43.72
2020	3.98	5.56	5.07	5.85	6.06	5.49	24.73	33.16	27.90	3.16	3.46	3.30	37.73	48.24	41.77
2025	3.69	5.65	5.04	5.31	5.57	4.86	22.65	33.13	26.60	3.24	3.62	3.42	34.89	47.97	39.92
2030	3.42	5.23	4.67	4.84	5.08	4.42	20.70	30.40	24.35	3.31	3.66	3.47	32.27	44.37	36.92

Table 4.12 Domestic Water Requirements - Census with Low HIV Impact Scenario

	Upper Buffalo			Middle Buffalo			Lower Buffalo			Upper Kubusi			Total		
	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a
2005	4.74	4.74	4.74	7.59	7.59	7.59	31.20	31.20	31.20	2.72	2.72	2.72	46.26	46.26	46.26
2010	4.76	5.40	5.21	7.37	7.46	7.23	30.64	34.08	31.93	3.05	3.18	3.11	45.83	50.13	47.48
2015	4.72	5.97	5.58	7.10	7.27	6.82	29.76	36.45	32.28	3.37	3.61	3.48	44.95	53.29	48.15
2020	4.63	6.46	5.89	6.80	7.04	6.38	28.74	38.53	32.43	3.67	4.03	3.84	43.84	56.05	48.54
2025	4.53	6.92	6.18	6.51	6.83	5.96	27.77	40.62	32.61	3.97	4.44	4.19	42.78	58.81	48.94
2030	4.43	6.77	6.04	6.26	6.57	5.72	26.78	39.32	31.50	4.28	4.73	4.49	41.74	57.39	47.76

Table 4.13 Domestic Water Requirements - Planning Team's Scenario

	Upper Buffalo			Middle Buffalo			Lower Buffalo			Upper Kubusi			Total		
	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a
2005	4.96	4.96	4.96	7.94	7.94	7.94	32.65	32.65	32.65	2.85	2.85	2.85	48.41	48.41	48.41
2010	5.20	5.90	5.68	8.05	8.14	7.89	33.43	37.19	34.84	3.33	3.47	3.40	50.00	54.69	51.81
2015	5.31	6.71	6.27	7.99	8.17	7.66	33.47	40.99	36.30	3.79	4.06	3.92	50.55	59.93	54.15
2020	5.34	7.44	6.79	7.84	8.12	7.36	33.13	44.41	37.38	4.23	4.64	4.43	50.53	64.61	55.95
2025	5.30	8.11	7.24	7.62	7.99	6.98	32.51	47.55	38.17	4.65	5.19	4.91	50.08	68.85	57.29
2030	5.31	8.12	7.25	7.51	7.88	6.86	32.13	47.17	37.79	5.13	5.68	5.39	50.08	68.85	57.29

Table 4.14 Domestic Water Requirements - Dwelling Count with High HIV Impact Scenario

	Upper Buffalo			Middle Buffalo			Lower Buffalo			Upper Kubusi			Total		
	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a
2005	5.53	5.53	5.53	8.85	8.85	8.85	36.40	36.40	36.40	3.18	3.18	3.18	53.95	53.95	53.95
2010	5.37	6.10	5.87	8.32	8.42	8.15	34.57	38.46	36.03	3.45	3.59	3.51	51.71	56.56	53.57
2015	5.10	6.44	6.03	7.67	7.85	7.36	32.15	39.38	34.87	3.64	3.90	3.77	48.56	57.58	52.03
2020	4.74	6.61	6.03	6.96	7.21	6.53	29.43	39.46	33.21	3.76	4.12	3.93	44.89	57.40	49.70
2025	4.39	6.72	6.00	6.32	6.63	5.78	26.95	39.43	31.65	3.85	4.31	4.07	41.52	57.08	47.50
2030	4.07	6.23	5.56	5.76	6.04	5.26	24.64	36.17	28.98	3.94	4.35	4.14	38.40	52.80	43.94

Table 4.15 Domestic Water Requirements - Dwelling Count with Low HIV Impact Scenario

	Upper Buffalo			Middle Buffalo			Lower Buffalo			Upper Kubusi			Total		
	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a
2005	5.64	5.64	5.64	9.03	9.03	9.03	37.13	37.13	37.13	3.24	3.24	3.24	55.05	55.05	55.05
2010	5.67	6.43	6.19	8.78	8.88	8.60	36.46	40.56	38.00	3.64	3.78	3.71	54.53	59.65	56.50
2015	5.61	7.10	6.64	8.45	8.65	8.11	35.41	43.37	38.41	4.01	4.30	4.15	53.48	63.42	57.30
2020	5.51	7.68	7.01	8.09	8.38	7.59	34.20	45.85	38.59	4.37	4.79	4.57	52.17	66.70	57.76
2025	5.39	8.24	7.36	7.75	8.13	7.09	33.05	48.34	38.80	4.72	5.28	4.99	50.90	69.98	58.24
2030	5.27	8.05	7.19	7.45	7.82	6.81	31.87	46.79	37.48	5.09	5.63	5.35	49.67	68.29	56.83

Table 4.16 Domestic Water Requirements - Dwelling Count with Planning Team's Scenario

	Upper Buffalo			Middle Buffalo			Lower Buffalo			Upper Kubusi			Total		
	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a	Lower Water Requirement Scenario Mm³/a	Upper Water Requirement Scenario Mm³/a	Intermediate Water Requirement Scenario Mm³/a
2005	5.88	5.88	5.88	9.40	9.40	9.40	38.68	38.68	38.68	3.38	3.38	3.38	57.34	57.34	57.34
2010	6.13	6.95	6.70	9.49	9.60	9.30	39.42	43.85	41.09	3.93	4.09	4.01	58.96	64.50	61.09
2015	6.23	7.88	7.37	9.38	9.60	9.00	39.30	48.14	42.63	4.45	4.77	4.60	59.36	70.38	63.60
2020	6.24	8.70	7.94	8.60	9.49	9.17	38.75	51.94	43.72	4.95	5.43	5.18	54.39	75.57	65.44
2025	6.23	9.53	8.51	8.96	9.40	8.20	38.22	55.90	44.87	5.46	6.11	5.77	58.87	80.93	67.35
2030	6.22	9.51	8.49	8.79	9.23	8.04	37.62	55.23	44.25	6.01	6.65	6.31	58.64	80.62	67.09

4.2.2.2 *Industrial Water Requirements*

The only planned industrial estate at this time is the East London Industrial Development Zone (IDZ) which is in the process of establishment.

BCM plans to develop this large-scale industrial development south of Buffalo City airport in stages over the next 20 or more years. It is envisaged that some of the industries will utilise treated effluent supplied from the East Bank wastewater treatment works (WWTW) operated by BCM. The volume of treated effluent supplied to the IDZ is estimated to increase from 1.46 Mm^3/a initially to 7.3 Mm^3/a once the IDZ is fully developed. The IDZ is expected to require a limited volume of potable water from the ABWSS increasing from 0.54 Mm^3/a around 2010 to 1.8 Mm^3/a once full development has taken place.

Three major, potential consumers previously indicated that they might wish to establish in BCM. The three are Gencor/Kynoch, Suntex and South African Breweries (SAB). In the early stages of the study, stakeholders expressed the view that provision should be made for them or other water intensive industries in the scenarios.

This approach was reconsidered at the Steering Committee meeting on 29 August 2006, at which time allowance for significant water intensive industries was viewed as being overly optimistic in the light of past experience and recent economic analyses done by BCM's IDP Department.

The allowances set out below were proposed as being appropriate:

- lower scenario: 2005 use plus 25% of the projected potable water requirement when the IDZ is fully developed;
- upper scenario: 2005 use plus 75% of the projected potable water requirement when the IDZ is fully developed;
- intermediate scenario: 2005 use plus 50% of the projected potable water requirement when the IDZ is fully developed and
- industrial water: the requirement for treated wastewater as a source of bulk water for the IDZ would be reviewed in the light of the scenarios outlined above.

During the review it became apparent that when the potable and industrial water requirements are combined, the resulting scenarios overestimate the water requirements that stakeholders have indicated are likely to materialise. Consequently, the water requirement scenarios were adjusted downwards as follows:

• lower scenario	2005 use plus 10% of the projected potable and industrial water requirement when the IDZ is fully developed;
• upper scenario	2005 use plus 50% of the projected potable and industrial water requirement when the IDZ is fully developed and
• intermediate scenario	2005 use plus 30% of the projected potable and industrial water requirement when the IDZ is fully developed.

The water requirement scenarios for industrial use are shown in Table 4.17 in respect of the Upper, Middle and Lower Buffalo schemes as well as for the Upper and Middle Kubusi schemes combined. The calculations are set out in Appendix 4.2.

4.2.3 Irrigation Water Requirements

The DWAF WSAM database records the areas listed below as requiring irrigation water.

• Buffalo River from the R20A and R20B quaternary catchments	488 ha
• Buffalo River from the R20E quaternary catchment	106 ha
• Nahoon River from the R30E quaternary catchment	331 ha
• Kubusi River from the S60A quaternary catchment	1 451 ha
Total	**2 376 ha**

Some 1 000 ha of soils along the Buffalo River are suitable for irrigation.

Presently the scheduled areas for irrigation are along the Kubusi River, with water managed by the Kubusi Irrigation Board. The scheduled areas are as set out below.

• Area above the Wriggleswade Dam	805.2 ha
• Area around the Wriggleswade Dam	36.2 ha
• Area below the Wriggleswade Dam	226.6 ha
Total	**1 068 ha**

The scheduled area along the Kubusi River was previously 1 112.8 ha, of which 44.8 ha below the Wriggleswade Dam have been de-scheduled.

Little water is supplied for irrigation purposes from the dams in the ABWSS, the bulk of water being drawn from run-of-river flow.

Discussions were held with representatives of DWAF's Regional Office in Cradock, the Provincial Department of Agriculture and AW with a view to ascertaining an approach to the determination of irrigation water requirements. The outcome of the discussions is outlined below.

Three principles should apply, namely:

- the irrigation demand out of each dam should only be the compensation release;
- the balance of the requirements should be provided from the natural run-of-river flow and
- water-use licences should be issued in respect only of the compensation releases and the areas that are currently scheduled.

The relationship between water requirements and irrigable areas for the purpose of the strategy would be on the basis of 6 000 m^3/ha/a plus 25% for losses (This would not preclude a larger area per unit of water being irrigated due to the more efficient use of water as is likely to be encouraged through pending water use efficiency regulations for irrigation).

The proposed provisions for irrigation water requirements arising from the principles outlined above are set out in Table 4.18 .

Table 4.17 Industrial Water Requirements

	Upper Buffalo			Middle Buffalo			Lower Buffalo			Upper Kubusi			Total		
	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a
2005	2.48	2.48	2.48	1.23	1.23	1.23	10.61	10.61	10.61	0.00	0.00	0.00	14.32	14.32	14.32
2010	2.48	2.48	2.48	1.23	1.23	1.23	10.81	11.61	11.21	0.00	0.00	0.00	14.52	15.32	14.92
2015	2.48	2.48	2.48	1.23	1.23	1.23	10.98	12.46	11.72	0.00	0.00	0.00	14.69	16.17	15.43
2020	2.48	2.48	2.48	1.23	1.23	1.23	11.16	13.36	12.26	0.00	0.00	0.00	14.87	17.07	15.97
2025	2.48	2.48	2.48	1.23	1.23	1.23	11.34	14.26	12.80	0.00	0.00	0.00	15.05	17.97	16.51
2030	2.48	2.48	2.48	1.23	1.23	1.23	11.52	15.16	13.34	0.00	0.00	0.00	15.23	18.87	17.05

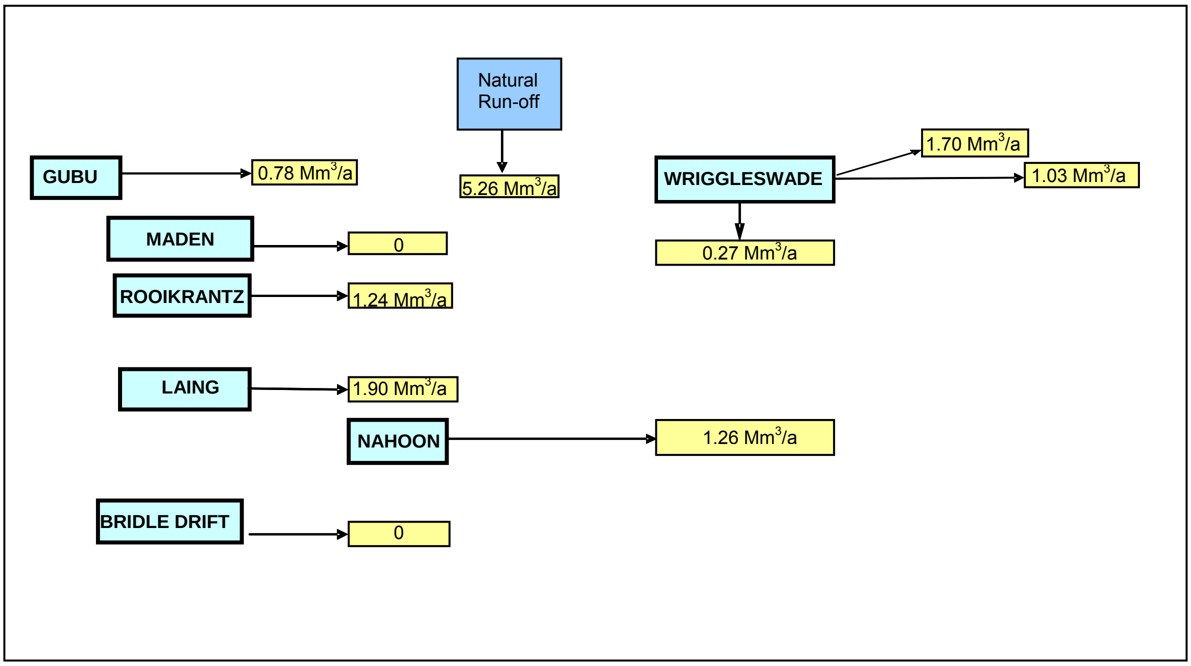
Industrial growth is expected only in the Lower Buffalo but an option should be considered in the event of industries establishing in the Middle or Upper Buffalo.

Table 4.18 Proposed Irrigation Provisions

Description	Area (ha)	Average Provision (Mm^3/a)
Irrigation from Maden Dam	0	0.00
Irrigation from Rooikrantz Dam	150	1.24
Irrigation from Laing Dam	240	1.90
Irrigation from Bridle Drift Dam	0	0.00
Irrigation from Nahoon Dam	160	1.26
Irrigation from Gubu Dam	104	0.78
Run-of-river irrigation between the Gubu and the Wriggleswade dams	701	5.26
Irrigation from the Wriggleswade Dam	400	3.00
Total Irrigation	**1755**	**13.44**

The proposed irrigation provisions are shown diagrammatically in Figure 4.3.

Figure 4.3 Diagrammatic Representation of the Proposed Irrigation Provisions



The proposed irrigation provisions allow for:

- 390 ha of the 594 ha requiring irrigation water from the R20A, R20B and R20E quaternary catchments of the Buffalo River;
- 160 ha of the 331 ha requiring irrigation water from the R30E quaternary catchment of the Nahoon River and

- all the scheduled areas supplied with irrigation water by the Kubusi Irrigation Board up-stream, adjacent to and down-stream of the Wriggleswade Dam, as well as water for the irrigation of some 137 ha further downstream along the Kubusi River.

The abstraction from dams in the Buffalo River, from which domestic and industrial water requirements are being supplied, exceeds the yields of those dams, even at assurances of supply less than 90%.

While the Nahoon Dam is not being fully utilized at present, the full yield is likely to be required to augment the supply from the Buffalo River.

Consequently it might not be realistic to meet the compensation releases in respect of the dams in the Buffalo and the Nahoon rivers.

On the other hand, should it be necessary to meet the irrigation water requirements for the areas reflected in the WSAM database, provision would have to be made for a further 204 ha from the R20A, R20B and R20E quaternary catchments of the Buffalo River as well as for an additional 171 ha of irrigation from the R30E quaternary catchment of the Nahoon River.

The resulting three scenarios, which arise from the possibilities, are:

- lower scenario — Provision of water requirements only for the scheduled area along the Kubusi River;
- intermediate scenario — Irrigation provisions equivalent to the compensation releases as shown in Table 4.18 and
- upper scenario — Irrigation provisions as shown in Table 4.18 together with irrigation requirements for an additional 204 ha (1.53 Mm^3/a) from the Buffalo River and for 171 ha (1.28 Mm^3/a) from the Nahoon River.

The irrigation water requirements for each scheme for the three scenarios are summarized in Table 4.19 on the basis of the full requirement along the Kubusi River being taken up at present, with releases from Gubu Dam, and that the remaining irrigation requirements will be taken up by 2020. The irrigation scenarios in Table 4.19 show the lower and upper scenarios first, followed by the intermediate scenario.

Table 4.19 Irrigation Water Requirements

	Upper Buffalo			Middle Buffalo			Lower Buffalo			Upper Kubusi			Middle Kubusi			Total		
	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a	Lower Water Requirement Scenario Mm^3/a	Upper Water Requirement Scenario Mm^3/a	Intermediate Water Requirement Scenario Mm^3/a
2005	0.00	1.24	1.24	0.00	1.90	1.90	0.00	1.26	1.26	6.04	6.04	6.04	3.00	3.00	3.00	9.04	13.44	13.44
2010	0.00	1.24	1.24	0.00	1.90	1.90	0.00	1.26	1.26	6.04	6.04	6.04	3.00	3.00	3.00	9.04	13.44	13.44
2015	0.00	1.24	1.24	0.00	2.67	1.90	0.00	1.90	1.26	6.04	6.04	6.04	3.00	3.00	3.00	9.04	14.85	13.44
2020	0.00	1.24	1.24	0.00	3.43	1.90	0.00	2.54	1.26	6.04	6.04	6.04	3.00	3.00	3.00	9.04	16.25	13.44
2025	0.00	1.24	1.24	0.00	3.43	1.90	0.00	2.54	1.26	6.04	6.04	6.04	3.00	3.00	3.00	9.04	16.25	13.44
2030	0.00	1.24	1.24	0.00	3.43	1.90	0.00	2.54	1.26	6.04	6.04	6.04	3.00	3.00	3.00	9.04	16.25	13.44

4.3 COMPARISON BETWEEN THE POTABLE WATER PRODUCED IN 2005 AND THE DOMESTIC PLUS INDUSTRIAL WATER REQUIREMENT SCENARIOS

In order to verify the reasonableness of the water requirements for domestic and industrial uses, the calculated domestic and industrial water requirements for 2005 were compared with the potable water produced at the WTWs. The water supplied for each scheme was determined from monthly water production records of the WTWs serving the particular scheme as shown in Table 4.20.

Table 4.20 Capacities and Production of WTWs in the Study Area

Water Treatment Works	Capacity (Mℓ/d)	Capacity (Mm^3/a)	Current Production (Mℓ/d)	Current Production (Mm^3/a)	Operator	Scheme	Source
Kei Road (1)	0.3	0.11	0.3	0.11	Amahlati LM	Middle Kubusi	Wriggleswade Dam
Rooikrantz	1.2	0.44	1.2	0.44	Amatola Water	Upper Buffalo	Rooikrantz Dam
KWT	13.0	4.75	12.0	4.38	BCM	Upper Buffalo	Rooikrantz and Maden dams
Laing	27.3	9.96	23.8	8.67	Amatola Water	Middle Buffalo	Laing Dam
Needs Camp	0.8	0.29	1.0	0.36	BCM	Middle Buffalo	Needs Camp Weir above Bridle Drift Dam
Umzonyana (2)	120.0	43.80	110.0	40.15	BCM	Lower Buffalo	Bridle Drift Dam
Nahoon	33.0	12.04	16.3	5.95	Amatola Water	Lower Buffalo	Nahoon Dam
Stutterheim	3.8	1.39	3.0	1.10	Amahlati LM	Upper Kubusi	Gubu Dam
Total	**199.4**	**72.78**	**167.6**	**61.16**			

1. *The capacity of the Kei Road WTW is being augmented by 4.5 Mℓ/d (1.64 Mm^3/a) with the possibility of a further augmentation of 4.5 Mℓ/d (1.64 Mm^3/a).*

2. *Investigations are in hand to augment the capacity of the Umzonyana WTW by an additional 30 Mℓ/d (10.95 Mm^3/a) to a total of 150 Mℓ/d (54.75 Mm^3/a).*

Rural areas in the south-western parts of the area of jurisdiction of BCM are supplied by AW from Sandile WTW, which is located in the Keiskamma River catchment, outside the municipal borders of BCM. The total capacity of that plant is 18 Mℓ/d (6.57 Mm^3/a), of which approximately 13 Mℓ/d (4.75 Mm^3/a) is currently supplied to BCM. The supplies to BCM from the Sandile WTW fall outside the scope of this study.

A comparison between the domestic and industrial water requirement scenarios for 2005 and potable water purified in the WTWs of the ABWSS is set out in Tables 4.21 and 4.22. Table 4.21 compares the water requirements and water produced in terms of volumes while the comparison in Table 4.22 is in terms of the percentage of water produced.

Overall the scenarios of domestic and industrial water requirements for 2005 compare favourably with the potable water produced in 2005/2006. The scenarios of water requirements vary from 98% to 117% of the potable water produced.

Also the scenarios of water requirements for domestic and industrial uses in the Lower Buffalo Scheme compare well with the potable water produced, varying from 89% to 107% of the potable water produced.

There is a significant difference, however, in the Upper and Middle Buffalo schemes as well as in the Upper Kubusi Scheme.

In the case of the Upper and Middle Buffalo schemes (which must be considered together), the water requirement scenarios were between 113% and 136% of the potable water produced. The difference can be ascribed to anomalies in the census data regarding the economic/income categories of rural communities, which translate to per capita water requirements that cannot be met with some of the current water supply and distribution systems.

The difference between the water requirement scenarios and the water produced in the Upper Kubusi Scheme is even larger, varying from 243% to 307%.

The differences can be ascribed to three factors, namely:

- anomalies in the census data regarding the economic/income categories in the smaller towns and rural communities. This is particularly the case in Cumakala, Stutterheim, Ngobagu and Kubusi in the Upper Kubusi Scheme. These anomalies could account for more than half of the differences between the water requirement scenarios and the potable water produced;
- the anomalies in the economic/income categories in the census data translate into per capita water requirements which cannot be met through some of the current water supply and distribution systems, particularly in the more rural areas of the ABWSS and
- there might be a water requirement amongst rural communities that is currently not being met.

In the absence of data to make adjustments, the water requirements arising from the census data have been adopted on the understanding that they may be high in respect of rural communities.

4.4 DEVELOPMENTS OUTSIDE THE AREA OF SUPPLY OF THE ABWSS

Developments outside of the current area of supply of the ABWSS are considered as options in this study. The water requirements will be additional to those outlined in previous sections of this chapter.

Currently the only significant water requirements are expected to arise from developments along the coast, coupled with the possibility of supplying rural settlements in the area of jurisdiction of the Amathole District Municipality from extensions to the ABWSS.

Table 4.21 Comparison between Domestic and Industrial Water Requirement Scenarios for 2005 and Potable Water Produced – Volume

Scenario	Upper Buffalo Mm³/a		Middle Buffalo Mm³/a		Lower Buffalo Mm³/a		Upper Kubusi Mm³/a		Total Mm³/a	
	Use	Combined	Use	Combined	Use	Combined	Use	Combined	Use	Combined
Census with High HIV Impact Scenario										
Domestic	4.65		7.44		30.58		2.67		45.34	
Industrial	2.48	7.13	1.23	8.67	10.61	41.19	0.00	2.67	14.32	59.66
Census with Low HIV Impact Scenario										
Domestic	4.74		7.59		31.20		2.72		46.26	
Industrial	2.48	7.22	1.23	8.82	10.61	41.81	0.00	2.72	14.32	60.58
Planning Team's Scenario										
Domestic	4.96		7.94		32.65		2.85		48.41	
Industrial	2.48	7.44	1.23	9.38	10.61	43.26	0.00	2.85	14.32	62.73
Dwelling Count with High HIV Impact Scenario										
Domestic	5.53		8.85		36.40		3.18		53.95	
Industrial	2.48	8.01	1.23	10.08	10.61	47.01	0.00	3.18	14.32	68.27
Dwelling Count with Low HIV Impact Scenario										
Domestic	5.64		9.03		37.13		3.24		55.05	
Industrial	2.48	8.12	1.23	10.26	10.61	47.74	0.00	3.24	14.32	69.37
Dwelling Count with Planning Team's Scenario										
Domestic	5.88		9.40		38.68		3.38		57.34	
Industrial	2.48	8.36	1.23	10.63	10.61	49.29	0.00	3.38	14.32	71.66
Water Produced at WTWs (See note below)		**4.93**		**9.03**		**46.10**		**1.1**		**61.16**

Note: Water Produced in WTWs in 2005:	Upper Buffalo		Middle Buffalo		Lower Buffalo		Upper Kubusi	
	WTWs	Production Mm³/a	WTWs	Production Mm³/a	WTWs	Production Mm³/a	WTWs	Production Mm³/a
	Kei Road	0.11	Laing	8.67	Nahoon	5.95	Stutterheim	1.1
	Rooikrantz	0.44	Needs Camp	0.36	Umzonyana	40.15		
	King Williams Town	4.38						

Table 4.22 Comparison between Domestic and Industrial Water Requirement Scenarios for 2005 and Potable Water Produced – Percentage

Scenario	Upper Buffalo		Middle Buffalo		Lower Buffalo		Upper Kubusi		Total		Upper and Middle Buffalo Combined	
	Volume Required Mm^3/a	% of Water Produced	Volume Required Mm^3/a	% of Water Produced	Volume Required Mm^3/a	% of Water Purified	Volume Required Mm^3/a	% of Water Produced	Volume Required Mm^3/a	% of Water Produced	Volume Required Mm^3/a	% of Water Produced
Census with High HIV Impact Scenario												
Combined Domestic & Industrial	7.13	145%	8.67	96%	41.19	89%	2.67	243%	59.66	98%	15.79	113%
Census with Low HIV Impact Scenario												
Combined Domestic & Industrial	7.22	147%	8.82	98%	41.81	91%	2.72	248%	60.58	99%	16.04	115%
Planning Team's Scenario												
Combined Domestic & Industrial	7.44	151%	9.38	104%	43.26	94%	2.85	259%	62.73	103%	16.82	121%
Dwelling Count with High HIV Impact Scenario												
Combined Domestic & Industrial	8.01	163%	10.08	112%	47.01	102%	3.18	289%	68.27	112%	18.09	130%
Dwelling Count with Low HIV Impact Scenario												
Combined Domestic & Industrial	8.12	165%	10.26	114%	47.74	104%	3.24	295%	69.37	113%	18.38	132%
Dwelling Count with Planning Team's Scenario												
Combined Domestic & Industrial	8.36	170%	10.63	118%	49.29	107%	3.38	307%	71.66	117%	18.99	136%
Water Produced at WTWs	**4.93**		**9.03**		**46.1**		**1.1**		**61.16**		**13.96**	

4.4.1 Coastal Area North East of East London

The Great Kei Local Municipality commissioned a study into the potable water requirements for the coastal area north east of East London up to the Kei River.

The findings of the study, which cover the water requirements up to 2015, are summarised in Table 4.23.

Table 4.23 Great Kei LM's Projected Shortfall in Water Supply – 2015

Centre/ area	Water Require-ments	Supply			Shortfall	Blending	Regional Scheme	TOTAL
	(kℓ/d)	Boreholes/ rainwater supply (kℓ/d)	Dams/ weirs/ springs (kℓ/d)		(kℓ/d)	(kℓ/d)	(kℓ/d)	(kℓ/d)
Komga	1 850	250	1 300		300	Nil		**300**
Mooiplaas	2 580	1 400	Nil		1 180	400		**1 580**
Kwelera	1 600	2 290	Nil		Nil	225		**225**
Kei Mouth, Morgan Bay, Haga Haga	2 760	Nil	2 860		Nil	Nil	700	**700**
Cintsa East, Cintsa West	965	135	400		430			**430**
Private Coastal Resorts	1 260	420	Nil		840	Nil		**840**
TOTAL	**11 015**	**4 495**	**4 560**		**2 750**	**625**	**700**	**4 075**

The estimated water requirement by 2015 in the centres and areas viewed by the Great Kei LM as being of importance for the augmentation of the water supply, together with an allowance to supply neighbouring centres in the vicinity of Kei Mouth is some 11 700 kℓ/d (4.27 Mm^3/a).

Allowing for supplies from groundwater, existing dams and rainwater harvesting, the shortfall is estimated at 2 750 kℓ/d to which must be added 625 kℓ/d for blending to improve the quality of groundwater at Mooiplaas and Kwelera. Taking into account the allowance to supply neighbouring centres/areas in the vicinity of Kei Mouth, the minimum water requirement from an augmentation scheme would be some 4 100 kℓ/d (1.50 Mm^3/a).

Often, local sources of water are less intensively utilized, or not utilized at all, once a bulk water supply scheme is installed. Hence the upper scenario of water requirement has been taken as being the eventuality that all the local sources are replaced by a bulk supply scheme with a capacity of 4.27 Mm^3/a. The lower scenario has as its premise that it will be possible to integrate the local sources of water into a bulk water supply scheme; in which event the water requirement from the bulk scheme would be 1.50 Mm^3/a.

While it should be possible to integrate surface water infrastructure into a regional scheme, it could be more difficult to include dispersed groundwater and rainwater harvesting into the scheme. There is also a tendency for urban centres as well as private coastal resorts to favour the greater assurance of supply provided by a bulk scheme compared with local small installations. Hence an intermediate scenario of water requirement can be taken as the total water requirement (including the allowance to supply neighbouring centres/areas in the vicinity of Kei Mouth) less the supply from surface water sources. In that event, no provision would be required for blending at Mooiplaas and Kwelera. The intermediate scenario would, therefore, require some 7 100 kℓ/d (2.60 Mm^3/a).

The demographic analysis undertaken on behalf of DWAF reflects a growth of 10% in the population of the coastal area over the period 2015 to 2030. The increase in water requirements has been taken as being similar for each of the three water requirement scenarios outlined above.

The demographic analysis does not take into account private coastal resorts/ developments, many of which are holiday homes, which are occupied for only part of the year. Also, the extent of new coastal developments after 2015 is not clear. In the absence of definitive information the assumption is made that for the lower water requirement scenario there will be no coastal developments after 2015. The upper water requirement scenario allows for double the quantity projected to be required by 2015. The intermediate water requirement scenario provides for a 10% increase in the requirement, which corresponds with the demographers' scenario of population growth. The resulting water requirement scenarios are set out in Table 4.24.

Table 4.24 Water Requirement Scenarios for the Coastal Area North East of East London

Scenario	Water Requirement 2015 (Mm^3/a)	Water Requirement for Population Increase (Mm^3/a)	Additional Water Requirement for Private Coastal Resorts/ developments (Mm^3/a)	Water Requirement 2030 (Mm^3/a)
Lower	1.50	0.15	0	1.65
Upper	4.27	0.43	0.46	5.16
Intermediate	2.60	0.26	0.05	2.91

The study undertaken for the Great Kei LM considered various sources of supply for the water and concluded that the most advantageous option would be a connection to the Lower Buffalo Scheme, possibly from the Gonubie reservoirs. The distribution system supplying those reservoirs has inadequate capacity to meet the water requirements and the proposal submitted to the Great Kei LM by its consultants is for a supply to be taken from the Wriggleswade Dam.

4.4.2 Coastal Area South West of East London

BCM commissioned two studies into the potable water requirements of rural settlements on the southern side of the Buffalo River and along the south west coast as far as Kayser's Beach. Further west the rural settlements in BCM are supplied with water from AW's Chafumna WTW while there are no coastal resorts within the BCM municipal area to the west of Kayser's Beach.

Proposals in the two studies are to supply the rural settlements from the Lower Buffalo Scheme, via the bulk supply from the Umzonyana and Nahoon WTWs. The point of supply is the Dam Spot reservoir from where the water will be conveyed past the Needs Camp WTW to consumers.

An option of supplying the water from Laing Dam and the Laing WTW (Middle Buffalo Scheme) was considered in one of the studies, but was found to be less advantagous than the supply from the Lower Buffalo Scheme.

The findings of the studies, which cover the water requirements up to 2015, are summarised in Table 4.25.

Table 4.25 Water Requirements of the Rural Settlements and Coastal Towns in the South Western Coastal Area – 2015

Users	Water Requirement Scenarios - 2015					
	Lower		Upper		Intermediate	
	(Mℓ/d)	(Mm³/a)	(Mℓ/d)	(Mm³/a)	(Mℓ/d)	Mm³/a)
Rural Settlements						
Needs Camp-Ncera/Ward 18 Water Supply	0.86	0.31	3.45	1.26	2.07	0.76
BCM Coastal Areas	0.26	0.10	1.05	0.38	0.63	0.23
New Developments						
Needs Camp / Kuni / Thorn Park	1.80	0.66	3.60	1.31	2.16	0.79
Total Rural Settlements and New Developments	**2.92**	**1.07**	**8.10**	**2.95**	**4.86**	**1.78**
Coastal Towns/Resorts						
Kayser's Beach / Kayser's Beach	0.51	0.19	0.53	0.19	0.52	0.19

Users	Water Requirement Scenarios - 2015					
	Lower		Upper		Intermediate	
	(Mℓ/d)	(Mm³/a)	(Mℓ/d)	(Mm³/a)	(Mℓ/d)	Mm³/a)
Township						
Erf 679 Kayser's Beach	0.02	0.01	0.02	0.01	0.02	0.01
Kidd's Beach / Oceanview A	0.33	0.12	0.39	0.14	0.36	0.13
Seavale	0.27	0.10	0.28	0.10	0.28	0.10
Christmas Rock	0.21	0.08	0.27	0.10	0.24	0.09
Cozi Corner	0.22	0.08	0.22	0.08	0.22	0.08
Palm Springs Resort / Penellen	0.03	0.01	0.04	0.01	0.03	0.01
Chalumna Estates Cottages	0.01	0.00	0.03	0.01	0.02	0.01
Low Cost Housing	0.00	0.00	0.03	0.01	0.01	0.00
Total Coastal Towns / Resorts	**1.60**	**0.59**	**1.81**	**0.65**	**1.70**	**0.62**
TOTAL	**4.52**	**1.66**	**9.91**	**3.60**	**6.56**	**2.40**

Note:

Source of data: Ninham Shand, December 2004 : Buffalo City Municipality, Bulk Supply to Needs Camp / Ncera System and Ward 16 Water Supply – Feasibility Study, Report No 3807/400563

and

FST, February 2005 : Buffalo City Municipality, BCM Coastal Areas Bulk Water Supply, Municipal Infrastructure Grant, Business Plan, Technical Report.

The scenarios for the water requirement at 2015 vary from 4.52 Mℓ/d (1.66 Mm³/a) to 9.91 Mℓ/d (3.60 Mm³/a). The intermediate scenario is 6.56 Mℓ/d (2.40 Mm³/a).

The scenarios do not take into account the use of groundwater or rainwater harvesting which could reduce the water requirements. The premise in the proposals prepared for BCM is that local sources of supply will not be integrated into the bulk water supply for the south western coastal area.

The intention of the augmentation of supplies is to strengthen and expand the current limited Needs Camp / Ncera supply and could result in the small Needs Camp WTW (with a capacity of 0.29 Mm³/a) as well of the supply from the Laing Dam, via Berlin/Potsdam, being replaced by a larger supply from the Umzonyana and Nahoon WTWs.

The demographic analysis undertaken on behalf of DWAF reflected a growth of 10% in the population of the coastal area over the period 2015 to 2030. One of the studies conducted on behalf of BCM assumed that the population would not increase above the level recorded in the 2001 census, while the other study assumed a 2.5% pa increase in population between 2004 and 2015. Consequently, the increase in water requirements over the period 2015 and 2030 has been taken as 0% for the Lower Scenario, 10% for the Intermediate Scenario and 45% in respect of the Upper Scenario.

Neither the demographic analysis nor the studies undertaken for BCM takes into account the longer-term growth of private coastal resorts/developments. Also, the extent of new coastal developments after 2015 is not clear. In the absence of definitive information the assumption is made that the growth of private coastal developments will mirror the population growth scenarios adopted for the rural settlements, namely 0% for the Lower Scenario, 10% for the Intermediate Scenario and 45% for the Upper Scenario.

The resulting water requirement scenarios are set out in Table 4.26.

Table 4.26 Water Requirement Scenarios for the Coastal Area South West of East London

Scenario	Water Requirement 2015 (Mm^3/a)	Water Requirement for Population Increase After 2015 (Mm^3/a)	Additional Water Requirement for Coastal Resorts/Developments (Mm^3/a)	Water Requirements 2030 (Mm^3/a)
Lower	1.66	0	0	1.66
Upper	3.60	1.33	0.30	5.23
Intermediate	2.40	0.18	0.06	2.64

4.4.3 Amahlati South Water Scheme

The Amahlati LM commissioned an investigation into the supply of water to various settlements in the area between Stutterheim, Kei Road and Bhisho, known as the Amahlati South Water Scheme. The scheme covers the area between the Upper Buffalo Scheme and the Upper Kubusi Scheme, but overlaps into the Upper Buffalo Scheme in respect of urban and rural settlements supplied from the Rooikrantz and Kei Road WTWs.

The proposals emanating from the investigation in essence link some of the areas supplied from the Rooikrantz WTW with the area supplied by the Kei Road WTW.

The areas, which currently fall outside of the ABWSS and which will be incorporated into the ABWSS when the Amahlati South Water Scheme is implemented, together with the population for which water is to be provided, are set out in Table 4.27.

Table 4.27 Communities in the Amahlati South Water Scheme which are not Currently Supplied from the ABWSS

Communities	Hokwana	Izeleni	Mxhalanga	Peelton Villages	Motel Park	Amabele/ Nonkululeko	TOTAL
Population	650	1 960	2 970	4 600	3 820	8 850	**22 850**

The communities are all rural and the projections in the investigation make provision for a potable water requirement of 25 ℓ/c/d. However, the criteria used in this study allow for 60 ℓ/c/d for rural (traditional) communities.

Consequently the lower water requirement scenario allows for 25 ℓ/c/d and the upper scenario provides for 60 ℓ/c/d.

The free basic water of 6 kilolitre per month (kℓ/m) per household equates to some 50 ℓ/c/d. Households are tending to demand that quantity as the minimum to which they are entitled. Hence 50 ℓ/c/d has been adopted as the intermediate water requirement scenario.

Based on the foregoing, the water requirement scenarios adopted for this study are as set out in Table 4.28.

Table 4.28 Water Requirement Scenarios for the Amahlati South Water Scheme in Respect of Areas not Currently in the ABWSS

Scenario	Water Requirement (kℓ/d)	Water Requirement (Mm^3/a)
Lower	570	0.21
Upper	1370	0.50
Intermediate	1140	0.42

The Amahlati South Water Scheme is in the process of being implemented and the water requirement scenarios have been assumed to take effect progressively from 2007 to 2010.

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Reconciliation Options (Options)

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5 RECONCILIATION OPTIONS (OPTIONS)

5.1 WATER CONSERVATION AND WATER DEMAND MANAGEMENT (WC/WDM)

5.1.1 Urban and Rural Use (Domestic)

WC/WDM strategy and implementation plans are presently being addressed by BCM through an internal report. Meanwhile, BCM is focusing on four aspects, namely:

- the installation of domestic water meters, particularly for those households which pay a flat monthly rate for water (referred to as the "deemed-to-use" households);
- pressure reduction in water reticulation networks;
- the installation of area meters in order to monitor water-use and to take corrective measures where necessary and
- development of a management information system to enhance management information presently available.

At individual consumer level there is a backlog of 17 000 existing erven for which water meters need to be installed to convert the "deemed-to-use" households to metered households which receive monthly accounts for the quantity of water used. To date, some 4 000 meters have been installed. These meters were donated to the Municipality by the Peoples' Republic of China. The intention is to eliminate the backlog over the next 4 years.

Running concurrently with this is an initiative to meter all new erven (mainly subsidy houses) and projects are underway at present to install more than 7 000 water meters.

BCM has undertaken a succession of pilot studies to try to quantify and forecast potential reductions in water use as well as in water losses. In a recent study conducted amongst the "deemed-to-use" households in Duncan Village (Gompo) meters were installed at 61 households. Fifty percent of the households used more than 20 kℓ/month and one used 240 kℓ/month.

Officials of BCM are of the view that a reduction of 20 to 35 kℓ/household/month is attainable through the installation of meters and the collection of water use charges from those metered households. This would amount to between 5 Mm^3/a and 8.8 Mm^3/a for the 21 000 "deemed-to-use" households.

The installation of the meters needs to be accompanied by enhancements to BCM's capacity to read the meters as well as to invoice consumers and to ensure payment.

Much work needs to be done in this respect. BCM's ability to achieve the potential reduction in water use is very dependent upon the institutional and management arrangements that are in place.

Pressure reducing valves have been installed in Duncan Village, but due to operational difficulties there have been network failures. Good progress has been made in parts of Mdantsane, however, where reductions which could amount to some 10 Mℓ/day (3.65 Mm^3/a) for Mdantsane as a whole have been achieved. Officials of BCM are of the view that some 15 Mℓ/d (5.5 Mm^3/a) could be saved through pressure reduction measures.

Area bulk meters are being installed to enable losses in particular wards to be quantified, isolated and repaired. A management information system (MIS) is being developed to facilitate corrective measures which would reduce water loss.

In March 2006 AW reintroduced a monthly consumption balance/analysis in which the consumptions of major consumers are reviewed. AW has a programme of ongoing monitoring of water allocations and losses together with zone metering. Similarly there is recovery of process water at the WTW at Nahoon Dam. In rural situations one of the more significant aspects leading to more water being used than the WSAs envisage is illegal connections. The elimination of illegal connections is being addressed, but not as a key priority.

Presently the officials of AW do not have further plans for WC and WDM measures other then to exercise vigilance through their MIS and to take remedial measures where necessary.

5.1.2 Urban use (industrial)

With the reductions in the textile industry, the consolidation of the Da Gama Textiles water intensive operation to their Zwelitsha facilities, and the closing by SAB of their bottling plant, there are very few water intensive industries served by the ABWSS.

A water recycling plant is being constructed at the Da Gama Textiles' Zwelitsha factory to eliminate the need for additional raw water from the ABWSS.

Water supplies to individual consumers are metered, while area meters have been installed and correlation is sought with individual meters. Exception reports are prepared for the larger consumers. Data on industrial water use will be included in the enhanced MIS to give a holistic picture of BCM's water services. No further WC or WDM measures are proposed at this time by the WSAs for industrial consumers.

5.1.3 Irrigation

There is very little irrigation demand out of the ABWSS. No specific releases are made from Rooikrantz Dam, while releases are made from the Nahoon and Gubu dams for irrigation during periods of drought. The farmers normally abstract from surplus flow in the rivers. Releases of 3 Mm^3/a, less overflows, are made from the Wriggleswade Dam to meet the needs of the scheduled irrigation areas along the Kubusi River. No irrigation releases are made by BCM from the Bridle Drift and Maden dams.

At this time there are no structured WC or WDM measures in place for irrigation water. None are planned by the Kubusi Irrigation Board, or by irrigators along the Gubu, Kubusi, Buffalo and Nahoon rivers.

5.1.4 WC/WDM interventions

Interventions for WC and WDM cover matters related to unnecessary or excessive use of water, the physical infrastructure, the management (institutional arrangements) relating to the day-to-day operation of the water and sanitation services as well as behavioural changes on the part of water managers and consumers.

BCM and AW have WC and WDM interventions in hand as outlined earlier in this chapter. At the Information Verification Meeting, the Planning Team was authorised by the stakeholders to propose WC and WDM interventions which could be adopted as options. This was done and the suggestions were considered and accepted at the Steering Committee meeting on 29 August 2006. At the same meeting members suggested further interventions, while allowances for losses as well as possible interventions to reduce the losses were discussed in three parts, namely:

- reticulation losses;
- losses in conveyance from WTWs to points of supply of reticulations in WSAs and
- losses in conveyance of water from dams to points of abstraction of raw water and treatment at WTWs.

The extent of losses for reticulations and conveyance from WTWs (downstream of WTWs) is generally measured as a percentage of water treated at WTWs, while the losses upstream of WTWs is generally measured as a percentage of raw water made available for treatment. In the case of the ABWSS this would apply to yields of the dams.

In line with this convention, interventions for the ABWSS are divided into the following categories:

- water use reduction, by consumers;
- water loss in reticulations as well as in conveyance systems from WTWs to reticulations (water loss downstream of WTWs) and
- water loss in conveyance from the dams to the WTWs and through the WTWs.

For completeness the interventions that are in hand are included with those interventions that are proposed. The interventions, together with an indication of possible savings in the use of water for lower, upper and intermediate scenarios are shown in Table 5.1.

Table 5.1 Interventions and Possible Savings in Water Use and Water Loss

Intervention	Reason/Benefit	Lower Mm^3/a	Upper Mm^3/a	Intermediate Mm^3/a	Status	Responsible Stakeholder
Domestic and Industrial						
1. Water Use Reduction						
Installation of water meters at "deemed-to-use" households	Due to 21 000 households paying a flat rate for water irrespective of the quantity used, water is not used sparingly. A reduction of 20 kℓ to 35 kℓ per household per month is possible.	5	8	6	In hand	BCM
Annual water audit	Needs to be implemented in order to monitor progress towards achieving water use and water loss reduction targets as well as to enable corrective measures to be taken.	Needed to achieve the water use and water loss reductions	Needed to achieve the water use and water loss reductions	Needed to achieve the water use and water loss reductions	Proposed	WSAs
Enhancement of effective meter reading, billing and debtor control	Billing and debtor control – needs enhancement without which the physical provision of water meters will not have the desired results with respect to water use reduction.	Needed to achieve the water requirement allowances	Needed to achieve the water requirement allowances	Needed to achieve the water requirement allowances	Proposed	WSAs
Enhancements to the current water use education programmes	Required to inform consumers and public body decision makers of the position regarding the water resources available in the ABWSS, as well as to encourage behavioural change with respect to water use efficiency.	Needed to achieve the water requirement allowances	Needed to achieve the water requirement allowances	Needed to achieve the water requirement allowances	Proposed	WSAs
Structured response in respect of default in water payment or excessive use	Required to reinforce behavioural changes by consumers and managers. The interventions could include flow reduction devices being installed in connections to consumers using excessively high volumes of water or who default on payment so as to limit flow to the level of the free basic water allocation.	Needed to achieve the water requirement allowances	Needed to achieve the water requirement allowances	Needed to achieve the water requirement allowances	Proposed	WSAs

Intervention	Reason/Benefit	Lower Mm³/a	Upper Mm³/a	Intermediate Mm³/a	Status	Responsible Stakeholder
Support to private and public bodies to maintain water use installations	A "working for water" type intervention to improve and maintain public as well as private water use fittings especially for households registered as being "indigent".	Needed to achieve the water requirement allowances	Needed to achieve the water requirement allowances	Needed to achieve the water requirement allowances	Proposed	WSAs
Amendment to the current consumer tariff structure	Amend the current consumer tariff structure if such amendments are necessary/beneficial, particularly to promote WC/WDM interventions for large consumers.	Needed to achieve the water requirement allowances	Needed to achieve the water requirement allowances	Needed to achieve the water requirement allowances	Proposed	WSAs
Use of "pour-flush" or other water efficient type sanitation systems in place of free-flush systems	Introduce "pour-flush" or other low water use toilet systems in place of free-flush waterborne sanitation systems in order to limit water requirements, particularly for households registered as "indigent".	1	2	1	Proposed	WSAs
Attend to water wastage at public facilities	Refurbish, repair and maintain water use installations at public facilities, particularly those owned and operated by the municipalities.	1	2	1	Proposed	WSAs
Total Possible Water Use Reduction		7	12	8		

Intervention	Reason/Benefit	Lower Mm³/a	Upper Mm³/a	Intermediate Mm³/a	Status	Responsible Stakeholder
2. Water Loss Downstream of WTWs						
Installation of area meters	Required to correlate user meters with supply to determine reticulation/conveyance losses.	1	2	1	In hand	BCM
Reduce pressures in reticulations during off-peak periods	Pressure reduction during off-peak periods reduces losses in the reticulation and through water use fittings.	3	5	4	In hand	BCM
Apply a management information system (MIS)	Required to track performance, to enable informed decisions to be taken and for the results of corrective measures to be monitored.	Needed to achieve the water use and water loss reduction	Needed to achieve the water use and water loss reduction	Needed to achieve the water use and water	In hand	WSAs

Intervention	Reason/Benefit	Lower Mm³/a	Upper Mm³/a	Intermediate Mm³/a	Status	Responsible Stakeholder
				loss reduction		
Water infrastructure asset management	Partly considered by the interventions outlined above, but requires a structured approach in accordance with best-practice manuals recently introduced into South Africa to reduce conveyance and distribution losses.	2	4	3	Proposed	WSAs
Improve the monitoring of the quality of construction of water installations	Enhance the capacity of public bodies to monitor the quality of construction of water use and water conveyance/reticulation installations.	1	2	1	Proposed	WSAs
Total Possible Reduction in Water Loss in Reticulations and during Conveyance from WTWs to Reticulations		7	13	9		

Intervention	Reason/Benefit	Lower Mm³/a	Upper Mm³/a	Intermediate Mm³/a	Status	Responsible Stakeholder
3. Water Loss at WTWs and Upstream						
Recovery of process water at Nahoon WTW	Reduce the quantity of raw water that needs to be supplied from the dams.	1	1	1	In hand	AW
Recovery of process water at WTWs	Extension of the water conservation measures used at the Nahoon WTW to the other 7 WTWs. (Stutterheim's WTWs being taken as an entity)	1	2	1	Proposed	AW WSAs
Reduction in abstraction losses	Improve the method, where appropriate, of conveying water from dams to the abstraction works at WTWs, particularly in respect of the Umzonyana WTW and the WTWs producing water for Stutterheim.	1	2	1	Proposed	AW WSAs
Total possible reduction in water loss in conveyance from dams to WTWs and through WTWs		3	5	3		

The possible water use reduction is compared in Table 5.2 to the quantity of water purified in 2005, namely 61.16 Mm³/a.

Table 5.2 Comparison between Possible Water Use Reduction and Current Water Purified

Water Users	Possible Reduction in Water Use		
	Lower %	Upper %	Intermediate %
Domestic and Industrial	10	20	13

The possible reduction in losses is compared in Table 5.3 with the percentage losses adopted when determining the domestic and industrial water requirements (referred to here as the "Estimated Current Losses") in Chapter 4. The values are based on the quantity of potable water produced in 2005 namely 61.16 Mm³/a.

Table 5.3 Comparison between the Estimated Current Losses and Possible Reductions in Water Losses

Component of System	Estimated Current Loss %*	Possible Reduction in Loss		
		Lower %*	Upper %*	Intermediate %*
Reticulation	15 to 20	8	22	15
Conveyance from WTWs to reticulation	4 to 6	Included above	Included above	Included above
Conveyance from dams to WTWs and at WTW	4 to 16	0	8	5
Total	**23 to 42**	**8**	**30**	**20**

*% = Percentage of water purified in 2005, namely 61.16 Mm³/a.

The lower scenario would reduce the estimated losses to between 15% and 34% of potable water produced. The upper scenario would result in the losses being reduced to between 0% and 12% of potable water produced. This would equate to a very well-run water supply system. The intermediate scenario would result in losses of 3% to 22% of the potable water purified, which is realistic.

The potential for the possible reduction in water use and losses is expected to be distributed amongst the schemes approximately as set out in Table 5.4

Table 5.4 Approximate Distribution of Possible Reduction in Water Use and Losses amongst the Schemes

Scheme	Percentage of Possible Reduction in Use/Losses		
	Water Use Reduction	Reticulation and Conveyance (WTW to Users)	Conveyance from Dams to WTWs and in WTWs
Upper Buffalo	20	10	5
Middle Buffalo	10	15	10

Scheme	Percentage of Possible Reduction in Use/Losses		
	Water Use Reduction	Reticulation and Conveyance (WTW to Users)	Conveyance from Dams to WTWs and in WTWs
Lower Buffalo	65	70	80
Upper and Middle Kubusi	5	5	5
Total	**100**	**100**	**100**

The estimated costs and timelines to implement the interventions are set out in Table 5.5.

Table 5.5 Estimated Costs and Timelines

	Estimated Cost (RM)	Timeline Years
Water metering at "deemed-to-use households" – the costs of providing individual meters for the "deemed-to-use" households are being subsidized by the donation of meters and a loan from ABSA Bank for the installation, as this is a revenue generating service. The estimated cost per household, which must be borne by BCM, is R250 per household for each of the 21 000 "deemed-to-use" households.	5	5
Annual water audit – a combined audit covering the WSAs and WSPs would be beneficial to monitor the actual use of water. The quantity abstracted from source, that available for treatment, that supplied to the WSAs and that used in the distribution network is necessary as part of the monitoring of this strategy. The work can be done by in-house staff or by PSPs, in which event the estimated, present day cost of undertaking the work is R1,5 million/annum.	1.5/a	1
Comprehensive and effective metering, reading, billing and debt control - while metering, reading, billing and debt control are practiced by the WSPs and WSAs, the additional meters are likely to require additional staff for the financial, administrative and technical management of the meters. It is expected that 5 additional people should be adequate with vehicles and equipment at an estimated present day cost of R0.4 million/person/year on average.	2.5/a	1
Enhancements to the current water use education programme – while work is currently being undertaken amongst communities and decision makers, it would be prudent to strengthen the activities in the light of the strategy and options being applied by the WSAs, and the measures to be taken in terms of this strategy to reconcile the availability of water with the requirements for water. The actual needs are not clear at this time, but 10 additional suitably trained staff, each with a vehicle and suitable equipment, will probably be necessary in the area covered by the ABWSS. The present day total cost per person is expected to be around R 0.4 million / annum.	4.0/a	1

	Estimated Cost (RM)	Timeline Years
Structured response in respect of defaults in water payment or excessive use of water – the existing staff should be able to handle this work, as it should form an integral part of their duties. Also, the additional staff proposed above for the infrastructure asset management should be adequate to handle the installation of flow restrictors. Hence, no additional costs are expected to be necessary for this intervention.	0	1
Support to private and public bodies to maintain water use installations – this intervention should be at the expense of individual consumers. To this end it would be beneficial to have people available to review records, to inspect installations and to advise consumers on how to go about maintaining their water use installations (water and sanitation). The service is particularly necessary, however, for households which have been registered as being "indigent" and which would be unable to pay for the use of water in excess of the free basic supply let alone for a support service. Upwards of 10% of the households are expected to fall within this category. Leaks and water wastage through faulty fittings should be corrected by the WSA's staff for these households. Two suitably trained and equipped persons per scheme (ie 10 people) each with a vehicle and suitable equipment, will probably be necessary. The present day total cost per person is expected to be around R 0.3 million/annum. **Amendment to the current consumer tariff structure –** water use related to the current stepped-tariff structure for domestic and industrial users should be monitored. Water use and tariffs should be benchmarked against similar uses elsewhere and remedial measures with respect to tariff adjustments implemented where necessary. The work should be part of the duties of existing staff and no additional costs should be necessary. **Use of "pour-flush" type sanitation system in place of free-flush waterborne systems –** acceptability of pour-flush or other types of water efficient sanitation systems should form part of the normal process of housing and sanitation improvement programmes. No additional staff or costs should be necessary to apply the principle. Education of decision makers and communities should be handled as part of the enhanced water use education as well as through the housing and sanitation improvement programmes. **Attend to water wastage at public facilities –** the people appointed to assist private and public bodies to maintain water use installations should be able to look after the public facilities once they have been refurbished or repaired. The cost of refurbishment and repair is uncertain at this time, but could be of the order of R10 million. **Area meters** - Zonal meters depend upon the number of zones and sizes of meters, which are yet to be determined. Present indications are that some R 5 million would be required.	3.0/a 0 0 10.0 5.0	1 1 1 1 3

	Estimated Cost (RM)	Timeline Years
Pressure reduction – a PSP has developed a system, whereby remuneration to the PSP is based upon a proportion of the saving in cost to a municipality as a result of less leakage, which is attributable to the lower pressures. The PSP has not shown particular interest in the reticulation networks supplied from the ABWSS. Detail cost estimates have not been prepared, but from experience elsewhere a reasonable capital sum would be equivalent to the value of the water saved over a period of about 2 years. That being the case in the ABWSS, the capital cost would probably be between R9 million and R18 million, with R12 million being a reasonable sum.	12.0	4
MIS – the MIS is being prepared in-house. There might be a need to engage the services of a PSP, the extent of whose services is not clear at this time. An allowance, however, of some R1 million should be suitable.	1.0	4
Water infrastructure asset management – while this work should form part of the day-to-day operations of the water services, it will require additional staff, vehicles and equipment. The actual needs are not clear at this time, but 10 additional suitably trained people each with a vehicle and with some equipment will probably be necessary in the area covered by the ABWSS. The average present day total cost per person is expected to be around R0.5 million/annum.	5.0/a	1
Improve the monitoring of the quality of construction of water use installations – there would be benefit in strengthening the building inspectorate and in ensuring adequate site supervision when water use installations are designed and constructed by both the private and public sectors. The site supervision and design are generally part of the capital costs, while it would be beneficial for an additional 2 inspectors per scheme on average (10 people) to be appointed with the necessary vehicles and equipment to monitor quality. The average present day cost is expected to be around R0.3 million per person per annum.	3.0/a	1
Recovery of process water at WTWs – While the recovery of process water is practiced at the Nahoon WTW, similar measures should be adopted at the other 7 WTWs (Stutterheim's WTWs being taken as an entity) as well as the proposed extensions to the Kei Road and Umzonyana WTWs. The costs will vary according to the nature and capacity of the works, but on average R1.5 million per WTW is considered realistic	10.5	1

	Estimated Cost (RM)	Timeline Years
Reduction in abstraction losses – the need for and or practicality of improving the methods of conveyance of water from dams to WTWs should be ascertained as a first step. The work might have to be delayed pending verification of the accuracy of methods of measuring releases from dams and abstractions at WTWs. A PSP would be the best means of determining the most favourable changes at an estimated cost of R1 million.	1.0	1
The cost of improved conveyance will depend upon the findings of the investigation, but could be of the order of R50 million.	50.0	5

All of the options for intervention should be part of the normal operation of a water and a sewerage system.

5.2 WASTEWATER USE

5.2.1 Availability of Wastewater for Use

The capacities of the WWTWs in the area of supply of the ABWSS and the quantities of wastewater which were treated in 2005 are summarised in Table 5.6.

Table 5.6 Capacities of the WWTWs and Wastewater Treated in the Study Area (2005)

Wastewater Treatment Works	Capacity (Mℓ/d)	Capacity (Mm³/a)	Quantity Treated 2005 (Mℓ/d)	Quantity Treated 2005 (Mm³/a)	Scheme	River into which Treated Effluent is Discharged
Schornville	5.0	1.82	4.8	1.75	Upper Buffalo	Buffalo
Zwelitsha	9.2	3.36	7.5	2.73	Upper Buffalo	Buffalo
Berlin	0.5	0.18	0.1	0.04	Middle Buffalo	Nahoon
Breidbach Ponds	0.8	0.29	>0.8	>0.29	Middle Buffalo	Yellowwoods/Buffalo
Bhisho Ponds	0.8	0.29	2.5	0.91	Middle Buffalo	Yellowwoods/Buffalo
Potsdam/ Mdantsane West	9.2	3.36	5.5	2.00	Serves the Middle Buffalo – discharges to the Lower Buffalo	Buffalo
Mdantsane East	18.0	6.57	13.0	4.74	Lower Buffalo	Buffalo
Reeston	2.5	0.91	0	0	Lower Buffalo	Buffalo
Amalinda Central	5.0	1.82	5.0	1.82	Lower Buffalo	Buffalo

Wastewater Treatment Works	Capacity (Mℓ/d)	Capacity (Mm^3/a)	Quantity Treated 2005 (Mℓ/d)	Quantity Treated 2005 (Mm^3/a)	Scheme	River into which Treated Effluent is Discharged
West Bank (Hood Point) (Screens)	12.0	4.41	10.0	3.65	Lower Buffalo	Sea
East Bank/Nahoon	40.0	14.60	33.0	12.04	Lower Buffalo	Sea
Quinera (Gonubie)	9.0	3.28	5.5	2.00	Lower Buffalo	Sea
Stutterheim			1.6	0.60	Upper Kubusi	Kubusi
Total	**112.0**	**40.89**	**89.3**	**32.57**		

1. The old works at Mdantsane East is being recommissioned to increase the capacity to 24 Mℓ/d (8.76 Mm^3/a).
2. Plans are well advanced to extend the Reeston WWTW to 20 Mℓ/d (7.3 Mm^3/a) to cater for 5 Mℓ/d (1.82 Mm^3/a) from Reeston, diversion from the Central Works and the development of the Arnoldton Node. The consultants preparing the EIA have been instructed to undertake the EIA for a regional works of up to 80 Mℓ/d (29.2 Mm^3/a).
3. A further 2 Mℓ/d (0.73 Mm^3/a) of mixed liquid with suspended solids from the East Bank WWTW is discharged to sea via the West Bank sea outfall.
4. Planning is in hand to increase the capacity of the Quinera (Gonubie) WWTW to 18 Mℓ/d (6.57 Mm^3/a), with the treated wastewater being discharged to the sea off Eastward-Ho.

The WC and WDM interventions consist primarily of providing domestic water meters for the “deemed-to-use” households as well as for new dwellings together with area meters for reticulation systems, pressure reduction in water distribution networks, improved management and recovery of process water at WTWs. The interventions have been grouped into those which reduce the use of water and into those which should lead to reduced losses in the abstraction, conveyance, distribution and reticulation systems. The water use reduction interventions are expected to have a direct impact on the volume of wastewater treated at the WWTWs. The water loss reductions might or might not impact upon the wastewater that is generated. Consequently, only the possible reduction in water use is taken into account when considering the possible reductions in wastewater, which is treated.

The possible reduction in water use is expected to be the result of less water being used by the “deemed-to-use” households, use of “pour-flush” or similar water-efficient toilets and less wastage of water at public facilities. The reduction due to all three interventions should pass in full or virtually in full, to the amount of water which needs to be treated at the WWTWs. Hence, the reduction in wastewater is taken as being equal to the water-use reduction.

The current (2005) availability of treated wastewater for use after allowance for the possible impact of WC and WDM interventions is summarised in Table 5.7. The detailed calculations are shown in Appendix 5.1.

Table 5.7 Treated Wastewater Available for Use after Allowance for Water Use Reduction

Scheme	Quantity of Wastewater Treated 2005	Possible reduction due to WC/WDM			Wastewater potentially available for use		
	Mm³/a	Lower Scenario Mm³/a	Upper Scenario Mm³/a	Intermediate Scenario Mm³/a	Lower WC/WDM Scenario Mm³/a	Upper WC/WDM Scenario Mm³/a	Intermediate WC/WDM Scenario Mm³/a
Upper Buffalo	4.48	1.2	2.4	1.6	3.3	2.1	2.9
Middle Buffalo	1.24	0.0	0.0	0.0	1.2	1.2	1.2
Lower Buffalo - Buffalo River - Nahoon River - Sea	 8.56 0 17.69	 2.3 0 2.5	 4.5 0 5.1	 3.1 0 3.3	 6.3 0 15.2	 4.0 0 12.6	 5.6 0 14.4
Upper Kubusi	0.60	0	0	0	0.6	0.6	0.6
Middle Kubusi	0	0	0	0	0	0	0
Total	**32.57**	**6.0**	**12.0**	**8.0**	**26.5**	**20.5**	**24.5**

Taking into account the potential impacts of WC and WDM interventions, some 24 Mm^3/a of wastewater could be available for use after treatment, with the lower and upper availability scenarios being 26 Mm³/a and 20 Mm³/a respectively.

Additional flows generated from WWTWs in each of the supply areas should be available for use. Treated wastewater available for use will depend upon the domestic and industrial requirements, the level of water and sanitation services made available to users of water and the effectiveness of water management applied by the WSAs.

Water treated at WWTWs in 2005 represented some 54% of the potable water produced at the WTWs of the ABWSS. After allowing for the reductions in flow to WWTWs as a result of WC and WDM interventions, the proportion of wastewater treated to potable water produced reduces to around 40%. The calculations are shown in Appendix 5.1.

Consequently scenarios for increase (or decrease) in the amount of water which would be available for use as a result of changes in the water requirements should be taken as 40% for the lower scenario and 50% for the upper scenario.

In considering scenarios, the flows from the Upper and Middle Buffalo should be taken together, due to the transfer of water from the Middle to the Upper Buffalo as well as due to the probable transfer of water into the Upper and Middle Buffalo from sources outside of the Buffalo River catchment, such as from the Wriggleswade Dam.

5.2.2 Existing and Planned Use of Wastewater

Currently wastewater is used in three ways, namely:

- recycling of wastewater by Da Gama Textiles at Zwelitsha;
- irrigation of East London, Gonubie and King William's Town golf courses and
- supply to two farmers.

The use of wastewater by Da Gama textiles at Zwelitsha is by means of treatment on the site of the plant and recirculation within the plant. This process results in a reduction in water requirements for the plant.

Some 0.3 Mℓ/d (0.1 Mm^3/a) of treated wastewater is supplied from the East Bank WWTW to the East London golf course while some 0.4 Mℓ/d (0.14 Mm^3/a) of treated wastewater as supplied from the Quinera (Gonubie) WWTW to the Gonubie golf course as well as to the two farmers. Some 0.2 Mℓ/d (0.07 Mm^3/a) of treated wastewater is supplied from the Schornville and Zwelitsha WWTWs for King William's Town's golf course.

Two interventions are planned for the use of wastewater, namely:

- supply of treated wastewater for the IDZ starting at 4 Mℓ/d (1.5 Mm^3/a) and possibly reaching 20 Mℓ/d (7.3 Mm^3/a) and
- irrigation of the Gonubie Eco Golf Course requiring some 1.5 Mℓ/d (0.5 Mm^3/a).

BCM has recently reviewed the rate at which the IDZ is expected to develop and has concluded that the tempo is likely to be slower than originally anticipated. Consequently at the Steering Committee Meeting on 29 August 2006, it was agreed to adopt lower scenarios for water requirements. The scenarios were reviewed during the preparation of this study and the following requirements for treated wastewater have been adopted:

- lower scenario : 10% of the estimated treated wastewater requirement for the full development;

- upper scenario : 50% of the estimated treated wastewater requirement for the full development and
- intermediate scenario : 30% of the estimated treated wastewater requirement for the full development.

As the need for the treated wastewater and the rate at which the requirement will increase is uncertain, it is assumed that the growth in the requirement will be linear over the period 2010 to 2030.

The requirement by 2030 is taken, therefore, as follows:

- lower scenario : 2 Mℓ/d (0.7 Mm^3/a);
- upper scenario : 10 Mℓ/d (3.7 Mm^3/a) and
- intermediate scenario : 6 Mℓ/d (2.2 Mm^3/a).

Currently the proposal is to supply the IDZ from the East Bank WWTW and the Gonubie Eco Golf Course from the Quinera (Gonubie) WWTW.

Both of the projects are at an early stage. Preliminary work has been done to establish the feasibility of pumping treated effluent from the East Bank WWTW, over the Buffalo River, to the IDZ. The route is difficult and long.

An alternative is to enhance the treatment at the West Bank outfall, to meet the requirements of the IDZ. Currently some 3.6 Mm^3/a is being discharged to sea through the outfall, which would be sufficient for at least the initial and medium-term needs of the IDZ. Thereafter, treated wastewater could be provided from the augmented Reeston WWTW or from the East Bank WWTW.

More than 50% of the wastewater generated in the area of supply of the ABWSS is discharged to sea through the West Bank outfall and from the East Bank as well as from the Quinera (Gonubie) WWTWs.

Even allowing for the requirements of existing users of treated wastewater and for the expected needs of the IDZ, up to 10 Mm^3/a of treated wastewater could be available from the wastewater being discharged to the sea for use for domestic and possibly for irrigation purposes. The wastewater could be treated to potable standard by means of desalination, or conventional water purification methods, which would be less expensive than desalinating seawater.

In the case of the West Bank WWTW, a plant would need to be constructed to produce treated wastewater of a suitable quality for further purification to industrial or possibly to domestic quality.

Table 5.8 Wastewater and Potential Wastewater Use Options, Costs, Timelines and Potential Quantities for Use

Scheme	Wastewater Treatment Works	Use Options	Potential Wastewater Use (Lower Scenario) Mm^3/a)	Potential Wastewater Use (Upper Scenario) (Mm^3/a)	Potential Wastewater Use (Intermediate Scenario) (Mm^3/a)	Estimated Cost (R million per Mm^3)	Timeline Years	Status	Responsible Stakeholder
Upper Buffalo	Schornville and Zwelitsha	King William's Town Golf Course	0.1	0.1	0.1	0	0	Existing	BCM
		Return flow to enhance yields of dams	3.2	2.0	2.8	0.5	0	Existing	
		Domestic	2.2	1.4	1.9	2.0	4	Possible	
		Irrigation	2.9	1.8	2.5	1.0	4	Possible	
Middle Buffalo	Breidbach (Ponds)	Return flow to enhance yields of dams	0.3	0.3	0.3	0.5	0	Existing	BCM
		Domestic	0.2	0.2	0.2	3.0	4	Possible	
		Irrigation	0.3	0.3	0.3	1.0	4	Possible	
	Bhisho (Ponds)	Return flow to enhance yields of dams	0.9	0.9	0.9	0.5	0	Existing	BCM
		Domestic	0.6	0.6	0.6	4.0	4	Possible	
		Irrigation	0.8	0.8	0.8	1.0	4	Possible	
Lower Buffalo	Potsdam and Mdantsane West	Return flow to contribute to EWR	1.4	0.8	1.2	0.5	0	Possible	BCM
		Domestic	1.0	0.6	0.8	2.0	4	Possible	
		Irrigation	1.3	0.7	1.1	1.0	4	Possible	

Scheme	Wastewater Treatment Works	Use Options	Potential Wastewater Use (Lower Scenario) Mm³/a)	Potential Wastewater Use (Upper Scenario) (Mm³/a)	Potential Wastewater Use (Intermediate Scenario) (Mm³/a)	Estimated Cost (R million per Mm³)	Timeline Years	Status	Responsible Stakeholder
	Mdantsane East and Reeston	Return flow to contribute to EWR	3.5	2.2	3.1	0.5	0	Possible	BCM
		Domestic	2.4	1.6	2.1	2.0	4	Possible	
		IDZ / Industrial	1.8	1.8	1.8	5.0	4	Possible	
	Central (From Reeston)	Return flow to contribute to EWR	1.4	0.9	1.2	0.5	4	Possible	
		Domestic	1.0	0.7	0.9	2.0	4	Possible	
	West Bank	IDZ / Industrial	1.8	0.9	1.6	4.0	4	Possible	BCM
		Domestic (Possibly)	1.7	0.8	1.4	5.0	4	Possible	
	East Bank	East London golf course	0.1	0.1	0.1	0	0	Existing	BCM
		IDZ / Industrial	1.8	5.5	3.7	4.0	4	Proposed	
		Domestic	6.5	3.3	5.0	2.0	4	Possible	
	Quinera (Gonubie)	Gonubie golf course and 2 farmers	0.1	0.1	0.1	0	0	Existing	BCM
		Gonubie Eco Golf Course	0.5	0.5	0.5	1.0	1	Proposal	
		Irrigation	0.9	0.5	0.8	1,0	4	Possible	
		Domestic	0.7	0.4	0.6	3.0	4	Possible	
Upper Kubusi	Stutterheim	Return flow to enhance yields of dams	0.6	0.6	0.6	0.5	0	Existing	ADM
		Irrigation	0.5	0.5	0.5	0.5	4	Possible	
Middle Kubusi			0	0	0	0	0		

At the Information Verification Meeting, the Planning Team was authorised by the stakeholders to propose water use measures which could be adopted as options, taking into account BCM's intentions to provide for wastewater use as part of its WWTWs' augmentation programme. For completeness, the existing use activities and those interventions which are planned or which are in hand are included with interventions suggested by the Planning Team in Table 5.8. The calculations are shown in Appendix 5.1.

5.3 STREAMFLOW REDUCTIONS

A balance is to be sought between reducing exotic forests and eradicating invasive alien plants (IAP) to increase water for alternative uses and retention of the forests and IAP for income as well as for employment-generating activities.

The Provincial Growth and Development Strategy makes a case for economically beneficial stands of IAP to be retained for use by communities. In 2003 the DWAF Office in King William's Town compiled a report based on a survey of wattle infestation in the Amatole area. What follows, under both the headings of 'afforestation' and 'invasive alien plants' is a brief summary of that report. The report can be found in Appendix 5.2.

The impact of streamflow reductions due to afforestation and IAP is outlined in Chapter 3 of this report.

In each sub-catchment the simulated removal of both forests and IAP increases the simulated streamflow values. However, the extent to which the removal of afforestation and IAP affects the streamflow varies among the sub-catchments.

The removal of all afforestation within the catchments of the dams in the ABWSS would increase the yields of the dams by some 17.3 Mm^3/a while the eradication of IAP would increase the yields of the dams by 11.4 Mm^3/a.

5.3.1 Afforestation

Most commercial and indigenous forests in the Amatole region, which include catchments outside of those from which water for the ABWSS is drawn, are in the high rainfall areas of the Amatola Mountains. The forests consist of approximately 380 km^2 of commercial *Pinus* and *Eucalypt* species, and indigenous afromontane forests.

A series of montane forest blocks surround fragmented urban and rural parts of the area. The forest complex runs from the Hogsback State Forest in the east to Fort Cunningham State Forest in the west, and includes large State-owned forest blocks as well as smaller patches which provide continuity between the larger blocks, especially in the Keiskammahoek area. The boundaries are not distinct and the forests merge with the rural and urban settlements. The centre of this forest complex lies some 20 km north-west of King William's Town and around 24 km south-west of Stutterheim, close to the headwaters of the Buffalo River.

In the study area, afforestation is of significance in the supply areas designated as the Upper Buffalo as well as the Upper and Middle Kubusi schemes. These areas will be focussed upon in this study as far as afforestation is concerned.

The forest complex holds both wet and dry forests, with scrub-forest at lower altitudes. Dominant trees of the canopy include *Podocarpus*, *Xymalos*, *Rapanea*, *Ptaeroxylon*, *Canthium*, *Celtis*, *Trichocladus*, *Curtisia* and *Vepris*. *Pinus* plantations, which adjoin the indigenous forests, occur as small, isolated, scattered pockets throughout the area.

Ciskei Forestry previously managed these forests. Control of all indigenous forests was handed over to the Directorate of Nature Conservation of the Eastern Cape Province in 1996, and management plans for all forests are in preparation or have been completed.

Commercial forestry companies (SAFCOL) and smaller private forestry concerns operate within the area and its surroundings. There are no grazing or hunting rights as specified in the Forest Conservation Act, although resource extraction (fuelwood, bark and building material) takes place.

The boundaries of the forests are not physically demarcated and there is considerable movement of faunal populations between adjacent forest areas. Together, the complex forms a large forest network, which is likely to maintain its biological integrity provided no further fragmentation or habitat destruction occurs.

Water-hungry, non-native plantations, above indigenous forest zones, deprive indigenous forests of water, potentially changing forest structure and functioning. A threat to the area's forests is unsustainable harvesting of indigenous timber, targeting *Podocarpus* in particular.

Present indications are that there is no intention to reduce the extent of commercial forestry, while the indigenous forests are being protected. Efforts are expected to be focussed upon reducing the negative impacts of exotic forests so as to make more water available for the indigenous forests and wetlands. In that event, little or no additional water is likely to become available from deforestation to affect the streamflow reductions in the Kubusi and Buffalo rivers.

Nevertheless, the removal of exotic forests remains an option to decrease the current level of streamflow reduction.

The catchment of the Wriggleswade Dam would be the most advantageous for deforestation as not only would the additional yield be the highest (almost 12 Mm^3/a if all the forests were to be removed), but the additional yield as a percentage of the afforestation water use is also the highest at some 90%.

The areas from which forests can be removed would need to be investigated, to ascertain the extent to which exotic forests can be reduced without adversely affecting the economy of the Eastern Cape. For the purposes of this study, three options are proposed. They represent the maintenance of the *status quo*, the limited removal of afforestation and an aggressive programme to remove alien forests. The resultant additional yields of the dams in the ABWSS could be similar to the volumes set out in Table 5.9.

Table 5.9 Possible Additional Yield if Exotic Forests are Partially Removed

	Possible Additional Yield Mm^3/a
Lower Scenario	0
Upper Scenario	5
Intermediate Scenario	2

5.3.2 Invasive Alien Plants

Wattle jungle in the study area, lends itself to formalising sustainable stands and eradicating unsustainable infestations. Wattle infestations in the area of greatest forestry growth, including parts of the study area, were surveyed and mapped by DWAF to classify wattle in terms of density and size class, as well as to estimate the resource value of the wattle. Stands of wattle were identified according to cover, ecological sensitivity and size classes.

Estimates of the extent of each stand larger than 1 ha, as well as utilisable volumes of timber in the relevant quaternary catchments were recorded. The stands were divided into timber suitable for pulpwood, charcoal and laths. Pulpwood and charcoal have a definite marketable value and laths are important both commercially and socially.

Unsubstantiated reports preceding the inception of the Amatola Wattle Survey were of large tracts of wattle infestations across the Amatola mountain range, and this was shown by the survey to be unfounded.

There are substantial areas where significant volumes of usable timber per hectare have been obtained from jungle wattle, and this can be increased with proper management.

The resource estimates within the study area are as set out in Table 5.10. Greater detail is contained in Appendix 5.2.

Table 5.10 Estimate of Wattle Resources

Scheme	Infestation ha	Sustainable area ha	Mass of Pulpwood ton	Mass of Charcoal ton	Mass of laths ton
Upper Buffalo	386	305	10 993	4 380	1 398
Upper Kubusi	1 048	1 001	8 775	16 002	8 385
Middle Kubusi	483	349	4 545	5 860	2 441
Total	**1 917**	**1 655**	**24 313**	**26 242**	**12 224**

- The marketable value of pulpwood is R300/ton of harvested wood, but this value varies with fluctuating markets. This amounts to around R7 million over the rotation period that the wattle is being grown. This is roughly 15 years.
- The marketable value of charcoal varies from R50/ton to R100/ton. To achieve R100 a ton, a well-managed retort system is necessary. The income could amount to R2 million over a 15-year rotation period.
- The marketable value of laths is about R150/ton, which amounts to about R2 million over the rotation period. Laths have a market in agriculture and as garden trellises, so the R2 million could prove to be an underestimate. Laths also have a shorter rotation period than 15 years.

The potential income from the sustainable stands of wattle jungle, when thinned-out and managed, could be around R1 million per year. The stands which are not sustainable and which cover some 260 ha can be removed without adversely affecting the income potential of the wattle. The removal of those stands could, however, impact negatively on communities that use the wood for fuel and building materials.

In the light of the above, three scenarios for the handling of wattle infestation have been considered for this study as set out in Table 5.11. The scenarios are to retain all the stands (lower scenario), to remove all the wattle (upper scenario) and to retain only the sustainable stands (intermediate scenario).

The wattle stands have been taken as afforestation in the modelling.

Table 5.11 Impact of Flow Reduction on Yield due to the Management of Wattle

Scheme	Infestation		Area of Wattle Cleared and Increase in Yield					
	Total ha	Sustainable ha	Lower Scenario		Upper Scenario		Intermediate Scenario	
			Area Cleared ha	Additional Yield Mm^3/a	Area Cleared ha	Additional Yield Mm^3/a	Area Cleared ha	Additional Yield Mm^3/a
Upper Buffalo	386	305	0	0	386	0.2	81	0.1
Upper Kubusi	1 048	1 001	0	0	1 048	0.3	47	0.1
Middle Kubusi	483	349	0	0	483	0.1	134	0.1
Total	**1 917**	**1 655**	**0**	**0**	**1 917**	**0.6**	**262**	**0.3**

The estimated cost of removing the wattle infestation is R3 500/ha, while the cost of converting the wattle jungle to forests is R5 000/ha.

Plantations that are retained and which can be categorized as reclaimable should be licensed, so that they can be managed as a high-value crop.

Weed IAP (*Lantana, Sesbania*) are also found in most riparian vegetation. In addition to the land-based IAP, water weed (hyacinth) and algal blooms are an increasing problem in some of the larger dams (Bridle Drift, Laing, Nahoon, and to a much lesser extent Wriggleswade), owing to nutrients originating from WWTWs, pollution from urban run-off and resultant eutrophication.

As the simulated removal of alien vegetation does not significantly increase the simulated streamflow values, the impacts on yield are not significant.

Nevertheless, invasive alien plants are widely regarded as the single greatest threat to South Africa's biological diversity. The water taken up by alien plants affects not only the water supply, but can also have negative impacts on water quality. Clearing such plants has proven beneficial for low-flow environments. A study analysed the Southern African Plant Invaders Atlas (SAPIA) database and recommended that eradication be explored for species confined to small areas or just beginning to become invasive, while for widespread species, priority areas should be identified as management focus areas.

The eradication of invasive weed should be actively continued from the perspective of the protection of biodiversity and possibly of water quality, rather than as a means of significantly increasing water availability for the ABWSS.

The Kubusi catchment has large wetland areas in its basin which are highly sensitive and need to be conserved. However, the Kubusi catchment also has the most suitable sites for plantations, on sites where they will not impact on the wetlands.

5.4 WATER QUALITY

5.4.1 Water Quality Data

This summary provides an overview of water quality indicators and issues identified at certain points within the rivers supplying water for the ABWSS and their present and likely future impacts on system operation. This summary is drawn from an evaluation of key reports, the insights of relevant personnel during the reconnaissance visit undertaken on 9 and 10 February 2005 and subsequent communication.

For the purpose of this summary, the rivers in the Amatole sub-region were divided into the sub-catchments shown in Table 5.12.

Table 5.12 Sub-catchments According to Schemes

Scheme	Sub-catchments	Gauge Number
Upper Buffalo	Buffalo River headwaters to Rooikrantz Dam	R2R002
	Buffalo River between Rooikrantz Dam and the King William's Town weir	R2H005
	Buffalo River from King William's Town to upstream of the James McIntyre Bridge	R2H010
Middle Buffalo	Buffalo River at Laing Dam	R2R001
Lower Buffalo	Buffalo River at Bridle Drift Dam	R2R003
	Buffalo River from Bridle Drift Dam to the sea	
	Nahoon River to Nahoon Dam	R3R001
	Nahoon River downstream of Nahoon Dam	
Upper Kubusi	Kubusi River to the Wriggleswade Dam	S6R002
Middle Kubusi	Kubusi River downstream of the Wriggleswade Dam	
	Yellowwoods River	

The sub-catchments were chosen to account for important water sources such as major dams, significant pollution sources, downstream water requirements that may be influenced by water quality, water transfers and relevant EWR sites. With regard to the Kubusi River downstream of the Wriggleswade Dam, the reach above the dam has been combined with the dam, since the overall impact is of relevance to this project. The water quality data are summarised in Appendix 5.3, with a more detailed description of the condition of the rivers in Appendix 5.4.

The water in the Buffalo River deteriorates from a virtually pristine state upstream of Rooikrantz Dam to a highly polluted state where the water enters the sea.

The main causes of the deterioration in water quality are diffuse pollution from urban and peri-urban areas as well as from rural settlements, point sources of pollution such as WWTWs and major industries together with the deposition of waste and metals at the East London harbour.

A similar situation applies in the Nahoon River, except that the level of pollution is lower and a significant part of the poor water quality can be ascribed to natural causes and possibly to agricultural return flows.

The water quality in the Kubusi River is generally good, although it is adversely affected by discharge from Stutterheim's WWTW.

5.4.2 Current Water Quality

This section contains a summary of the general, current water quality of the river reaches, as well as an overview of the likely effects of this water quality on the system and potential management options in the light of the water quality findings. Various river reaches exhibit the water quality conditions outlined below. See Appendices 5.3 and 5.4 for the report.

Upper Buffalo River above King William's Town and between King William's Town and Laing Dam

The Buffalo River headwaters to Rooikrantz Dam are in an almost pristine condition.

Diffuse pollution sources cause a marked deterioration in water quality between Rooikrantz Dam and King William's Town, with a near 5-fold increase in the median salinity, an 8-fold increase in phosphate concentration and faecal coliform counts peaking at 600 000 per 100 mℓ.

A further doubling of the median salinity and four-fold increase in phosphate concentration between King William's Town and Laing Dam results in a dense mat of water hyacinth at the James McIntyre Bridge above Laing Dam. The deterioration is attributable to effluent from King William's Town's and Zwelitsha's WWTWs as well as diffuse urban/peri-urban run-off and industrial pollution primarily from Da Gama Textiles' plant at Zwelitsha.

Buffalo River at Laing Dam

Storage attenuation results in a one-third reduction in salt concentration at the Laing Dam outlet. Rapid die-off in the reservoir reduced faecal coliform counts to zero. There is also a large reduction in phosphate concentration due to settling in the dam sediment. However, this remains high enough to promote eutrophic conditions, with high Chlorophyll-a concentrations, excessive growth of aquatic plants, nuisance algae and cyan bacteria and reduced light penetration. Oxygen depletion in the bottom water results in low reduction of iron and manganese. All of this necessitates costly Powdered Activated Carbon (PAC) dosing at the Laing Dam water treatment works to remove toxins secreted by cyan bacteria and to obviate taste and odour problems.

A feedback loop exists whereby the salinity of the water abstracted from Laing Dam affects that of the effluent discharged back to the dam. This is especially pronounced during droughts when high salinity peaks occur. Scour releases of polluted bottom water from Laing Dam are used to reduce algae ingress to the WTW. Model studies showed that dilution with Wriggleswade Dam water would have hardly any impact on non-conservative pollutants and bring about limited improvement in salinity (AWRSA 1999).

Buffalo River from Laing Dam to Bridle Drift Dam

There are few pollution sources between Laing Dam and the upstream end of Bridle Drift Dam. However, the nutrient load spilled from Laing Dam is sufficient to support eutrophication and the spread of invasive water hyacinth. Little improvement in salinity was observed in Bridle Drift Dam, since the load is dominated by the upstream inflow. The median phosphate concentration nearly doubled to 0.07 mg/ℓ resulting in high Chlorophyll-a concentrations, with very high peak concentrations and occasional potentially toxic cyan bacterial blooms. Water quality in Bridle Drift Dam is affected by overflowing sewers and other diffuse sources from Mdantsane. Carbon filtration is desirable to remove dyes and control taste and odour problems at the Umzonyana WTW.

Buffalo River from Bridle Drift Dam to the Sea

A 25% rise in salinity, exceptionally high phosphate concentrations (median 1.5 mg/ℓ) and significant faecal contamination were observed at Buffalo Pass. This is attributed to the curtailment of flow from the Bridle Drift Dam combined with input from the Mdantsane WWTW.

The sediments in the harbour area of the estuary at East London are contaminated by heavy metals. High faecal coliform and total coliform counts have also led to reported non-compliance with the South African water quality guidelines for mariculture and bathing in the adjacent coastal zone.

Nahoon River to Nahoon Dam

Natural sources result in elevated salinity in Nahoon Dam. Phosphate concentrations are not very elevated (0.02 mg/ℓ) but the Chlorophyll-a concentration is high enough to cause concern (22 µg/ℓ), necessitating PAC dosing at the Nahoon Dam WTW. Possible pollution sources include the Newlands Township, Berlin WWTW and a Sentrachem herbicide factory.

Kubusi River and the Wriggleswade Dam

Relatively small quantities of treated wastewater from the Stutterheim WWTW enter the Kubusi River. The median salinity (19.6 mS/m) is relatively low. The salinity of the water in the Wriggleswade Dam is assumed to be due to natural salt sources.

Yellowwoods River

The Yellowwoods River exhibits very high salinity, faecal coliform counts, COD, nutrients and algal blooms. These are attributable to drainage from rural settlements, overflowing sewers and overloaded WWTWs (Bisho, Breidbach and Ilitha). The high salinity levels appear to largely result from natural sources. Transfer of water from the Wriggleswade Dam via this river would dilute the pollution levels in the Yellowwoods River, but also contaminate the transferred water. The mode of release (i.e. continuously or in short duration slugs) will affect both transmission losses and water quality.

5.4.3 Water Quality Objectives

Resource water quality objectives for the Amatole system have not yet been set. These need to take account of all significant categories of water use, the EWR as well as what can realistically be achieved.

The AWRSA put forward proposed management targets and water quality objectives for major impoundments as summarised in Table 5.13. These must be viewed as an interim measure.

Table 5.13 Proposed Water Quality Management Targets and Objectives for Major Impoundments

Impoundment	TDS (mg/ℓ)		Soluble P (mgP/ℓ)		Chlorophyll-a (μg/ℓ)		*E.coli* (N/100 mℓ)	
	Objective	Target	Objective	Target	Objective	Target	Objective	Target
Rooikrantz Dam	100	75	0.05	0.035	5	3	150	100
Laing Dam	400	350	0.10	0.07	15	10	300	200
Bridle Drift Dam	350	300	0.035	0.025	30	20	200	100
Nahoon Dam	400	300	0.070	0.050	7	5	200	100
Gubu Dam	100	75	0.05	0.035	5	3	150	100
Wriggleswade Dam	200	150	0.05	0.03	15	7	200	100

More recently the preliminary water quality reserve and resource categories listed in Table 5.14 have been proposed.

Table 5.14 Summary of Key Water Quality Reserve Requirements

Quaternary		R20A	R20F	R20G	S60A	S60B	S60E
River		Buffalo	Buffalo	Buffalo	Kubusi	Kubusi	Kubusi
Water Quality Category		C	C/D	C	B	B	B
$MgSO_4$ (95%)	mg/ℓ	37	37	37	16	16	27
Na_2SO_4 (95%)	mg/ℓ	20	20	20	20	20	20
$MgCl_2$ (95%)	mg/ℓ	51	51	51	15	15	51
$CaCl_2$ (95%)	mg/ℓ	105	105	105	21	21	63
$NaCl_2$ (95%)	mg/ℓ	45	217	217	45	45	45
$CaSO_4$ (95%)	mg/ℓ	351	351	351	351	351	351
Sodium (95%)	mg/ℓ	68	103	84	9	9	84
Magnesium (95%)	mg/ℓ	21	79	18	7	7	18
Potassium (95%)	mg/ℓ	-	49.2	47	49	49	-
Calcium (95%)	mg/ℓ	38	38	31	10	10	31
Chloride (95%)	mg/ℓ	132	200	78	24	24	78
Sulphate (95%)	mg/ℓ	30	262	21	13	13	21
Phosphate (PO_4) (95%)	mg/ℓ	0.065	0.04	0.04	0.065	0.04	0.065
Total Inorganic Nitrogen (95%)	Mg-N/ℓ	0.25	-	-	0.25	-	0.25
TIN / SP ratio (90%)	-	-	52.5	52.5	-	52.5	-
PH (5% - 95%)	-	6.5-9.0	6.5-8.0	6.5-8.0	6.5-8.0	6.5-8.0	6.5-9.0

Quaternary		R20A	R20F	R20G	S60A	S60B	S60E
River		Buffalo	Buffalo	Buffalo	Kubusi	Kubusi	Kubusi
Water Quality Category		C	C/D	C	B	B	B
Dissolved Oxygen	mg/ℓ	>6.5	-	-	-	-	>6.5
Dissolved Oxygen	%	-	>80%	>100%	>100%	>100%	-
Ammonia (NH_3)	Mg-N/ℓ	0.007	0.034	0.007	0.007	0.007	0.007

The EWR determination includes the following requirements for toxics for all of the above catchments:

Acute toxicity: 100% TUa≤1 and Chronic toxicity: 99% TUc<5

or

90%≤TWQR (Target Water Quality Range), 99%<CEV and 100%<AEV

or

< TWQR (more protective value to be selected)

It should be noted that the proposed requirements are only for the EWR and the BHN. As such they do not define the water quality objectives or management targets, since they do not include all uses. Nor do the requirements take account of broader yield, operational and social factors. It should also be recognised that the Reserve applies primarily to river reaches rather than directly to the complex requirements for impoundments.

Since resource quality objectives are not yet available, it is not possible to set definitive end-of-pipe targets required to achieve them. Moreover, setting such targets would require a comprehensive modelling study since the cause-effect chain is complex and has to take account of hydrological fluctuation, in-stream and in-lake processes and operating procedures.

5.4.4 Impact of interventions

Detailed modelling is needed to assess the impact of specific interventions. However, useful inferences can be drawn from the modelling carried out for the 2010 water requirement conditions during Phases 1 and 2 of the AWRSA. The main inferences are summarised as follows:

- the interim water quality and management targets for the upper Kubusi River at Gubu Dam are met;
- at the Wriggleswade Dam the TDS objective is met but the management target is exceeded during severe droughts. Since TDS pollution sources are

insignificant, this cannot be prevented by normal system operating rules. Moreover, the TDS concentrations are well within acceptable limits;

- although the simulated Chlorophyll-a at the Wriggleswade Dam remains below the water quality objective, annual peaks routinely exceed the management objective. *E.coli* peaks were also evident during peak drought conditions resulting in exceedence of the management target and, on one occasion, the management objective. These occurrences can best be obviated by better control of diffuse sources nearer to the dam and reduction of phosphate loading from Stutterheim's WWTWs;
- occasional exceedence of the TDS management target occurred when Rooikrantz Dam is drawn down during extreme droughts, but without exceeding the 100 mg/ℓ objective. Since there are no significant TDS pollution sources in this catchment and even the peak TDS concentrations are very low, it can be concluded that the management target is too low. It is likely that low flow TDS concentrations would in any event have been higher than those modelled in the dam. No attempt to reduce the TDS peaks by means of the manner in which the Maden and Rooikrantz dams are operated is justified. Simulated soluble phosphate (SP), Chlorophyll-a and *E.coli* concentrations are all well within the management targets;
- Nahoon Dam shows frequent exceedence of the TDS management target and occasional exceedence of the TDS objective. However, given the absence of significant TDS pollution sources it can be concluded that the variation is largely due to the natural catchment response. This leads to the conclusion that the management targets and resource objectives may be too low. As expected, the model results show a substantial reduction in the simulated TDS concentrations in Nahoon Dam when all of the available lower TDS Wriggleswade Dam water is transferred to the Nahoon River. Close scrutiny of these results also suggests that for intermediate transfer rates the simulated differences between the drought peak concentrations are extremely sensitive to imbalances between the quantity of water transferred and the water demand placed on Nahoon Dam. For example, scenario 4 in the AWRSA, which assumes a 9 Mm^3 transfer from the Wriggleswade Dam to the Nahoon Dam, shows a higher 1980's drought TDS peak than is the case for option 3, where only 6 Mm^3 was transferred. The anomaly can be explained by the very different dam storage volume trajectories for the two options, which indicates that the increase in transfer is not in balance with the specified water demand. Since the TDS peaks are so sensitive to subtle differences between water transfer and water demand on Nahoon Dam it would be unwise to attempt to fine tune the transfer amount to suit water quality, since the future hydrological pattern is not known in advance and the future peaks could easily be made worse rather than be improved;
- since salinity-related costs to industrial and domestic consumers generally bear a roughly linear relationship with supply TDS concentration, it follows that there is little overall economic difference if the Wriggleswade transfer goes to the

Nahoon River or to the Yellowwoods River, provided it is all used effectively to meet demand. Therefore there is no compelling reason why TDS concentration should be the main criteria in deciding this allocation, provided that safe levels are not exceeded (which is not the case). Part of this water resource might also be used to ensure a supply of low TDS water to particularly sensitive industrial users;

- during the severe 1980s drought, high peak TDS concentrations arose in Laing Dam due to a combination of exhaustion of the fresh water input from the upstream catchment and draw down of Laing Dam, which accentuated the feedback loop between abstraction from Laing Dam and effluent returned to the dam. The AWRSA simulations highlighted the strong correlation between TDS peak concentration and low dam storage. From this point of view an assured supply of water from the Wriggleswade Dam during drought conditions could help to alleviate TDS peaks in Laing Dam. Alternatively, it could provide a low TDS treated water supply that could be fed into the supply zone directly. This might be preferable, since part of this water could be supplied to the more sensitive users, rather than first mixing it with the more saline Laing Dam water;

- transfer of water from the Wriggleswade Dam has little effect on simulated TDS concentrations in Laing Dam. The main effect is transferred to Bridle Drift Dam. However, even here the net effect is small and the changes in peak concentrations are sensitive to imbalances between water transfer and water demand distribution;

- the option of using the TDS status of Laing, Bridle Drift and Nahoon dams to trigger releases from the Wriggleswade Dam was found to offer only limited advantage, but at the expense of greatly reducing assurance of supply. It is therefore concluded that salinity-based operating rules should not be used as the basis for making such releases. The most effective approach would be to rather reduce controllable TDS effluent sources;

- a three-year programme to eliminate the TDS load from lands irrigated with saline textile effluent at the Da Gama Textiles' plant in Zwelitsha is already well advanced. No further action is immediately obvious in this regard. Removal of salts from municipal effluent could also be considered. However, this option is expensive and should only be adopted as a last resort. The effect of the control of the textile effluent should be evaluated before further action is taken;

- the model results show that a range of options for using the Wriggleswade Dam transfer water have little effect on phosphorus, Chlorophyll-a or *E.coli* concentrations in Laing Dam or on the downstream Bridle Drift Dam. Hence these variables warrant little consideration in deciding on how to employ transfers of water from the Wriggleswade Dam;

- by contrast, the option of removing all point sources of pollution from the Buffalo River system results in meeting all of the soluble phosphate (SP) management targets and resource objectives at both Laing Dam and Bridle Drift Dam.

Chlorophyll-a management targets and resource objectives would be met at Laing Dam, with only occasional failures at Bridle Drift Dam;

- very large reductions in soluble phosphate and Chlorophyll-a concentrations can also be achieved at Bridle Drift Dam simply by eliminating Mdantsane sewer leaks. In this regard the AWRSA indicated that Mdantsane sewer leaks accounted for 65% of the soluble phosphate point source load to the entire Buffalo River system and
- it follows that management of sewer leaks and control of effluent point-source quality is the most effective means available for reducing eutrophication precursors.

From the above, the most effective interventions should be centred on:

- reduction of saline effluent sources in the Buffalo River system (this is already in hand);
- elimination of sewer leakage in the Mdantsane area;
- reduction of phosphorus loading from point sources (tightening phosphate standards to (say) <1 mg/ℓ would bring about large reductions in load) and
- control of diffuse pollution from informal settlements to reduce bacterial contamination.

In terms of operating rules:

- water quality should not be used as the criteria for controlling release from the Wriggleswade Dam since the effect on water quality parameters is small and control of pollution sources is much more effective;
- releases should rather be directed to optimise water supply;
- limited control of peak water quality concentrations in the dams can be achieved by preventing excessive draw down of Laing, Bridle Drift and Nahoon dams. This may be possible to some extent by reducing water abstractions. This will only be possible (1) where an alternative source of supply exists, or (2) if demand restrictions are imposed, or (3) if compensation releases can be reduced during times of severe drought. With regard to item (3), inappropriate application of excessive Reserve releases could cause serious deterioration in the water quality in dams and downstream river reaches (ie throughout the middle and lower Buffalo River system) and
- with these factors in mind, it is important to test operating rules, including those for meeting Reserve requirements, using suitable system water quality models. Modelling is also required to determine the most appropriate point-source water quality targets required to achieve the resource water quality objectives.

5.4.5 Possible Intervention to Improve Water Quality

The main issues that require attention are the point-source pollution from WWTWs and diffuse sources of pollution from towns, industries, peri-urban areas and settlements.

Currently there is no integrated programme aimed at improving the quality of water in the rivers supplying the ABWSS. Several of the WWTWs from which water is returned to the Buffalo and Nahoon rivers are being augmented or there are plans for augmentation. Also the quality of effluent discharged from the Da Gama Textiles' plant at Zwelitsha is being improved and the quantity reduced through the recycling of treated wastewater.

5.4.6 Modelling requirements

System water quality modelling is required to:

- test and if necessary modify operating rules, including those for meeting Reserve requirements;
- determine the most appropriate point-source water quality targets required to achieve the resource water quality objectives;
- provide information for the actual setting of realistic and effective resource water quality objectives and
- test the effectiveness of interventions taken to curtail pollution sources.

The above requirements can best be met in this dam-dominated system by means of monthly time-step modelling that takes account of the dynamic system operation. In the case of TDS, this can be best achieved using the WRPM (with the WQT model providing the essential calibration information). The IMPAQ model provides a ready means of modelling system phosphorus, Chlorophyll-a and *E.coli*. These models are the most suitable choice since they have already been set up for the system and appear to yield reasonable results. More detailed dam modelling could be considered for some dams, but the need for this requires careful evaluation for each dam as to whether the perceived increase in accuracy is sufficient to justify the effort.

Although earlier model calibrations have been made, these need to be extended to utilise the longer historical flow and water quality records now available. Revisions made to the system hydrology will also affect the water quality model calibrations. Re-calibration would need to take due account of the recent improvements arising from measures that are already underway to curtail pollution sources.

Table 5.15 sets out the interventions that are proposed by this study, together with resources, estimate of capital cost and timelines.

Table 5.15 Water Quality Interventions, Resources, Estimated Cost and Timelines

Intervention	Purpose	Resources	Water Quality Requirements	Cost RM	Timeline Years	Status	Responsible Stakeholder
All Schemes							
MIS	Provide information on sanitation, sewerage systems and WWT for management decisions, for corrective action to be taken and for the results of the action to be monitored.	Can be prepared in-house possibly with the assistance of a PSP. Once the MIS is in place it should be managed by staff in the WSAs' staff structures.	Needed to reduce point and diffuse sources of pollution. Key pollutants include EC, TDS, SP, TP, E.Coli, Chlorophyll-a (in dams), temperature (in dams), SS, turbidity, COD, NH4, N, OA and pH.	1.0	2	Proposed	WSAs
Sewer infrastructure asset management .	Provide a structured approach in accordance with best practice manuals recently introduced into South Africa to manage and maintain the sewerage and WWT assets, to reduce sewage and WW spills as well as to enhance the quality of treated WW returned to the rivers.	5 Additional maintenance teams, each consisting of a plumber and 3 assistants together with a vehicle and the necessary equipment. The present day cost per team is expected to be around R0.7 million/annum.	Needed to reduce point and diffuse sources of pollution. For example, the AWRSA indicates that removal of sewer leakage in Mdantsane alone might eliminate the severe eutrophication problems at Bridle Drift Dam.	3.5/a	2	Proposed by this study	WSAs
Enhancement to the current sanitation education programme.	Change the behaviour of communities, and industrialists with respect to the use of sanitation systems and the consequences of abuse of the systems with a view to avoiding sewage spills and to reduce return flows of inadequately	5 additional training teams, each consisting of a trainer, an assistant, a vehicle and the necessary equipment. The present day cost per team is expected to be around R0.4 million/annum.	Needed to overcome abuse of the sanitation and sewerage systems in order to reduce point and diffuse sources of pollution.	2.0/a	1	Proposed by this study	WSAs

Intervention	Purpose	Resources	Water Quality Requirements	Cost RM	Timeline Years	Status	Responsible Stakeholder
	treated WW to the rivers and streams.						
Support to households to maintain sanitation and sewerage installations.	Reduce diffuse pollution arising from the overflow of sewers or the discharge from sanitation systems on private property. Inspect households, advise on remedial measures to be taken by households, provide a service to empty pits and conservancy tanks or to unblock sewers on private property where practicable (particularly for households which are registered as being indigent).	5 Additional teams, each consisting of a plumber and 2 assistants together with a vehicle and the necessary equipment. The present day cost per team is expected to be around R0.4 million/annum.	Needed to reduce diffuse sources of pollution.	2.0/a	1	Proposed by this study	WSAs
Support to public bodies to maintain sanitation and sewerage installations.	Reduce diffuse pollution arising from the overflow of sewers or the discharge from sanitation systems on public property. Inspect public installations, advise on remedial measures to be taken by public bodies and take steps to attain compliance with the advice.	The same team which provides a similar service to households.	Needed to reduce diffuse sources of pollution.	0	1	Proposed by this study	Municipalities
Improve monitoring of the quality of construction of sanitation and	Improve the quality of sanitation installations to reduce the risk of: seepage from the system; blockages	Enhance the building inspectorates by 5 inspectors, with the necessary transport. The	Needed to reduce diffuse sources of pollution.	1,5/a	1	Proposed by this study	Municipalities

Intervention	Purpose	Resources	Water Quality Requirements	Cost RM	Timeline Years	Status	Responsible Stakeholder
sewerage installations.	and overflows, all as a result of inadequate design or poor construction.	average present day cost is expected to be around R0,3 million per person per annum.					
Improve solid waste collection and refuse/waste picking in open spaces.	Prevent solid waste and refuse from entering or being dumped in the watercourses.	Enhance the refuse collection and waste picking capacity by 5 teams, with the necessary transport. The average present day cost is expected to be around R0,6 million per team per annum.	Needed to reduce diffuse sources of pollution.	3.0/a	2	Proposed by this study	Municipalities
Improve solid waste disposal.	Prevent solid waste, leachate and refuse from entering or being dumped in the watercourses.	Existing staff.	Needed to reduce diffuse sources of pollution.	0	2	In hand	Municipalities
Model the System.	Establish the most beneficial manner in which to operate the system from the perspective of water quality.	A suitable experienced PSP.	Needed to ascertain the most advantageous manner in which to operate the system.	3.0	2	Proposed	DWAF
Upper Buffalo Scheme							
Improve WWT at the:							
King William's Town WWTW	Reduce salinity, phosphates and E.Coli in treated WW returned to the Buffalo River. Remove the conditions which promote IAPs, particularly water hyacinth, and eutrophication of	Existing staff and PSPs for the augmentation/ upgrading. Thereafter existing staff.	According to the environmental requirements for the particular WWTW. Initial recommendation: TDS<300 mg/ ℓ SP<1 mgP/ℓ E.Coli<130 N/100 mℓ.	3.0	3	Proposed by this study	BCM

Intervention	Purpose	Resources	Water Quality Requirements	Cost RM	Timeline Years	Status	Responsible Stakeholder
	downstream dams.						
Zwelitsha WWTW	Reduce salinity, phosphates and E.Coli in treated WW returned to the Buffalo River. Remove the conditions which promote IAPs, particularly water hyacinth, and eutrophication of downstream dams.	Existing staff and PSPs for the augmentation/ upgrading. Thereafter existing staff.	According to the environmental requirements for the particular WWTW. Initial recommendation: TDS<300 mg/ ℓ SP<1 mgP/ℓ E.Coli<130 N/100 mℓ.	3.0	3	Proposed by this study	BCM
Da Gama Textiles plant at Zwelitsha	Reduce salinity and phosphates in treated WW returned to the Buffalo River. Remove the conditions which promote IAPs, particularly water hyacinth, and eutrophication of downstream dams.	Existing staff to monitor the results of the interventions introduced by the owners of the plant and to take corrective action where necessary.	As per the permit.	0	1	In hand	De Gama Textiles
Middle Buffalo Scheme							
Bhisho WWTW	Reduce salinity, COD, nutrients and E.Coli in treated WW returned to the Yellowwoods River. Remove the conditions which promote algal blooms. Protect the quality of the water from the Wriggleswade Dam.	Existing staff and PSPs for the augmentation/ upgrading. Thereafter existing staff.	According to the environmental requirements for the particular works (Possibly equivalent to the "General Standards" previously applicable). Initial recommendation: TDS<300 mg/ ℓ SP<1 mgP/ℓ E.Coli<130 N/100 mℓ.	3.0	3	Proposed by this study	BCM
Breidbach WWTW	Reduce salinity, COD, nutrients and E.Coli in treated WW returned to the Yellowwoods River.	Existing staff and PSPs for the augmentation/ upgrading. Thereafter existing	According to the environmental requirements for the particular works. Initial	3.0	3	Proposed by this study	BCM

Intervention	Purpose	Resources	Water Quality Requirements	Cost RM	Timeline Years	Status	Responsible Stakeholder
	Remove the conditions which promote algal blooms. Protect the quality of the water released from the Wriggleswade Dam.	staff.	recommendation: TDS<300 mg/ ℓ SP<mgP/ℓ E.coli<130 N/100mℓ.				
Ilitha WWTW	Reduce salinity, COD, nutrients and E.Coli in treated WW returned to the Yellowwoods River. Remove the conditions which promote algal blooms. Protect the quality of the water released from the Wriggleswade Dam.	Existing staff and PSPs for the augmentation/ upgrading. Thereafter existing staff.	According to the environmental requirements for the particular works. Initial recommendation: TDS<300 mg/ ℓ SP<1 mgP/ℓ E.Coli<130 N/100 mℓ.	3.0	3	Proposed by this study	BCM
Lower Buffalo Scheme							
Potsdam/ Mdantsane West WWTW	Reduce salinity, phosphates and E.Coli in treated WW returned to the Buffalo River. Remove the conditions which promote IAPs, particularly water hyacinth, and faecal contamination, downstream of Bridle Drift Dam, including on the beaches at the coast.	Existing staff and PSPs for the augmentation/ upgrading. Thereafter existing staff.	According to the environmental requirements for the particular WWTW. Initial recommendation: TDS<300 mg/ ℓ SP<1 mgP/ℓ E.Coli<130 N/100 mℓ.	5.0	3	Proposed by this study	BCM
Mdantsane East/Reeston WWTW	Design, construct and operate the WWTW to Reduce salinity, phosphates and E.Coli in treated WW from its catchment and from the Central WWTW returned to the Buffalo River. Remove the conditions which	Existing staff and PSPs for the augmentation/ upgrading. Thereafter existing staff.	According to the environmental requirements for the particular WWTW. Initial recommendation: TDS<300 mg/ ℓ SP<1 mgP/ℓ E.Coli<130 N/100 mℓ.	10.0	4	In hand	BCM

Intervention	Purpose	Resources	Water Quality Requirements	Cost RM	Timeline Years	Status	Responsible Stakeholder
	promote IAPs, particularly water hyacinth, and faecal contamination downstream of Bridle Drift Dam, including on the beaches at the coast.						
Berlin WWTW	Reduce phosphates in treated WW returned to the Nahoon River. Remove the conditions which cause algal blooms in the Nahoon Dam.	Existing staff and PSPs for the augmentation/ upgrading. Thereafter existing staff.	According to the environmental requirements for the particular WWTW. Initial recommendation: TDS<300 mg/ ℓ SP<1 mgP/ℓ E.Coli<130 N/100 mℓ.	3.0	3	Proposed by this study	BCM
Sentrachem herbicide factory	Reduce salinity and phosphates in treated WW returned to the Nahoon River. Remove the conditions which cause algal blooms in the Nahoon Dam.	Existing staff to monitor the results of the interventions introduced by the owners of the plant and to take corrective action where necessary.	As per the permit.	0	4	Proposed by this study	Sentrachem
Upper Kubusi Scheme							
Stutterheim WWTW	Reduce phosphates and E.Coli in treated WW returned to the Kubusi River.	Existing staff and PSPs for the augmentation/ upgrading. Thereafter existing staff. .	According to the environmental requirements for the particular WWTW. Initial recommendation: SP<1 mgP/ℓ E.Coli<130 N/100 mℓ.	2.0	3	Proposed by this study	ADM
Middle Kubusi Scheme							
Enforce controls on settlements along the water courses, the Yellowwoods	Improve the quality of water in the Yellowwoods River and its tributaries as well as to limit the deterioration of the quality of the water	A Development Control Officer per municipality with the necessary transport and support from the relevant	Needed to reduce diffuse sources of pollution.	1.0/a	2	Proposed by this study	Amahlati LM BCM

Intervention	Purpose	Resources	Water Quality Requirements	Cost RM	Timeline Years	Status	Responsible Stakeholder
River and its tributaries between the Wriggleswade tunnel and the points of abstraction of the water transferred from the Wriggleswade Dam.	transferred from the Wriggleswade Dam.	municipality to take remedial action in the event of corrective action being required. The present day cost is expected to be around R1 million/annum.					

The interventions proposed in Table 5.15 are necessary irrespective of whether treated wastewater is returned to the rivers or is treated further for use.

5.5 AUGMENTATION OF WATER SUPPLIES

5.5.1 Potential Surface Water Assets

5.5.1.1 Existing and Bulk Water Supply Augmentation - the Wriggleswade Transfer Scheme

The existing augmentation scheme is that from the Wriggleswade Dam in the Kubusi River. The scheme is illustrated in Figure 1.3, but needs additional work to attain the full benefits for which it was intended, as outlined below.

The tunnel and canal from the Wriggleswade Dam are intended to deliver at a flow rate of 4 m^3/s, but due to the long weirs being at lower than intended levels the capacity of the canal is 3 m^3/s. The intention is to remedy the situation but there are no plans to do so in the near future.

Environmentalists are of the view that any flow rate in excess of 1 m^3/s will cause deterioration of the physical characteristics of the KwaNkwebu River downstream of the canal and could adversely affect the endangered Eastern Cape rocky (a fish). DWAF are in the process of investigating a conduit to address this issue and have commissioned an environmental study for the conduit as well as for the measures that need to be taken for the water to be conveyed through the Yellowwoods River and its tributaries. Present indications are that the remedial measures are likely to cost some R20 million at 2006 rates for construction.

Six distribution options for transferring water from the Wriggleswade Dam have been proposed in previous studies as set out below.

The first option involves the construction of a small balancing dam on the Yellowwoods River with raw water pumped from there to a WTW and then distributed via new pipelines to Berlin and Bhisho. Part of this option is to augment the WTW at Laing Dam to supply allocations that cannot be met by the existing WTW as well as from the Maden and Rooikrantz dams.

The second option is a variation on the first option, with a balancing dam and WTW at a site near Kei Road. The purified water would be distributed via gravity pipelines.

These two options have the benefit of the water being abstracted from the Yellowwoods River before becoming polluted by diffuse and point sources from Bhisho, Breidbach and Ilitha as well as from some of the settlements along the Yellowwoods River and its tributaries. In addition, the second option links with the proposals for the Amahlati South Water Supply Scheme, which is currently being implemented with the supply from the Wriggleswade Transfer Scheme via an augmentation of the WTW at Kei Road.

The third option involves releases from the Wriggleswade Dam to flow down the Nkobongo and Nahoon rivers to supply the Mdantsane/East London area from the Nahoon Dam in conjunction with Bridle Drift Dam. This option also involves extending the WTW at Nahoon Dam.

The fourth option is a variation on the third option, with releases down the Nkobongo and Nahoon rivers to fully utilise the capacity of the existing WTW at Nahoon Dam. The remainder would be released down the Yellowwoods River to supplement Laing Dam.

The fifth option is a variation on the fourth option, with the water being passed through Laing Dam to Bridle Drift Dam. This alternative can be linked to the Amahlati South Water Supply Scheme.

The sixth option is a variation on the fifth option, with some of the Wriggleswade Dam water being intercepted at a small balancing dam on the Yellowwoods River. Water would then be distributed via a new gravity pipeline to King William's Town's WTW and by pumping to a higher WTW through a new pipeline to serve the area between Berlin and Fort Jackson. The WTW at Laing Dam would not be extended but excess yield from Laing Dam would be transferred to Bridle Drift Dam.

5.5.1.2 Possible Bulk Water Supply Options

A number of potential options to augment the supply of water from the Wriggleswade Dam have been identified in previous studies. The schemes are described briefly below.

- Toise River

  A weir at North Slope in the Toise River with a transfer tunnel to the Wriggleswade Dam.

- Thomas River

  A weir located at Allandale with an 11 km tunnel to the Toise River (at Wartburg). Water would then be transferred from the Toise River to the Wriggleswade Dam via the abovementioned tunnel.

- Thorn River

  A weir located at Clachlan with a 22 km tunnel to the Toise River (at Wartburg). Water would then be transferred from the Toise River to the Wriggleswade Dam via the abovementioned tunnel.

- Thomas and Thorn Rivers

  This option includes the abovementioned Thorn River weir as well as a weir at Stonehenge with a 3.5 km tunnel which will connect to the possible tunnel linking the Thorn and Toise rivers outlined above. Water would then be transferred from the Toise River to the Wriggleswade Dam via the abovementioned tunnel.

Possible options to augment water supplies to the ABWSS, which are separate from the Wriggleswade transfer option, have been identified in previous studies. The options are outlined below.

- Kubusi River

  A dam on the farm Matola downstream of the Wriggleswade Dam.

- Keiskamma River

  Transfer of water from the Sandile and Binfield Park dams in the upper catchment of the Keiskamma River has been mooted as the potential next source of water to augment the supply to the ABWSS. Systems analysis will need to be performed to confirm this as a possibility. The dams currently serve Dimbaza, settlements and irrigators.

A potential dam site exists at Ravenswood Farm, 1 km upstream of where the N2 road crosses the river. Water would be pumped to a point at the watershed between the Keiskamma and Buffalo rivers from where the water would gravitate into Laing Dam via a tributary of the Buffalo River.

A further potential dam site exists at Thornwood Farm, 20 km downstream of Ravenswood as the crow flies. The site is 20 m above sea level, thus pumping would be required, possibly directly to East London.

A final, potential dam site exists at the confluence of the Keiskamma and Tyume rivers. This would involve pumping the water to the Buffalo catchment.

- Gqunube River

  Potential dam sites exist at Mhalla's Kop, approximately 8 km northeast of Macleantown, and at Groothoek/Waterfall, approximately 4 km northeast of the road between East London and Stutterheim. In both cases water would have to be pumped along the watershed between the Nahoon and Gqunube rivers from where the water would be gravitated either to a WTW at East London or to the WTW at the Nahoon Dam.

- Kwelera River

  A potential dam site exists at Wesselshoek, approximately 4 km upstream of where the N2 road crosses the Kwelera River. Water would be pumped from this proposed dam to a point on the watershed between the Gqunube and Kwelera rivers from where the water would gravitate to a treatment works in East London. This option could also be combined with the Gqunube option outlined above.

- Great Kei River

  A potential dam site exists at nGqutu near the confluence of the Kubusi and the Great Kei rivers. The sediment load of the Great Kei River, the distance to the ABWSS, the poor water quality and the pumping heads required does not make this a very favourable option.

- Buffalo River

  There is the possibility of raising the existing dams, and a new dam could be built at Fairways Farm approximately 10 km north of King William's Town along the road to Queenstown. Water could gravitate from the latter dam site to King William's Town.

- Nahoon River

  A potential dam site has been identified on the farm Stone Island 3 km upstream of the road linking Berlin and Macleantown, from where water could be gravitated to East London/Mdantsane or released downstream to the Nahoon Dam.

A preliminary assessment of the yields from possible dams at the sites listed above, together with the estimated yield from the existing Sandile and Binfield Park dams, are contained in the AWRSA. Unit reference values (URVs) and estimated cost for each option have been updated. The results are summarised in Table 5.16 .

Recent construction costs of dams are approximately double what they were in 1999. Hence the URV, capital and O&M costs have been taken as about twice what they were given in the AWRSA.

Table 5.16 Preliminary Estimates of Yields from and Costs of the Possible Bulk Water Supply Augmentation Schemes

Potential Asset Option	River	Available Yield * (Mm^3/a)	Unit Reference Value – 2006 (R/m^3)	Estimated Cost 2006		Timeline Years
				Capital (R million)	O&M (R million/a)	
Stone Island	Nahoon	5.3	2.8	132	2.5	10
Sandile/Binfield Park	Keiskamma	8.7	3.4	220	8.0	4
Groothoek/ Waterfall	Gqunube	12.1	3.5	343	8.6	10
Mhalla's Kop	Gqunube	7.9	3.6	235	8.7	10
Wesselshoek	Kwelera	10.9	3.8	343	7.7	10
Matola	Kubusi	15.8	4.0	490	17.5	10
Ravenswood	Keiskamma	21.3	4.1	607	26.6	10
Thornwood	Keiskamma	29.5	4.4	897	23.9	10
nGutu	Great Kei	55.0	6.1	1804	74.1	15
Junction (Tyume)	Keiskamma	9.0	6.3	495	11.6	10
Blackpool (Clachlan)	Thorn	3.4	6.5	210	4.4	10
Fairways	Buffalo	1.1	6.7	75	1.0	10
North Slope	Toise	2.1	6.8	142	1.6	10
Allandale	Thomas	1.7	8.8	148	1.6	10

*Note: * Available yield is defined as firm yield less EWR (taken as 30% of firm yield) less irrigation less conveyance losses in rivers.*
AWRSA: Amatole Water Resources System Analysis Phase II (November 1999) - Augmentation of Water Resources

5.5.2 Potential Groundwater Assets

The analysis of the groundwater available to augment the bulk water supply for the ABWSS showed the possibility of a yield of 0.2 Mm^3/a from a possible aquifer along the Nahoon River in quaternary catchment R30E. The possible aquifer is referred to as R30E-Middle. The yield would need to be proven in a detailed study as a pilot in order to ascertain the feasibility of incorporating groundwater into the ABWSS, the possibility of the conjunctive use of surface and groundwater as a result of releases to the Nahoon River from the Wriggleswade Dam as well as the potential for enhanced yields through the development of deep wells.

The possible aquifer is downstream of where the Nkobongo River discharges into the Nahoon River. The water from the Wriggleswade Dam would be released to the Nkobongo River near Kei Road, from where the water would flow to the Nahoon River.

The pilot study should be undertaken in two phases. The first phase would be an investigation to verify the aquifer and to provide the data for a decision to be taken as to whether or not it is worthwhile developing a well-field. The second phase would be the development of the well-field.

The proposed approach to establishing the viability of developing the well-field (Phase 1) would involve:

- a detailed hydrocensus/borehole census within the proposed area for development;
- an in-depth remote sensing study, comprising aerial photographic interpretation and satellite imagery, to identify prominent and discernible features;
- the location of the ten best sites using the aerial photographic interpretation;
- a geophysical survey, using magnetic and electromagnetic techniques, and the identification of the five best drilling targets;
- drill the five best drilling targets;
- conduct 72-hour constant discharge tests on each successful borehole;
- assess the hydrochemistry of each successful borehole;
- conduct test releases of water from the Wriggleswade Dam and ascertain the order of magnitude of losses and
- estimate the recharge which could result from the releases from the Wriggleswade Dam.

From the above exercise it should be possible to establish the feasibility or otherwise of developing a reliable assured groundwater well-field.

The exercise should also give an indication of the yields that can be expected from scientifically-sited boreholes in the other aquifers.

Phase 2 would involve equipping the three best boreholes and connecting them to the ABWSS.

Preliminary estimates of the cost of each phase to develop a well field of 0.2 Mm^3/a, together with the timeline is set out in Table 5.17 .

Table 5.17 Preliminary Estimate of Cost for Development of a Possible Groundwater Aquifer Yielding 0.2 Mm^3/a along the Nahoon River

Possible Aquifer		Estimated No of Boreholes		Estimated Cost 2006		Timeline Years
		Drilled	Equipped	Capital (R million)	O&M (R million/a)	
R30E Middle	Phase 1 - Investigation	5	-	1	-	1
	Phase 2 - Development	-	3	1	0.3	1

Two options exist for the use of the groundwater if sufficient volumes are available. The first is to pump the water directly into the supply system for Newlands. The second is to pump and to gravitate the water to the WTW at Nahoon Dam, blending the groundwater with the purified water, for onward transmission to consumers in the Lower Buffalo Scheme.

5.5.3 Potential Desalination Assets

Desalination used to be a less favourable option than other water supply augmentation alternatives, owing to higher capital and operating cost. Changes in technology, however, are making desalination an increasingly attractive possibility for water-stressed areas. Improved membrane technology has reduced the cost of desalinated water to roughly that of the average retail price of potable water in South Africa.

Desalination can be implemented in a short time, which is a major advantage, and can be used to purify treated wastewater for potable, industrial or agricultural uses as well as to purify seawater for the same purposes.

The provision of small desalination plants by property developers to cater for proposed coastal developments along the coast to the north east and south west of East London is becoming an issue. Similarly, the potential use of treated wastewater from the Potsdam/Mdantsane West, Mdantsane East/Reeston, the West Bank, East Bank and the Quinera (Gonubie) WWTWs and/or the desalination of seawater to augment surface and groundwater supplies are important potential sources of water required for East London and the coastal developments.

The negative aspects of desalination are high-energy requirements and the production of highly saline brine. The former has secondary environmental impacts, while the latter has direct environmental impacts, particularly when discharged to watercourses or to plant-rich surf or tidal zones.

Experience from desalination plants around the world, producing some 24 billion m³/day of purified water, is that:

- some 70% to 80% of treated wastewater, which is purified further by desalination methods, can be recovered while some 50% to 60% of seawater is recovered;
- purification of treated wastewater by means of desalination requires around 1 kilowatt hour (kWh) of electricity per m³ of purified water produced while desalination of seawater needs some 4 kWh/m³;
- the costs of purifying water by means of desalination are very sensitive to the capacities of the plants. An Australian example is that the cost per m³ of purifying seawater in a 110 Mℓ/d plant is less than half of that of treating seawater in a 20 Mℓ/d plant;
- South African suppliers of desalination equipment claim that seawater can be purified to potable standard for less than R6/m³, which compares favourably with the cost of surface water sources in many parts of the country;
- desalination costs have reduced by some 80% of what they were in 1980 and continue to fall, possibly by a further 10% over the period covered by the study. The potential reduction is dependent, however, on the cost of energy which currently constitutes between 40% and 50% of operating expenses, as well as a significant part of the capital cost and
- while treated wastewater can be purified to water qualities which exceed international public health standards for potable water by means of pre-treatment, desalination (generally reverse osmosis (RO)) and disinfection, public prejudice against the use of such water is strong. Use of treated wastewater after purification for industrial and agricultural purposes is more acceptable.

In the case of augmentation of coastal supplies to the ABWSS, therefore, two options exist for the application of desalination namely:

- purification of treated wastewater at one or all of the West Bank, East Bank and Quinera (Gonubie) WWTWs. This is in essence use of wastewater and is a method of purifying the wastewater as covered in the section on the use of wastewater and

- purification of seawater to augment the surface and possible groundwater sources supplying the ABWSS.

Present indications are that the development of a well field along the shore to abstract seawater is not promising. Consequently, abstraction from the sea, or possibly from one of the estuaries, seems the most promising option.

Also, due to the lower costs which can be attained through economy of scale, a single desalination plant to meet the shortfall in requirements of East London and the coastal developments would be more beneficial than two or more smaller plants. A seawater desalination plant working in conjunction with a treated wastewater purification plant would also be beneficial from the perspectives of operation, conjunctive use of the wastewater and seawater sources and optimisation of the delivery system to the existing infrastructure.

Either the West Bank or the East Bank WWTW sites would be suitable, with the former having the benefit of the sea outfall for the disposal of brine from both the treated wastewater and seawater purification processes. The disadvantage of the West Bank site is that a WWTW would have to be constructed as sewage is currently screened before being discharged to sea.

Desalination equipment is modular. Consequently the installation can be planned and designed such that parts of the plant cater for the full capacity required to meet the shortfall in surface water and groundwater requirements with the desalination components being added as required to meet long-term as well as short-term drought or operating requirements. The plant could also be used for “peak topping”, thereby using less expensive sources of water to the full.

As the requirements for desalination of seawater is uncertain at this time, an estimated cost per Mm^3/a is given in Table 5.18. Due to economies of scale the estimate would be conservative for plants with larger capacity and might have to be adjusted.

Table 5.18 Preliminary Estimates of Cost for Desalination per Mm^3/a

Potential Use	Unit Reference Value 2006 (R/m^3)	Estimated Cost 2006	
		Capital (RM)	O & M (RM/a)
Domestic	6	30	4
Industrial	4	20	3
Irrigation	3	15	3

CHAPTER 6
Risks

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6 RISKS

6.1 IMPLEMENTATION OF THE STRATEGY

The potential areas or aspects of risk with respect to implementing the strategy, which will require particular attention together with suggestions for risk mitigation measures are set out in Table 6.1.

Table 6.1 Potential Risks and Mitigation Measures

Potential Risk	Suggested Mitigation Measures	Estimated Cost not Included in the Options (R million)
A stakeholder does not accept the strategy or some of its options.	DWAF intervenes to remove the objection.	0
A stakeholder does not, or is unable to, implement an intervention or to create an asset required by the strategy or some of its options.	DWAF or the body responsible for managing the strategy intervenes to assist the stakeholder. Technical assistance could be provided from other stakeholders should the cause be due to the lack of capacity.	Will depend upon the nature, if any, of the technical assistance.
Funds are not available to implement an intervention or to create an asset required by the strategy or some of its options.	DWAF or the body responsible for managing the strategy intervenes to assist the stakeholder. Funding could be accelerated from National or Provincial programmes.	Will depend upon the nature of assistance required.
The part of a stakeholder body responsible to implement an intervention or to create an asset is unable to gain the necessary support/approvals from another part of that stakeholder body.	DWAF or the body responsible for managing the strategy intervenes to assist/mediate between the two parts of the stakeholder.	0
The necessary administrative/financial management/systems are not available or developed to support the WC and WDM interventions.	DWAF or the body responsible for managing the strategy intervenes to assist. Funding and enhancement of capacity could possibly be provided from within the stakeholder bodies or from outside or from National or Provincial programmes.	Will depend upon the nature of the assistance required.
Water in excess of that provided for in the strategy or its options is used by consumers, particularly households registered as being indigent.	The body responsible for managing the strategy would work with the officials and politicians of the responsible stakeholder(s) with a view to taking corrective measures.	Will depend upon the nature of the assistance required.
Water users object to the use of treated wastewater.	Enhance the education interventions amongst the objecting users with a	Will depend upon the nature of the

Potential Risk	Suggested Mitigation Measures	Estimated Cost not Included in the Options (R million)
	view to removing the causes of the concerns. Funding and enhancement of capacity could possibly be provided as part of the National water use efficiency initiatives of DWAF. Alternative use options should be considered if agreement cannot be reached.	assistance required.
A favourable intervention or the least expensive option for the creation of an asset cannot be implemented.	The body responsible for managing the strategy intervenes to remove the hindrance. In the event of failure, the next most advantageous option would be adopted.	0
Disagreement arises between stakeholders regarding the strategy, or any of its options or the way in which the strategy is managed.	The body responsible for managing the strategy would endeavour to resolve the disagreements. Failure to remove the disagreement could be handled in terms of the agreements governing the relationship between the parties, or in the extreme event be taken to mediation or arbitration for settlement.	Will depend upon the nature of the disagreement and the procedure which needs to be followed.
A stakeholder is unable to adequately monitor its portion of the system in accordance with the monitoring indicators required to manage the strategy.	The body responsible for managing the strategy would intervene to assist the stakeholder to remove the reason(s) for the monitoring not being adequate, which could include other stakeholders providing technical assistance or supporting the stakeholder's applications for funding from National or Provincial programmes.	Will depend upon the nature of the assistance required.
Construction of an asset prematurely or with unnecessarily large capacity.	Careful review of the 'triggers' which would herald commitment to the construction of the asset.	Will depend upon whether or not the study which will have been undertaken needs to be updated or refined.
The assurance of supply of certain of the dams is or would be inadequate.	Provide in the strategy for the system yield to have an assurance of supply of 98%, with any shortfall between the quantity of water available from a dam and that required from the dam being augmented from another dam in the	0

Potential Risk	Suggested Mitigation Measures	Estimated Cost not Included in the Options (R million)
	ABWSS. (In essence the ABWSS being operated as a system with an overall assurance of supply of 98% for the system as a whole).	
The requirements of the strategy or some of its options might be too onerous for the strategy to be successfully implemented.	DWAF or the body responsible for managing the strategy would critically review the aspects of concern and would arrange for less onerous requirements where practicable.	Will depend upon the nature of the interventions or asset creation activities which are too onerous.
The process of annual review of the strategy and its options is too onerous and/or too expensive.	DWAF would critically review the process and the structure of the strategy to improve the position.	0

6.2 CLIMATE CHANGE

An aspect which is not directly related to interventions and the creation of assets, but which holds a risk for the relevance of the strategy as a whole, as well as for the options which are selected, is the possible influence of climate change.

Studies into possible climatic change for the Eastern Cape region, within which the Amatole sub-region is situated, suggest increased late summer rainfall, increased temperatures, a change in the intensity and timing of the rainfall regime with longer dry periods in winter as well as during early summer. A review of some of these studies is included in Appendix 6.1. Areas east of the escarpment could become wetter, however, with more rainy days and increased rainfall intensities. Any change in the climate is reflected in the hydrology, potentially increasing variability of runoff into rivers and dams.

Higher rainfall as well as increased rainfall intensities should translate to greater water availability in the late summer months, but probably not in a form conducive to direct abstraction, nor to storage in the ground. The rainfall would also be late to meet the peak water requirements of spring and early summer for both domestic and irrigation users.

Optimum availability of water when it is needed would, therefore, require adequate storage in dams sized for larger rain events over shorter periods than has been customary as well as to meet the peak requirements of spring and early summer, particularly if there is an increase in temperature.

Without compensatory storage, lower water availability could occur in periods of peak demand as well as during dry seasons, as a result of longer dry periods in winter, increasing the risk of dams running low and a consequent decrease in the availability of water. This situation would be aggravated if the water is used inefficiently.

Briefly, likely future climatic changes would necessitate greater efficiency in the storage of water, the possible raising of dams to handle a more intensive rainfall pattern as well as increased rainfall coupled with well-managed abstraction from dams to accommodate longer dry periods during early/mid summer and winter.

Increased dam capacities could help to address these matters, while also assisting in flood attenuation, the collection of water over shorter periods and to allow for abstraction with little or no replenishment over longer periods.

One of the scenarios of the consequences of climate change is that summers would be wetter, but winters would not be drier. If this scenario materialises, increasing the capacities of the dams would still be desirable to enhance the yield from the ABWSS and possibly to attenuate floods in the rainy season. If climatic conditions do not change, it should not be necessary to increase the storage in the existing dams, except if it is beneficial from the perspective of operating the ABWSS as a system.

Irrespective of the consequences of climate change, emphasis on efficiency and optimum use of the ABWSS will be of great benefit.

6.2.1 Options to Mitigate the Risk of Climate Change

- Increase water use efficiency
- Increase the capacities of dams.

Interventions to increase water use efficiency are contained in the section of this report covering WC and WDM.

The capacities of new dams to augment the supply to the ABWSS including the possible need to provide for climate change, should be taken into account when the feasibility studies for the dam or dams are undertaken.

The benefits of increasing the capacities of existing dams will vary according to the dams for which capacity needs to be increased, probably for one or more of the Laing, Bridle Drift, Nahoon and Wriggleswade dams. The other dams are too small to have a significant impact upon the volume of water stored.

Additional storage in the Bridle Drift, Nahoon and Wriggleswade dams would limit water being lost unnecessarily from the system, particularly to the sea. Additional storage in Laing Dam would better secure the supply for the Upper and Middle Buffalo schemes, while being a backup for Bridle Drift Dam.

6.3 STRUCTURE OF THE ABWSS

Currently East London is dependent upon a single source of supply, the Bridle Drift Dam, and a single WTW, Umzonyana. Failure in part or in whole of the dam, the WTW or the conveyance systems for raw and purified water would impact significantly on the industrial, tourism, commercial and domestic activities of the city.

Should coastal developments to the north east and south west of East London be supplied from the ABWSS through East London's bulk supply infrastructure the vulnerability will increase.

Diversification of sources of supply would be beneficial, such as a second supply for East London from Nahoon Dam and/or desalination of wastewater or seawater feeding into key supply zones of East London.

The second, or even third, sources of supply would assist in the provision of potable water for the coastal developments.

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7 THE ABWSS AS A SYSTEM

7.1 INSTITUTIONAL ARRANGEMENTS

Two of the major concerns that stakeholders have with respect to institutional arrangements, are governance and finance. The present indications are that the current governance and financial arrangements do not encourage co-operation between stakeholders with a view to operating the ABWSS as a system.

Focus has been placed in this study upon identification of the central weaknesses of the current arrangements and on formulating options to address the issues with a view to acceptable governance and financial arrangements being attained in order to ensure an adequate supply of water well into the future, to reduce water requirements, to prevent unnecessary pollution of the water resources and to enable the five schemes (and other assets that might be constructed to meet the water requirements) to be integrated into a system.

At the Stakeholder Workshop held on 20 April 2005 the matters listed below were viewed as being the ones requiring attention from the perspectives of governance and finance.

- fragmentation of functions (comprising ownership, operation, management, planning and resource development) and the ABWSS not being operated as a system;
- pricing, sales arrangements, one party not wishing to purchase water from another and the utilization of income from water (water supply and sewerage services) for non-water related activities, all resulting in a reduction of the funds available from water revenues for reinvestment in water infrastructure and management and
- the need for DWAF (or possibly a statutory body) to take a leading role in resource and general water management as well as in pollution prevention.

Each matter is considered in turn below.

7.1.1 Fragmentation of Functions

The ownership, operation and management of the components of the ABWSS are illustrated in Table 7.1.

Table 7.1 Ownership, Operation and Management of Components of the ABWSS

Component	ADM		AW		BCM		DWAF	
	Own	O&M	Own	O&M	Own	O&M	Own	O&M
Dams								
Maden					X	X		
Rooikrantz				X			X	
Laing				X			X	
Bridle Drift					X	X		
Nahoon				X			X	
Gubu				X			X	
Wriggleswade				X			X	
WTWs								
Rooikrantz			X	X				
KWT					X	X		
Laing			X	X				
Needs Camp					X	X		
Umzonyana					X	X		
Nahoon			X	X				
Stutterheim	X	X						
Kei Road	X	X						
WWTW								
Schornville					X	X		
Zwelitsha					X	X		
Berlin					X	X		
Breidbach Ponds					X	X		
Bhisho Ponds					X	X		
Mdantsane West/Potsdam					X	X		
Mdantsane East					X	X		
Reeston					X	X		
Amalinda Central					X	X		
West Bank (Hood Point) (Screens)					X	X		
East Bank/Nahoon					X	X		

Component	ADM		AW		BCM		DWAF	
	Own	O&M	Own	O&M	Own	O&M	Own	O&M
Quinera (Gonubie)					X	X		
Stutterheim	X	X						
Distribution and Reticulation								
Upper Buffalo	X	X	X	X	X	X		
Middle Buffalo			X	X	X	X		
Lower Buffalo					X	X		
Upper Kubusi	X	X						
Middle Kubusi								

ADM draws water for its Kei Road WTW from the Wriggleswade Transfer Scheme's canal and supplies potable water to consumers, mainly in the small towns and rural settlements in the vicinity of Kei Road. The area of supply will be enlarged through the implementation of the Amahlati South Water Supply Scheme. That scheme will link to water services supplied by AW from the Rooikrantz Dam and the Rooikrantz WTW.

Raw water for Stutterheim is abstracted from the Kubusi River and some of its tributaries. WTWs produce potable water from which the water is distributed to consumers within Stutterheim as well as to neighbouring towns and settlements.

ADM owns, operates and manages the WWTWs serving Stutterheim and the neighbouring towns.

AW operates and manages the dams owned by DWAF and releases raw water to BCM from the Rooikrantz Dam for purification by BCM at KWT and for the raw water supply to Da Gama Textiles in Zwelitsha. AW also owns the WTWs and produces potable water at the Rooikrantz, Laing and Nahoon dams.

AW delivers the water produced at the Rooikrantz WTW to consumers in the rural settlements to the north and north west of KWT/Bhisho. The area of supply is within the municipal boundaries of both Amahlati LM and BCM. AW delivers the water produced at the Laing WTW to consumers in the rural settlements between Mdantsane and KWT/Bhisho, to the Berlin industrial area as well as to BCM to augment the supply from Rooikrantz Dam for KWT/Bhisho when such augmentation is necessary. Most of the consumers are within the BCM municipal boundary. A small number of rural settlements in the Ngqushwa LM also receive water from this supply. AW delivers the water from Nahoon Dam to Newlands as well as to reservoirs at Mdantsane for distribution to consumers by BCM together with water which BCM itself produces.

AW operates and manages the Gubu and the Wriggleswade dams as well as the Wriggleswade Transfer Scheme, making raw water available to users when the need arises.

AW does not own, operate or manage WWTWs.

BCM owns, operates and manages the Maden and the Bridle Drift dams. The former dam provides raw water via the Rooikrantz Dam for purification in KWT. Water from Bridle Drift Dam is abstracted by BCM downstream of the dam at Umzonyana, where BCM produces potable water and distributes it to consumers in East London, neighbouring coastal developments and Mdantsane.

BCM owns, operates and manages all the WWTWs within the area of supply of the ABWSS, except for those serving Stutterheim and its neighbouring towns.

DWAF owns the Rooikrantz, Laing, Nahoon, Gubu and Wriggleswade dams and oversees their management by AW.

The current arrangement is shown diagrammatically in Figure 7.1.

In order to illustrate the participation of each stakeholder in the ABWSS, the extent to which each stakeholder produced potable water, treated wastewater or provided storage for raw water during 2005 is summarised in Table 7.2.

The quantity of potable water produced in 2005 as recorded by stakeholders is set out in Chapter 4, while the volume of wastewater recorded as having been treated during that period is given in Chapter 5. The yields of the dams will depend upon the assurance of supply and the EWR categories that will be adopted by stakeholders as outlined in Chapter 3. Consequently only an approximation of the proportions of yield from the dams owned by the various stakeholders can be given.

Table 7.2 Stakeholders, Potable Water Produced, Wastewater Treated and Raw Water Provided - 2005

Stakeholder	Potable Water Produced (Mm³/a)	Proportion of Potable Water Produced %	Wastewater Treated (Mm³/a)	Proportion of Wastewater Treated %	Yield of Dams at 98% Assurance of Supply with no EWR Supplied (Mm³/a)	Proportion of Yield %
ADM	1.21	2.0	0.60	1.8	0	0
AW	15.06	24.6			0	0
BCM	44.89	73.4	31.97	98.2	29.9	31.5
DWAF					65.0	68.5
Total	61.16	100.0	32.57	100.0	94.9	100.0

The outline shown in Table 7.1, Figure 7.1 and in Table 7.2 gives an indication as to the roles of the stakeholders, the manner in which their activities interrelate and the proportions which each contributes to the water and sanitation services in the ABWSS.

In summary, AW has the largest role in maintaining and operating dams while being the second largest producer of potable water.

BCM is the largest producer of potable water, treats by far the greatest quantity of wastewater and is the second largest provider (owner, operator and manager) of storage.

DWAF is the largest owner of storage.

Due to the number of stakeholders it will be difficult to operate the ABWSS as a system, unless there is a reallocation of roles and responsibilities (possibly accompanied by changes in the ownership of assets) or unless the arrangement is governed under the control of a body by clear arrangements and service delivery agreements which set out the roles and responsibilities of the stakeholders together with remedial measures which apply in the event of a stakeholder not fulfilling its obligations. Agreements currently exist, but they are inadequate and they need to be refined in places in order to address the issues, which are the cause of the ABWSS not being operated as a system.

There are several ways (options) in which amendments can be made. Some promising options are briefly considered below and are illustrated in Figure 7.2 to Figure 7.5.

7.1.2 Options for the Ownership, Operation and Management of Assets in the ABWSS

The ownership, operation and management of existing and future assets in the ABWSS can be arranged in several ways, four of which are outlined below. The options are:

- Option 1: extend and refine the current arrangements;
- Option 2: BCM as the main operator;
- Option 3: AW and DWAF as the supplier of raw water with the WSAs producing and distributing potable water and
- Option 4: AW (or a water company of which the WSAs have a part) as the producer of potable water.

Each of the four options is outlined briefly below.

Option 1 - Extend and Refine the Current Arrangements

The arrangement is shown diagrammatically in Figure 7.2.

In essence the functions of the stakeholders remain the same with DWAF developing new surface and possibly groundwater resources. AW would operate and manage the new assets.

However, due to the close relationship between the treatment of wastewater and its use, the proposal is that the relevant WSA (possibly only BCM) would produce potable/industrial water from wastewater if that option is selected to augment the supply of raw water. Similarly, if the treatment and use of wastewater were to be handled conjunctively with the desalination of seawater, BCM would own, operate and manage the desalination assets.

This option does not resolve the underlying issues, which currently have an adverse effect upon the operation of the ABWSS. In order to address those issues, the method of operating the schemes and arrangements between the parties would need refinement in service delivery agreements (SDAs) with respect to:

- transparency between stakeholders of the manner in which the unit cost of water would be determined by each stakeholder;
- consistency between stakeholders as to what is included in the price of water as well as the manner in which account would be taken of costs;
- the manner in which charges would be levied between stakeholders and terms of payment;
- licensing and water allocations to stakeholders together with the resulting payment obligations;

- the extent to which BCM would utilise its own dams – before being required to draw water from DWAF's dams;
- agreement that new assets would be developed only once existing assets in the ABWSS are well utilised;
- DWAF would develop and own new surface water and subterranean water resources, AW would operate and manage those assets, while the WSAs would provide, operate and manage assets for the use of wastewater and desalination;
- the manner in which the ABWSS would be augmented to serve consumers outside of the current area of supply of the ABWSS;
- the quality of the water, which would be returned to the ABWSS by the WSAs and the manner in which sewage and wastewater spills would be avoided;
- remedial measures in the event of a stakeholder not fulfilling its obligations;
- the quality of potable/industrial water provided by one party to another and
- the body that would orchestrate agreements and ensure compliance with the SDAs.

Option 2 – BCM as the Main Operator

The arrangement is shown diagrammatically in Figure 7.3 and is based on a geographical separation of functions.

In this option BCM would own, operate and manage all the existing and future assets, which provide water to BCM or which treat wastewater emanating exclusively or largely from Buffalo City. BCM would also own, operate and manage the assets, which currently belong to AW and to DWAF within BCM.

Consumers outside of BCM would be provided with water in bulk by either AW/DWAF or by the relevant WSA. BCM would provide water in bulk to adjoining WSAs where that is the most appropriate arrangement.

The WSAs would own, operate and manage the infrastructure delivering water to consumers and in handling wastewater generated by the consumers.

Assets required to augment the supplies exclusively for BCM would be developed and owned by BCM, while assets to serve other WSAs together with or apart from BCM would be developed by DWAF and be operated as well as managed by AW.

In essence, therefore, all the dams in the ABWSS, with the exception of the Gubu and Wriggleswade dams would be owned, operated and managed by BCM. BCM would also own, operate and manage all the WTWs and WWTWs in the area of supply of the ABWSS, except where ADM wishes to retain those functions in its area of jurisdiction. The same principle would apply to WSAs outside of the area currently supplied by the ABWSS, such as the coastal zones and rural settlements.

The same or a similar arrangement would apply for bulk water supplies to consumers within the area of jurisdiction of BCM, but outside of the area of supply of the ABWSS, as well as to the treatment and use of wastewater from those consumers.

To give effect to the option, agreements would be required between the stakeholders covering matters such as:

- the transfer of assets to BCM;
- SDAs between the stakeholders to cover the services that one stakeholder would provide to another;
- the manner in which charges would be levied between stakeholders and terms of payment;
- licensing and water allocations to stakeholders together with the resulting payment obligations;
- the manner in which the ABWSS would be augmented to serve consumers outside of the current area of supply of the ABWSS;
- development of further assets only after the Gubu and Wriggleswade dams are fully utilised and
- remedial measures in the event of a stakeholder not fulfilling its obligations.

Option 3 - DWAF/AW as the Raw Water Supplier

The arrangement is shown diagrammatically in Figure 7.4 and is based on separating raw water supply from potable/industrial water production and distribution. The option is based on a "product" separation of functions.

In this option DWAF would own all the dams and raw water conveyance assets (which would be operated and managed by AW) while the WSAs would own, operate and manage all the WTWs, WWTWs and wastewater use installations. Desalination plants could be owned, operated and managed by either DWAF/AW or BCM, with the latter being preferred as the sea would be the raw water source and also to promote the conjunctive use of wastewater and the desalination of seawater.

The WSAs would deliver water to consumers.

To give effect to this option, agreements would be required between the stakeholders covering matters such as:

- the transfer of assets between DWAF, AW and BCM;
- SDAs between DWAF/AW and the WSAs regarding the quantity and quality of raw water provided to the WSAs as well as for the wastewater returned by the WSAs to the rivers;
- transparency between stakeholders of the manner in which the unit cost of raw water would be determined;
- the manner in which charges would be levied between stakeholders and terms of payment;
- licensing and water allocations to stakeholders together with the resulting payment obligations;
- agreement that new assets would be developed only once existing assets are well utilised;
- the manner in which the ABWSS would be augmented to serve consumers outside of the current area of supply of the ABWSS;
- DWAF would develop and own surface water and subterranean water resources, AW would operate and manage those assets, while the WSAs would provide, operate and manage assets for the production of potable/industrial water, for the treatment and use of wastewater and for the desalination of seawater;
- the manner in which the WSAs would avoid sewage and wastewater spills;
- remedial measures in the event of a stakeholder not fulfilling its obligations and
- the body that would orchestrate agreements and ensure compliance with the SDAs.

Option 4 – AW or a Water Company as the Supplier of Potable Water

The arrangement is shown diagrammatically in Figure 7.5.

In this option DWAF would own all the dams and raw water conveyance assets, which would be operated and managed by AW or a water company owned by the WSAs and by AW. Also AW or the water company would own, operate and manage all the WTWs, WWTWs, wastewater use installations and seawater desalination plants.

The WSAs would deliver water to consumers, although the duties of AW or the water company could be extended to include the supply of potable water to individual consumers. This aspect falls outside the scope of a bulk water strategy and is not considered as part of the option.

To give effect to this option, agreements would be required between the stakeholders covering matters such as:

- establishment of a water company owned by all or some of the stakeholders or a change in the authorizations applicable to AW;
- the transfer of assets between DWAF, BCM and AW or the water company;
- SDAs between DWAF and AW or the water company as well as between AW or the water company and the WSAs regarding the quantity and quality of potable/industrial water provided to the WSAs as well as for the wastewater returned by AW or the water company to the rivers;
- transparency between stakeholders of the manner in which the unit cost of potable and industrial water is determined;
- the manner in which charges would be levied between stakeholders and terms of payment;
- licensing and water allocations to stakeholders together with the resulting payment obligations;
- DWAF would develop and own surface water and subterranean water resources, AW or the water company would operate and manage those assets, while AW or the water company would provide, operate and manage assets for the production of potable/industrial water, for the treatment and use of wastewater and for the desalination of seawater;
- the manner in which the ABWSS would be augmented to serve consumers outside of the current area of supply of the ABWSS;
- the manner in which AW or the water company and the WSAs would avoid sewage and wastewater spills;
- remedial measures in the event of a stakeholder not fulfilling its obligations and
- the body that would orchestrate agreements and ensure compliance with the SDAs.

7.1.3 Consideration of the Options

All four options have pros and cons and have precedent elsewhere in South Africa.

The disadvantage of options 2, 3 and 4 is that assets and staff need to be transferred between stakeholders, with considerable changes to stakeholder organizations. Much management time and effort will be involved and there could be an impact upon the viability of one or more of the stakeholders with respect to the delivery of water and sanitation services. Also, as all stakeholders serve consumers beyond the boundaries of the ABWSS, changes would have to take into account those consumers and how they can best be served.

Stakeholders who attended the Working Meeting on 13 March 2007 reported that a process of institutional reform in the water sector involving ADM, the Chris Hani DM, BCM and AW has recently started. This will necessitate the existing institutional arrangement continuing for the next 2 to 5 years at least.

It will be incumbent upon the stakeholders to address the shortcomings in the current institutional arrangements governing the ABWSS as part of the reform process, as a precursor to continuing with the current arrangements or in deciding upon an alternative arrangement.

The remainder of this chapter, therefore, considers Option 1 and ways in which the current institutional arrangement between stakeholders could be refined to improve shortcomings. Many of the refinements would in any event be required for the other options and would not be lost should an alternative institutional arrangement be selected by stakeholders.

7.1.4 Water Pricing, Sales Arrangements and the Utilization of Income

There is not a meeting of the minds between DWAF, AW and BCM regarding the manner in which costs should be determined for the supply of bulk water in the ABWSS.

An analysis of the manner in which AW, BCM and DWAF account for water has been undertaken based upon limited records for 2005. The analysis is contained in Appendix 7.1. The record periods were not identical but the information was sufficiently consistent to draw conclusions. The three stakeholders were selected, as they are responsible for all the storage and for 98% of the potable water produced in the ABWSS.

Figure 7.1 Current Arrangement

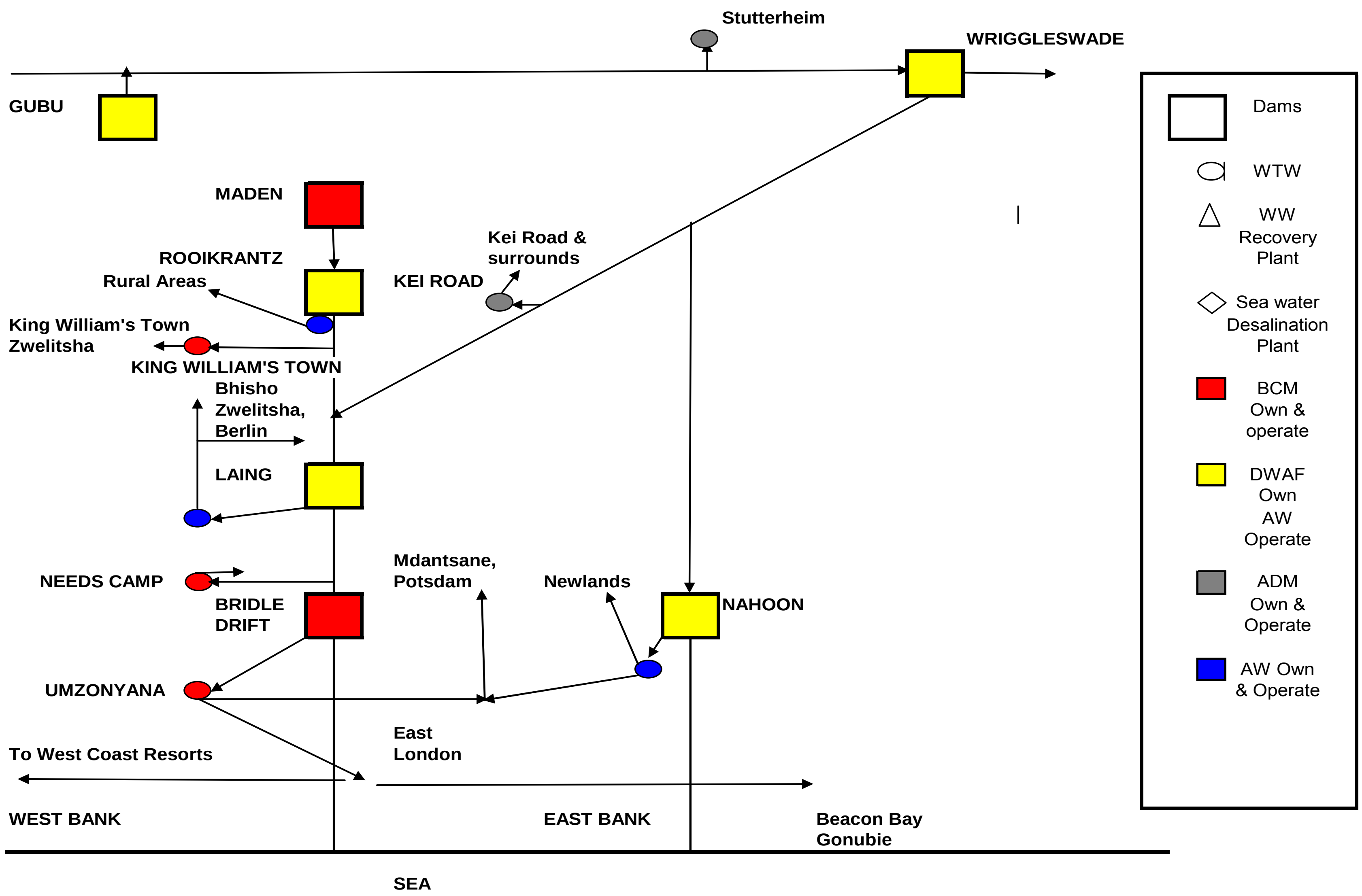


Figure 7.2 Option 1 - Extend Current Arrangements

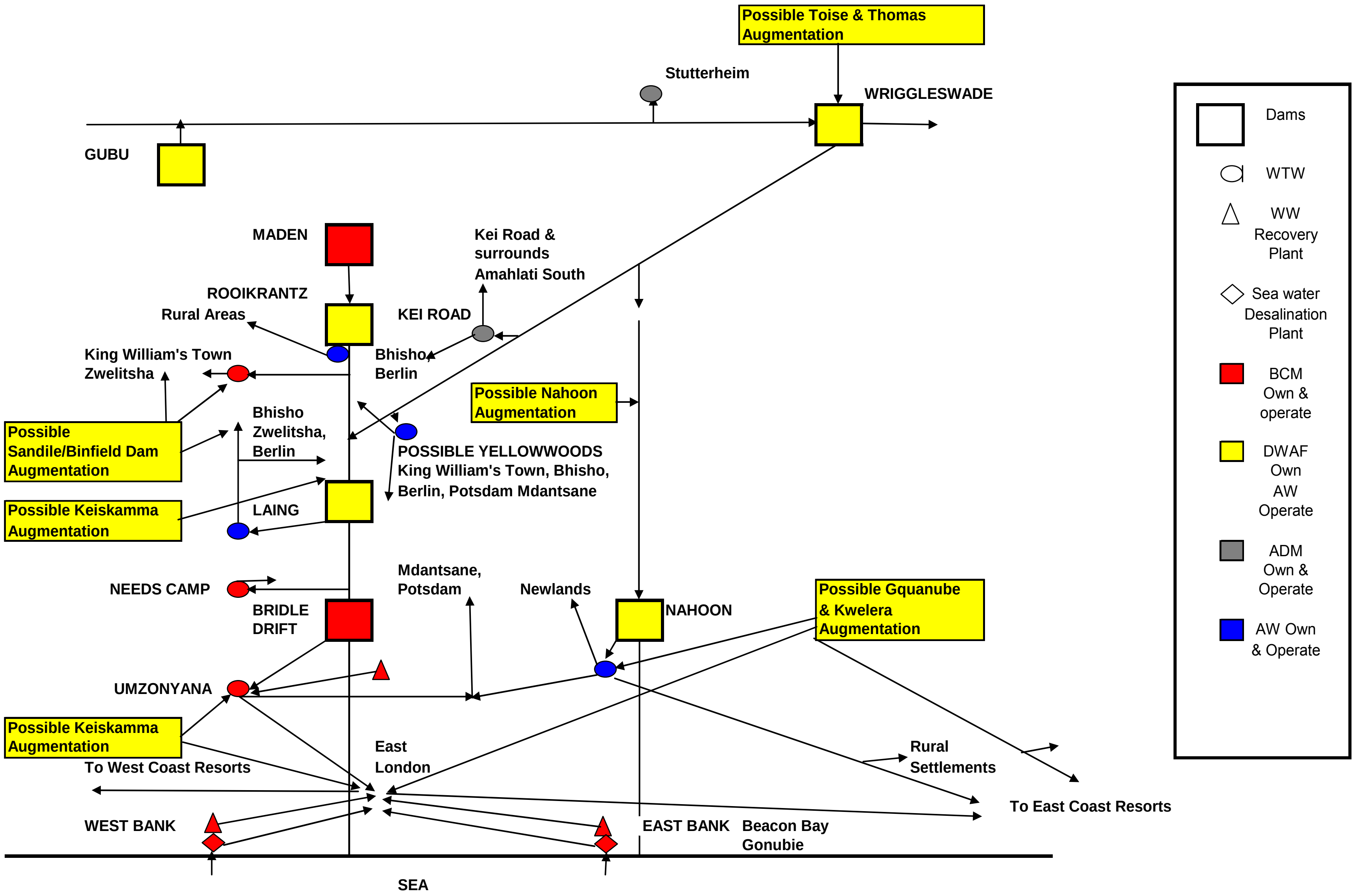


Figure 7.3 Option 2 – Buffalo City Municipality as the Main Operator

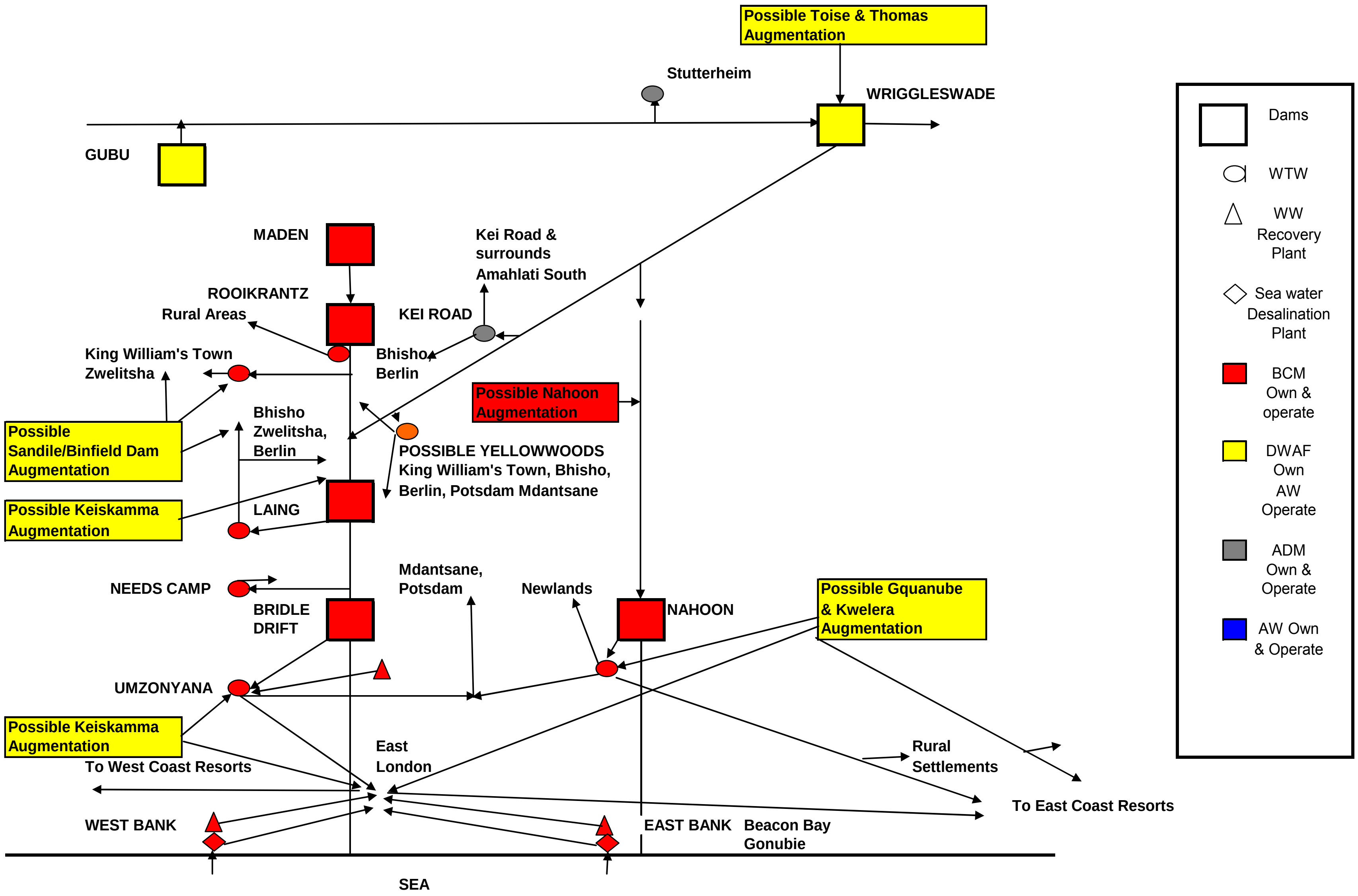


Figure 7.4 Option 3 – DWAF/Amatola Water as the Raw Water Supplier

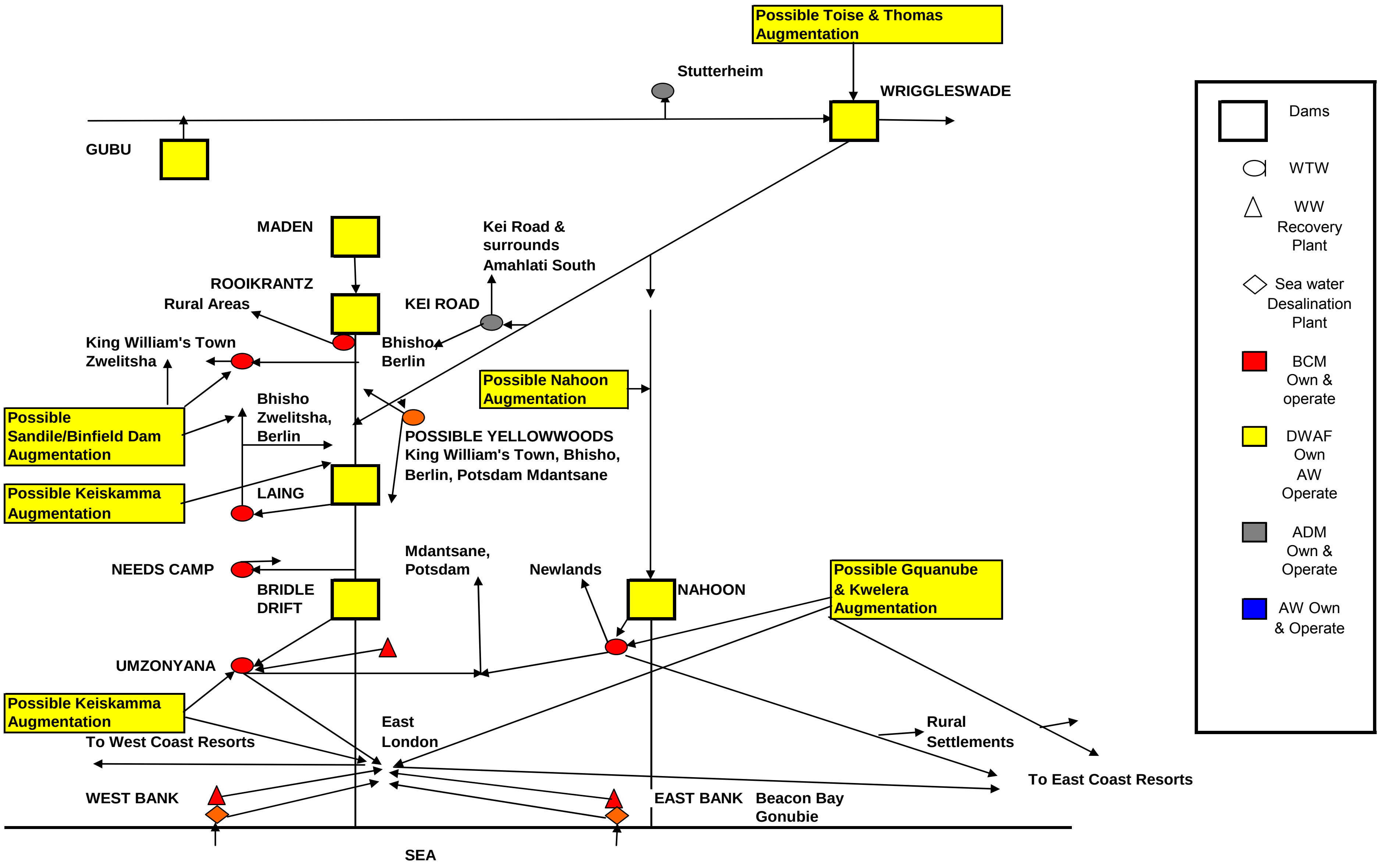
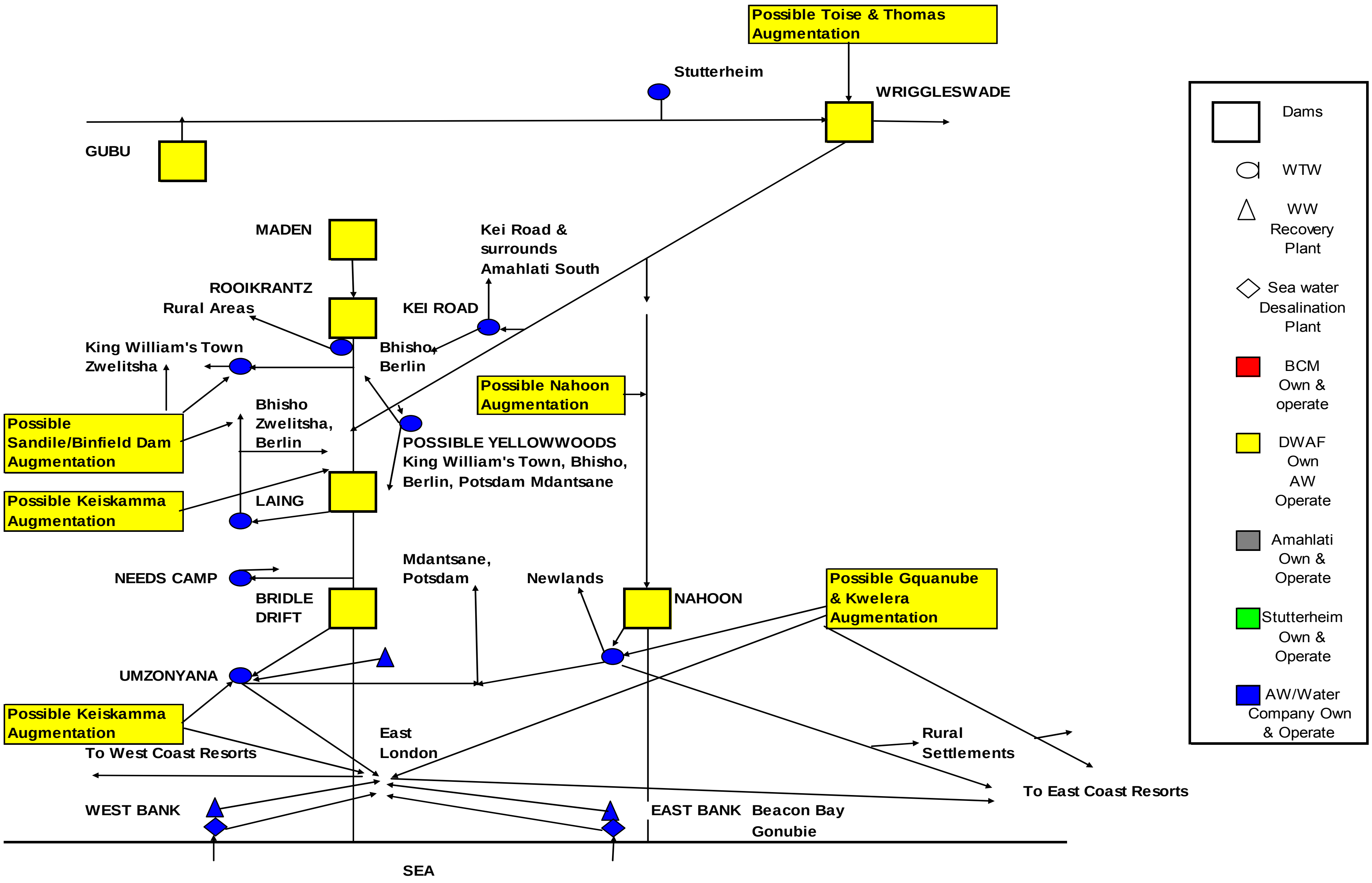


Figure 7.5 Option 4 – Amatola Water or a Company as the Supplier of Potable Water



Key conclusions drawn from the analysis are the following:

- AW and BCM adopt different methods to account for:
  - general expenses, chemicals and electricity;
  - management and administration costs;
  - interest, redemption of capital and depreciation and
  - purchase of bulk water.

  Together, these aspects could account for up to 200c/kl of the difference between the costs reflected by AW and those shown by BCM;

- more water is abstracted from the Bridle Drift Dam than the assured yield of the dam, without BCM accounting for the cost of the additional raw water. The "over abstraction" amounts to some 40% of the yield of the dam at a 98% assurance of supply. From the AWRSA the least expensive augmentation option yielding the minimum shortfall has a unit reference value of 148c/kl (at 1997 values);

- if the difference in the manner in which BCM accounts for the production of purified water is added to the unit reference value of an augmentation scheme as outlined above, then the overall cost of potable water from BCM would be similar to that charged by AW to BCM;

- "Return on assets" (RoA) in DWAF's charges to AW is the largest single component of DWAF's bulk water charges to AW, amounting to almost 66c/kl. Also this component is calculated on the basis of an annual re-evaluation of the value of assets and not on construction cost, which seems to be the basis that BCM adopts for its calculations. In turn, bulk water purchases and the water research levy is the largest component of AW's charge to BCM. The RoA reflects the opportunity cost of water and the proceeds are made available to WSAs for water and sanitation projects;

- the under utilization of assets, (particularly the Wriggleswade transfer scheme where virtually none of the capacity is utilized and the Nahoon WTW where less than 50% of the installed capacity is used), coupled with high costs of the small WTWs (such as Rooikrantz and Needs Camp) have an adverse effect upon the overall cost of producing potable water, ranging from some 90c/kl in the case of the Nahoon WTW to more than 1 000c/kl in the case of the Rooikrantz WTW. Existing assets should be fully utilized before new assets are developed, while consideration should be given to alternatives for the small WTWs;

- DWAF is not recovering what its pricing calculations indicate it should. The main reason is that the unit cost of raw water provided by DWAF for domestic and industrial purposes is based upon the sale of 41.45 Mkℓ/a, whereas 15.9 Mkl/a is registered to AW (the only registered user). In 2005, AW sold some 16.67 Mkℓ/a after purchasing some 18.3 Mkℓ/a from DWAF, which did not receive an income for the remainder;

- BCM obtained the benefit of DWAF's dams without contributing to their cost, while DWAF did not obtain the benefit of cost recovery to the extent reflected by the calculations for the unit cost of raw water. Particularly the RoA was not realised and
- financial compensation for return flows does not appear to be taken into account.

The analysis identified some possible causes of discrepancies, which could result in misperceptions related to the costs of raw water and potable water that is produced. By giving attention to the aspects outlined above, common ground could be found for a pricing strategy, which would enable the ABWSS to be operated as a system, without hindrance of the pricing mechanism.

While each stakeholder operates within a broader institutional and financial framework, it would be beneficial if a consistent way of accounting, allocating costs and inclusion of items in the financial statements can be agreed. At a meeting of the ASSC on 15 May 2007 a template was tabled which could form the basis for consistency amongst stakeholders in recording costs/pricing of bulk water. The template is reproduced in Appendix 7.2.

In addition the SDAs between the stakeholders should include the manner of determining volumes for the determination of unit costs particularly with respect to the application of EWRs, water allocations which are not taken up, water use which is not taken into account when determining unit costs and the way in which return flows are taken into account.

Finance for municipal services always presents a challenge. The situation appears to be compounded in this instance by the pricing and asset utilization issues outlined above. Certain stakeholders are of the view that the situation is made worse by revenues generated through water and sanitation services being utilized for purposes other than for water and sanitation as well as through cross-subsidisation that is not transparent.

While this may be true, the Local Government Municipal Systems Act, 2000 (Act No. 32 of 2000) is specific in Section 79 that "If a municipality decides to provide a municipal service through an internal mechanism ……………………, it must-

(a) allocate sufficient human, financial and other resources necessary for the proper provision of the service ….. ".

All the municipalities served by the ABWSS have opted for internal delivery mechanisms and are bound, therefore, by the requirements of Section 79 of the Act.

It will be incumbent therefore on the institution charged with overseeing the ABWSS to work with the relevant water and sanitation delivery stakeholders to obtain the necessary resources, whether or not they are obtained from water and sanitation revenues or other sources as well as to attain transparency in the manner in which costs are determined and in which cross-subsidisation/RoA are recorded.

7.1.5 A Body to take a Leading Role in Resource and General Water Management as well as in Pollution Prevention

The need was expressed by certain stakeholders at the Stakeholder Workshop held on 20 April 2005 that DWAF (or possibly a statutory body) should take a leading role in resource and general water management as well as in pollution prevention.

At the Steering Committee meeting held on 29 August 2005 stakeholders requested the Planning Team to make proposals for a statutory body, established in terms of the National Water Act, together with the necessary structure, to manage the implementation of the strategy. The committee or body should have the ability to attain compliance with the regulations and that "rules of engagement" between the stakeholders should be provided for in the institutional arrangements.

The position was reviewed at the Working Meeting on 13 March 2007. The consensus was that a suitable Strategy Steering Committee (SSC) would be adequate. A statutory body could be a 'fall-back institutional arrangement' in the event of the voluntary association of stakeholders (governed by appropriate SDAs) being inadequate.

The National Water Act (Act No. 36 of 1998) (NWA) makes provision for two forms of statutory bodies, which could provide the fall-back institutional arrangement. The forms of the bodies are:

- Catchment Management Agencies (CMAs) (Chapter 7 of the NWA) and
- water user associations (WUAs) (Chapter 8 of the NWA).

The suitability of each of the bodies for the institutional arrangement for the ABWSS is outlined below.

7.1.5.1 Catchment Management Agency

The preamble to Chapter 7 of the NWA outlines the purpose of CMAs as follows:

"The purpose of these agencies is to delegate water resource management to the regional or catchment level and to involve local communities, within the framework of the national water resource strategy ………. the ultimate aim is to establish catchment management agencies for all management areas ……".

In due time, nineteen CMAs will be established, each CMA being the responsible authority for water resource management in a Water Management Area (WMA). The ABWSS forms one of five sub-areas within the Mzimvubu to Keiskamma Water Management Area (WMA 12). The other four sub-areas are:

The Keiskamma sub-area;

The Upper Kei sub-area;

The Middle Kei sub-area and

The Lower Kei sub-area.

Consequently the ABWSS would form only part of the responsibility of the CMA, which would have to give considerable attention to the other sub-areas. It is unlikely that the CMA would be in a position to give most of its attention to the ABWSS, and definitely not all of its attention.

Due to the broad stakeholder membership of the CMA across the WMA and well beyond the area of supply of the ABWSS, a CMA is unlikely to be an arrangement of stakeholders for the management of the strategy arising from this study. It could, however, be a body that has the ability to attain compliance with regulations and which can formulate as well as manage "rules of engagement" between the stakeholders, but might well not have the capacity to give adequate attention to the matter.

7.1.5.2 Water User Association

The preamble to Chapter 8 of the NWA outlines the purpose of a WUA as follows:

" ………. Although water user associations are water management institutions their primary purpose, unlike catchment management agencies, is not water management. They operate at a restricted localised level, and are in effect co-operative associations of individual water users who wish to undertake water-related activities for their mutual benefit. A water user association may exercise management powers and duties only if and to the extent these have been assigned or delegated to it. ………. The functions of a water user association depend on its approved constitution, ………..''

The ABWSS and the institutions, which own and operate it, comply with the requirements of a WUA in respect of operations being at a restricted localised level, the individual water users (or the bodies which provide water to the end users) wish (and need) to co-operate, while the water-related activities are to mutual benefit. The ability for a WUA to be formed to enable the ABWSS to be operated as a system would depend, therefore, upon the powers and duties that would be assigned to it as well as upon approval by the Minister of Water Affairs and Forestry of the WUA's constitution.

A WUA could be an arrangement of stakeholders for the management of the strategy arising from this study. It could also be a body that has the ability to attain compliance with regulations and which can formulate as well as manage "rules of engagement" between the stakeholders.

In the event of an SSC proving inadequate to manage the strategy arising from this study, a WUA would be the most appropriate body for the management of the strategy as well as to formulate and manage "rules of engagement" between the stakeholders.

7.1.5.3 Proposed Institutional Arrangement for the ABWSS

The institutional arrangement for the implementation of the strategy arising from the study was again considered at the Steering Committee meeting held on 8 November 2007. At the meeting stakeholders agreed that the following two committees will be established:

- Amatole System Strategy Steering Committee (ASSSC) and
- Amatole System Operations Co-ordination Committee (ASOCC).

The ASSSC will have influence but no executive authority. Its objectives will be to:

- ensure an adequate supply of water for the ABWSS;
- ensure that the ABWSS is operated as a system;
- monitor progress of the strategy;
- ensure the strategy remains relevant;
- oversee the periodic updating of the strategy;

- be a representative forum of stakeholders;
- facilitate between stakeholders where necessary and
- communicate the strategy to stakeholder bodies (particularly the upper echelons of the organisations) as well as to interested and affected parties.

The view of the stakeholder representatives at the Steering Committee meeting was that the following stakeholders should be represented on the ASSSC:

- ADM;
- AW;
- BCM;
- DWAF (Regional Offices and relevant Head Office Directorates);
- Provincial Department of Agriculture;
- Provincial Department of Economic Development and Environment Affairs;
- Provincial Department of Provincial and Local Government and
- the Kubusi Irrigation Board.

The ASOCC will build upon the good work done by the existing ASCC and will in essence be the formalisation of an existing informal arrangement between relevant stakeholders.

The ASOCC will not take over any of the operational duties or responsibilities of the stakeholders, but will co-ordinate their activities to the extent required for the ABWSS to be operated as a system. Its objectives will be to facilitate:

- the operation of the ABWSS as a system;
- monitoring for strategy purposes and
- the preparation of SDAs.

The view of stakeholder representatives at the Steering Committee meeting was that the following stakeholders should participate in the ASOCC:

- ADM;
- AW;
- BCM;
- DWAF (Regional Offices supported by relevant Head Office Directorates);
- Kubusi Irrigation Board and
- Da Gama Textiles.

Amongst the first tasks of the two committees would be the preparation and signing of memoranda of understanding and terms of reference for the functioning of the committees.

The manner in which the two committees will operate and the issues each will address are likely to evolve over time. It is envisaged that the committees will act impartially and that decisions will be made by means of consensus.

Officials of the stakeholder bodies tend to be very busy. Consequently, it will be necessary to appoint a PSP to provide technical assistance to the ASSSC and the ASOCC, at least in the initial stages until the committees are well established. The PSP will advise the committees and undertake tasks designated to the PSP by either or both committees. Central to these tasks will be assistance with monitoring and updating of the strategy, so as to retain the strategy's relevance as well s to assist the two committees to take decisions timeously but not prematurely.

In essence the ASSSC and the ASOCC (with the support of a PSP where necessary) will fill the current gap that exists to enable the strategy to be implemented, for the ABWSS to be operated as a system while enabling the WSPs and WSAs to fulfil their constitutional as well as legal obligations to water users in their areas of jurisdiction.

7.2 OPERATION OF THE ABWSS AS A SYSTEM

The report "Strategy for Operation of Amatole System", prepared by Ninham Shand, covers details regarding the operation of the seven main dams in the ABWSS.

In 1999, the WRYM and the Water Resources Planning Model WRPM were configured for the ABWSS. The focus of the operating rules was to reduce the supply for certain allocations from Gubu Dam when storage drops below a predetermined level and to transfer water from the Wriggleswade Dam to supplement Laing, Bridle Drift and Nahoon dams. The models are intended for use in planning the further development of the system, particularly for the transfer of water from the Kubusi River via the Wriggleswade Transfer Scheme, and to manage the dams in order to minimise the impacts of severe droughts as well as to reduce the extent to which dams are overtopped or water is released unnecessarily to flow to the sea.

In Chapters 3 and 5 of this reconciliation strategy report, consideration is given to different assurances of supply from the dams in the ABWSS as well as to the desirability of operating the system from the perspective of improving water quality. The conclusion was reached that the system should be operated from the perspective of maximising yield rather than trying to improve water quality by means of releases from the dams. Water quality can best be improved by attending to the causes of pollution.

Furthermore, the yield from the system can be increased by operating the dams at different assurances of supply, thereby reducing loss from the system as a result of unnecessary spillage from the dams.

While the selection of assurances of supply would be the prerogative of stakeholders, the general principle to maximise the yield from the dams is to adopt lower assurances of supply for the dams which currently supply directly to WTWs (Maden and Rooikrantz together, Laing, Bridle Drift and Nahoon dams) and to have higher assurances of supply for the Gubu, and Wriggleswade dams, for dams which might be required in future as well as from the use of wastewater and desalination should those options be adopted so that an adequate assurance of supply is attained for the ABWSS, when operated as a system.

Also, for the ABWSS to be operated as a system and to reduce costs to consumers, it will be beneficial if the existing assets of stakeholders can be used to the maximum, before new assets are developed. The assets are not only the dams, but also the WTWs and water conveyance systems owned by each stakeholder.

An arrangement to operate the ABWSS as an extension of the current ownership and management structure and to maximise the use of existing assets, as well as those assets which might be required, could be similar to that illustrated in Figure 7.6 and quantified in Table 7.3 and Table 7.4. While the arrangement relates to an extension of the existing ownership and management structure, the principles apply, with modification where necessary, to the other ownership/management options outlined earlier. The spreadsheet upon which Figure 7.6, Table 7.3 and Table 7.4 are based, is contained in Appendix 7.3.

Figure 7.6 reflects the ownership of the dams, WTWs, potential wastewater recovery plants and possible seawater desalination plants. In respect of each of the five schemes, which make up the ABWSS, the Lower and Upper scenarios determined through this study are shown for water requirements (without taking into account reductions due to WC/WDM interventions) and dam yields while WTWs' capacities are recorded. Possible dams to augment the supply of water to each of the five schemes of the ABWSS are also shown. The figure serves to illustrate the water requirements, availability of water, potential sources of supply to augment the existing dams as well as existing and potential WTWs in respect of each of the five schemes.

The Lower and Upper scenarios have been selected to illustrate the principles of operation. Scenarios between the Lower and Upper scenarios, as well as scenarios which take into account reductions in water requirements due to WC/WDM interventions could be handled as variations of the approach for either the Lower or Upper Scenario.

Table 7.3 quantifies the manner in which the ABWSS can be operated as a system to optimise the use of the available water resources, to maximise the use of the assets of each of the stakeholders and to identify the maximum extent to which new assets would be necessary to meet shortfalls between water requirements and water availability for domestic and industrial purposes. A similar approach is adopted in Table 7.4 in respect of domestic, industrial and irrigation water requirements.

Arising from the analysis summarised in Figure 7.6 as well as in Tables 7.3 and 7.4, a method by which the ABWSS can be operated as a system is outlined below. For ease of reference the method is described in terms of each of the five schemes that make up the ABWSS and reference is made to the row and column numbers shown in Table 7.3 and Table 7.4.

The options selected to meet the water requirements are not the only ones, which can meet the requirements. They serve to illustrate the manner in which the ABWSS can be operated as a system to fully utilize the dams and WTWs' assets, as well as to show the impact of the upper water requirement scenarios (without the benefit of WC/WDM interventions) on the need for additional asset creation.

The water requirement scenarios that have been selected do not take into account the potential reduction in water use due to WC and WDM interventions or for the use of treated wastewater while the water availability scenarios exclude the return of wastewater to enhance the yields of the dams. The effect of both WC/WDM and wastewater return/use are shown separately.

The yields of the Maden, Rooikrantz, Laing, Bridle Drift and Nahoon dams have been taken at a 90% assurance of supply for the upper scenario and at a 98% assurance of supply for the lower scenario. The yields of the Gubu and Wriggleswade dams have been taken at 98% assurance of supply for both the upper and lower scenarios. Provision has been made for additional interventions and storage to bring the overall yield for the ABWSS as a whole to a 98% assurance of supply.

For ease of representation, Table 7.3 shows the situation with respect to the domestic and industrial requirements for and supply of potable water, as this is the main aspect in which the municipalities are engaged. Table 7.4, which is included later in the text, builds upon the domestic and industrial requirements by including the irrigation requirements.

The manner in which each of the five supply schemes can be operated as part of an integrated system is outlined below.

7.2.1 Upper Buffalo - (Domestic and Industrial Uses)

Cells B2 to E2 of Table 7.3 show the Lower and Upper domestic and industrial potable water requirement scenarios for the Upper Buffalo Scheme. The Lower Scenario is 5.9 Mm^3/a (excluding any requirements outside of the current area of supply of the ABWSS) (cells B2 and D2). The Upper Scenario is 12.49 Mm^3/a (including 0.5 Mm^3/a for requirements outside of the current area of supply of the ABWSS - notably in Amahlati South) (cells C2 and E2).

The water to meet the requirements would be sourced from the Maden, Rooikrantz Laing and Wriggleswade dams, as is currently the case (cells F3 to F5). For all the scenarios the full yield of the Maden and Rooikrantz dams at 90% assurance of supply would be utilized, while water would be abstracted from the Wriggleswade and Laing dams to varying degrees (cells I2 to I5, J2 to J5, K2 to K5 and L2 to L5).

Water would be purified at the Kei Road, Rooikrantz, KWT and Laing WTWs as is currently the case. For the first of the Lower Scenarios (cells O2 to O7), no amendment to the present way of operating would be necessary. A disadvantage of the arrangement is that the full capacity of the Rooikrantz and KWT WTWs would not be utilized (2.56 Mm^3/a would be utilized against a capacity of 5.19 Mm^3/a (cells O4 and N4)).

In the second of the Lower Scenarios (cells Q2 to Q7) the demand on the Laing Dam and the Laing WTW would be reduced by utilizing capacity, which is currently being provided through the augmentation of the Kei Road WTW. By reducing the requirements from the Laing Dam and the Laing WTW to a lesser extent, the arrangement would have sufficient capacity for the relatively expensive Rooikrantz WTW to be taken out of service. A disadvantage remains that the full capacity of the KWT WTW would not be utilized.

The full capacities of the Rooikrantz and KWT WTWs would be utilized for one of the Upper Scenarios (cell P4), while the remaining water would be purified at the Kei Road WTW (cells P3 and P6) and at the Laing WTW (cell P5). The full capacity of the Kei Road WTW, after it is augmented, would not be used.

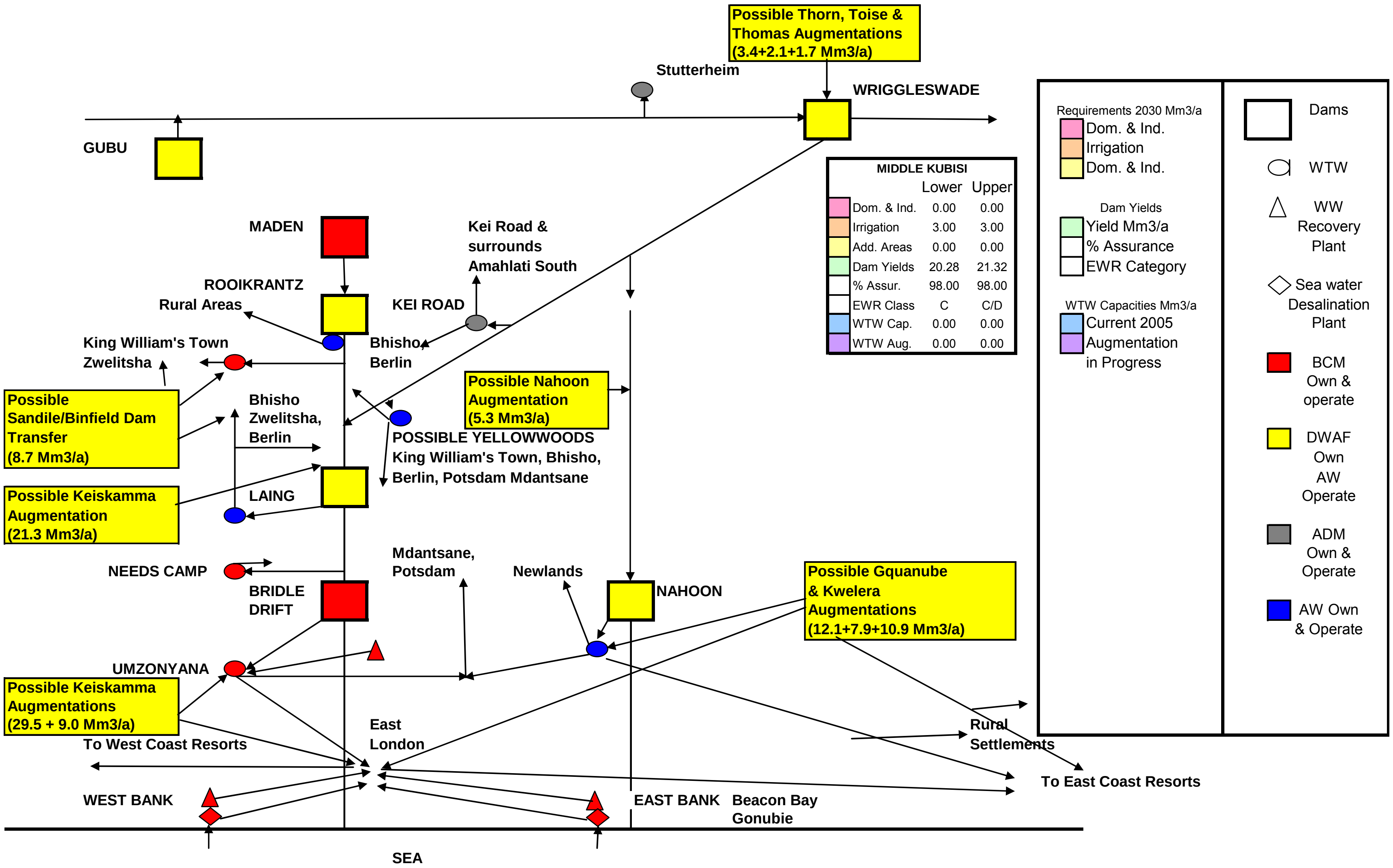
Figure 7.6 Arrangement to Distribute Water within the System

UPPER KUBUSI	Lower	Upper
Dom. & Ind.	3.31	6.65
Irrigation	0.78	6.04
Add. Areas	0.00	0.00
Dam Yields	2.11	2.11
% Assur.	98.00	98.00
EWR Class	C/D	C/D
WTW Cap.	1.39	1.39
WTW Aug.	0.00	0.00

UPPER BUFFALO	Lower	Upper
Dom. & Ind.	5.90	11.99
Irrigation	0.00	1.24
Add. Areas	0.00	0.50
Dam Yields	1.97	2.56
% Assur.	98	90
EWR Class	C	C
WTW Cap.	5.30	5.30
WTW Aug.	1.64	3.28

MIDDLE BUFFALO	Lower	Upper
Dom. & Ind.	6.07	10.46
Irrigation	0.00	3.43
Add. Areas	0.00	0.00
Dam Yields	12.54	14.33
% Assur.	98.00	90.00
EWR Class	C	C
WTW Cap.	10.25	10.25
WTW Aug.	0.00	0.00

LOWER BUFFALO	Lower	Upper
Dom. & Ind.	31.76	70.77
Irrigation	0	2.54
Add. Areas	3.30	10.40
Dam Yields	32.36	38.31
% Assur.	98	90
EWR Class	C	C/D
WTW Cap.	55.84	55.84
WTW Aug.	0.00	10.95



MIDDLE KUBISI	Lower	Upper
Dom. & Ind.	0.00	0.00
Irrigation	3.00	3.00
Add. Areas	0.00	0.00
Dam Yields	20.28	21.32
% Assur.	98.00	98.00
EWR Class	C	C/D
WTW Cap.	0.00	0.00
WTW Aug.	0.00	0.00

Table 7.3 Options to meet Potable Water Requirements at 2030

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
	WATER REQUIREMENTS - 2030					WATER RESOURCES							WATER TREATMENT CAPACITY					
	NATURE	EXISTING SUPPLY AREA		ADDITIONAL AREAS		SOURCE	YIELDS FROM DAMS		POTENTIAL USE FROM DAMS		OPTIONS		WTW	CURRENT WTW CAPACITY	POSSIBLE USE OF CURRENT WTW CAPACITY		OPTIONS FOR ADDITIONAL WTW CAPACITY	
		LOWER	UPPER	LOWER	UPPER		LOWER	UPPER	LOWER	UPPER	LOWER	UPPER			LOWER	UPPER	LOWER	UPPER
		Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a		Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a	Mm3/a	Mm3/a		Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a
1	Upper Buffalo					Upper Buffalo							Upper Buffalo					
2	Dom. & Ind.	5.90	11.99	0.00	0.50				5.90	12.49	6.69	12.49			5.90	12.49	6.69	12.08
3						Wriggleswade	20.28	21.32	0.11	4.35	1.75	4.35	Kei Road (Existing)	0.11	0.11	0.11	0.11	0.11
4						Maden & Rooikrantz	1.97	2.56	2.56	2.56	2.56	2.56	Rooikrantz &KWT	5.19	2.56	5.19	2.56	4.75
5						Laing	12.54	14.33	3.23	5.58	2.38	5.58	Laing	9.96	3.23	5.58	2.38	5.58
6													Kei Road (Augment.ation)			1.61	1.64	1.64
7													KWT and/or Laing					
8	Middle Buffalo					Middle Buffalo							Middle Buffalo					
9	Dom. & Ind.	6.07	10.46	0.00	0.00				6.07	10.46	6.07	10.46			6.07	15.62	6.07	15.62
10						Laing	12.54	14.33	6.07	10.46	6.07	10.46	Laing	9.96	5.78	9.96	5.78	9.96
11						Wriggleswade	20.28	21.32	0.00	0.00	0.00	0.00	Needs Camp	0.29	0.29	0.29	0.29	0.29
12													Laing (Augment.ation)			5.37		5.37
13	Lower Buffalo					Lower Buffalo							Lower Buffalo					
14	Dom. & Ind.	31.76	70.77	3.30	10.40				35.06	85.71	35.06	81.21			35.06	81.17	35.06	81.17
15						Bridle Drift & Nahoon	32.36	38.31	35.06	38.31	35.06	38.31	Umzonyana & Nahoon	55.84	35.06	55.84	35.06	55.84
16						Laing			0.00	-1.71	0.00	-1.71	Umzonyana (Augmentation)			10.95		10.95
17						Wriggleswade			0.00	11.11	0.00	11.11	Umzonyana and/or Nahoon (Augment.) and/or a New WTW			14.38		14.38
18						Wastewater Return/use	20.30			20.30		20.30						
19						Possible Sandile/Binfield Transfer												
20						(8.7 Mm3/a)	8.70			8.70								
21						Nahoon Augmentation	5.30					5.30						
22						(5.3 Mm3/a)												

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R
	WATER REQUIREMENTS - 2030					WATER RESOURCES							WATER TREATMENT CAPACITY					
	NATURE	EXISTING SUPPLY AREA		ADDITIONAL AREAS		SOURCE	YIELDS FROM DAMS		POTENTIAL USE FROM DAMS		OPTIONS		WTW	CURRENT WTW CAPACITY	POSSIBLE USE OF CURRENT WTW CAPACITY		OPTIONS FOR ADDITIONAL WTW CAPACITY	
		LOWER	UPPER	LOWER	UPPER		LOWER	UPPER	LOWER	UPPER	LOWER	UPPER			LOWER	UPPER	LOWER	UPPER
		Mm³/a	Mm³/a	Mm³/a	Mm³/a		Mm³/a	Mm³/a	Mm³/a	Mm³/a	Mm3/a	Mm3/a		Mm³/a	Mm³/a	Mm³/a	Mm³/a	Mm³/a
23						Gqunube + Kwalera Augmentation	30.90					7.90						
24						(12.1+7.9+10.9 Mm3/a)												
25						Keiskama Augmentation	38.50			9.00								
26						(29.5 + 9.0 Mm3/a)												
27						Desalination	22.00											
28	Upper Kubusi					Upper Kubusi							Upper Kubusi					
29	Dom. & Ind.	3.31	6.65	0.00	0.00				3.59	6.93	3.59	6.93			3.31	6.65	3.31	6.65
30						Gubu	2.11	2.11	2.11	2.11	2.11	2.11	Stutterheim	1.39	1.39	1.39	1.39	1.39
31						Wriggleswade			1.48	4.82	1.48	4.82	Kubusi/Wriggleswade		1.92	5.26	1.92	5.26
32	Middle Kubusi					Middle Kubusi							Middle Kubusi					
33	Dom. & Ind.	0.00	0.00	0.00	0.00				18.69	0.00	17.05	0.00			0.00	0.00	0.00	0.00
34						Surplus water from Wriggleswade	20.28	21.32	18.69	0.00	17.05	0.00			0.00	0.00	0.00	0.00
35						Middle Buffalo												
36									5.03	0.00	5.88	0.00						
37						Surplus water from Laing	15.32	16.83	5.03	0.00	5.88	0.00						
38	TOTAL	47.04	99.87	3.30	10.90		69.26	78.63										
39	Quantity to provide an overall assurance of supply of 98%					Quantity Required	9.37											
40						Quantity Available			23.72	0.00	22.93	0.00						
41						Potential Interventions to Provide the Quantity for an overall assurance of supply of 98%												
42						WC/WDM	16			9.37		9.37						

In the other Upper Scenario the full capacities of the Kei Road WTW (cells R3 and R6) and KWT WTW (cell R4) would be utilized with the shortfall being made up from the Laing WTW. The Rooikrantz WTW would be taken out of service. The second augmentation of the Kei Road WTW should not be necessary.

In both the Upper Scenarios raw water would be abstracted from the Wriggleswade Transfer Scheme and be delivered to the KWT WTW for treatment in order to fully utilize the capacity of the KWT WTW. A suitable abstraction point would be in the vicinity of Breidbach.

7.2.2 Middle Buffalo - (Domestic and Industrial Uses)

Cells B9 to E9, of Table 7.3 show the Lower and Upper domestic and industrial water requirement scenarios for the Middle Buffalo Scheme. The Lower Scenario is 6.07 Mm^3/a (excluding any requirements outside of the current area of supply of the ABWSS) (cells B9 and D9). The Upper Scenario is 10.46 Mm^3/a (which excludes requirements outside of the current area of supply of the ABWSS as no such areas are currently envisaged) (cells C9 and E9).

The water to meet the requirements would be sourced from the Laing Dam, as is currently the case (cell F10). For all the scenarios water would be abstracted from Laing Dam at a 90% assurance of supply (cells I9 to I11, J9 to J11, K9 to K11 and L9 to L11).

Water would be purified at the Laing and the Needs Camp WTWs as is currently the case. For the Lower Scenarios (cells O9 to O12 and Q9 to Q12), no amendment to the present way of operating would be necessary. Taking into account the requirements of both the Upper and Middle Buffalo schemes, close to the full capacity of the Laing WTW would be utilized for the first of the Lower Scenarios (capacity of 9.96 Mm^3/a and a requirement of 9.01 Mm^3/a (cells N10, O5 and O10)). Less of the capacity of the Laing WTW will be utilized in the second of the Lower Scenarios in that a smaller quantity of water would be transferred to the Upper Buffalo Scheme (capacity of 9.96 Mm^3/a and a requirement of 8.16 Mm^3/a (cells N10, Q5 and Q10)).

The full capacities of the Laing and the Needs Camp WTWs would be utilized to meet the requirements of the Middle Buffalo Scheme for both the Upper Scenarios (cells N10, P10, R10 and N11, P11, R11). The Laing WTW will have to be augmented by some 5.37 Mm^3/a (cells P12 and R12) to supply water to both the Upper and Middle Buffalo schemes for the Upper scenarios (cells P5 and P10 for the first of the Upper scenarios and R5 together with R10 for the second Upper Scenario). An augmentation of that magnitude would more than fully utilize the yield of the Laing

Dam (yield of 14.33 Mm³/a at a 90% assurance of supply (cell H10)) and water purification capacity of 15.33 Mm³/a (cell N10 together with either cell P12 or cell R12).

In the event of the augmentation schemes for the coastal area south west of East London being constructed, the relatively expensive Needs Camp WTW could be decommissioned. Consumers currently being served by the Needs Camp WTWs would be supplied from the Umzonyana and Nahoon WTWs, which produce potable water at lower cost. The water required for that purpose has been taken into account in the allowance for additional areas in the Lower Buffalo Scheme (cells D14 and E14). Also the water supplied from Laing Dam to the area in close proximity of Needs Camp could be reduced, thereby marginally reducing the requirements from the Laing WTW.

7.2.3 Lower Buffalo - (Domestic and Industrial Uses)

Cells B14 to E14, of Table 7.3 show the Lower and Upper domestic and industrial water requirement scenarios for the Lower Buffalo Scheme. The Lower Scenario is 35.06 Mm³/a (consisting of 31.76 Mm³/a within the area of supply of the ABWSS (cell B14) and 3.30 Mm³/a (cell D14) for supplies to the coastal area to the south west of East London within BCM's area of jurisdiction and which is outside of the current area of supply of the ABWSS (cell D14)). The Upper Scenario is 81.17 Mm³/a (consisting of 70.77 Mm³/a within the area of supply of the ABWSS (cell C14) and 10.40 Mm³/a (cell E14) for supplies to the coastal areas to the south west and north east of East London and which are outside of the current area of supply of the ABWSS (cell E14)).

To meet the water requirements of both the Lower scenarios, the water would be sourced from the Bridle Drift and Nahoon dams (cells I14, I15, I16, I17 and K14, K15, K16, K17). Close to the full yields of the Bridle Drift and Nahoon dams at 90% assurance of supply would be required (35.06 Mm³/a required (cells I14 and K14) and 38.31 Mm³/a available (cell H15)).

The full yields of the Bridle Drift and Nahoon dams at 90% assurance of supply would be required to meet the water requirements of both the Upper scenarios (cells H15, J15 and L15), together with the remaining water from the Wriggleswade Dam at 98% assurance of supply which is not utilized for the Upper and Middle Buffalo as well as for the Middle Kubusi (cell G34 less cells J3, J11 and J31 or cell G34 less cells L3, L11 and L31). The result is that for both Upper scenarios, some 11.11 Mm³/a would be available from the Wriggleswade Transfer Scheme (cells J17 and L17), which if diverted down the Nahoon River in the main, would make up the shortfall between the yield of the Nahoon Dam (4.04 Mm³/a at 90% assurance of supply) and the capacity of the Nahoon WTW (12.04 Mm³/a). Little if any water would be available from Laing Dam as virtually its full yield would be required to meet the Upper Scenario requirements of the Upper and Middle Buffalo schemes.

In addition to the water from the Bridle Drift, Nahoon and Wriggleswade dams, additional water supplies would be necessary for the Upper water requirement scenarios. From the potential water supply augmentation schemes that have been identified in Chapter 5, several could be considered. The most suitable selection would depend upon the extent to which wastewater is returned to the rivers to augment the yields of the dams or used to contribute towards meeting the EWRs as well as the extent to which treated wastewater discharged downstream of the Bridle Drift and Nahoon dams is used. The most advantageous surface water assets will also depend upon the manner in which BCM proposes to develop its WTWs and its water distribution network.

The analysis in Table 7.3 allows for wastewater return/use as the initial interventions to augment the supply of water, followed thereafter by the construction of surface water assets. The quantity in cell G18 is the combination of the estimates of water returned to the rivers to augment the yields of dams in the Upper and Middle Buffalo schemes, as well as in the Upper Kubusi Scheme, together with treated wastewater discharged below the Bridle Drift Dam in the Lower Buffalo Scheme that would contribute towards meeting the EWR together with treated wastewater currently being discharged to the sea from the East Bank, West Bank and Quinera (Gonubie) WWTWs that would be used for domestic and industrial purposes.

The successful return and use of wastewater could augment the supply of raw water by some 20 Mm³/a (cell G18).

The first Upper Scenario in Table 7.3 reflects the strengthening of the dominance of the Umzonyana WTW. To this end the potential dams on the Keiskamma River and its tributaries would be appropriate as the major source [17.70 Mm³/a (cells F20, F26, G20, J20, and J25)] supplying raw water to the Umzonyana WTW. These potential dams have the disadvantage of not having the most advantageous unit reference values (URVs).

The second Upper Scenario reflects the establishment of a second supply route from Nahoon to the northern parts of East London and the north east coastal area. An appropriate route for the supply would be along the watershed between the Nahoon and Gqunube rivers. The main sources of supply would be from dams in the Nahoon, Gqunube and Kwelera rivers amounting to some 13.2 Mm³/a (cells F22 and F24, G21 and G23, L21 and L23). The potential dams have amongst the lowest URVs of the augmentation options considered

The existing capacities of the Umzonyana and Nahoon WTWs exceed the requirements for potable water as reflected in both of the Lower water requirement scenarios (55.84 Mm³/a of purification capacity and a potable water requirement of 35.06 Mm³/a (cell N15 with cell O14 or cell Q14). However for both the Upper scenarios, the WTWs would have to be augmented (cell N15 with cell P14 or cell R14).

BCM is investigating the implications of augmenting the Umzonyana WTW by some 10.95 Mm³/a (cells P16 and R16). Should that augmentation be implemented, a further 14.38 Mm³/a of purification capacity would be required (cells P17 and R17). The most advantageous locality for the augmentation would depend upon the water distribution pattern selected by BCM.

7.2.4 Upper Kubusi - (Domestic and Industrial Uses)

Cells B29 to E29, of Table 7.3 show the Lower and Upper domestic and industrial water requirement scenarios for the Upper Kubusi Scheme. The Lower Scenario is 3.31 Mm³/a [excluding any requirements outside of the current area of supply of the ABWSS (cells B29 and D29)]. The Upper Scenario is 6.65 Mm³/a [(which excludes requirements outside of the current area of supply of the ABWSS as no such areas are currently envisaged (cells C29 and E29)].

The water to meet the requirements would be sourced from the Gubu Dam as well as from the run-of-river flow of the Kubusi River and its tributaries between the Gubu and Wriggleswade dams, as is currently the case, and possibly from the Wriggleswade Dam via the Wriggleswade Transfer Scheme. For all the scenarios the full yield of the Gubu Dam at 98% assurance of supply would be utilized (cells G30 to L30), while water would be abstracted from the run-of-river flow and possibly from the Wriggleswade Dam to varying degrees (cells I31 to L31).

Whether water is abstracted from the run-of-river flow in the Upper Kubusi or is drawn from the Wriggleswade Transfer Scheme, the water would not be available to other users who benefit from the Wriggleswade Dam. The quantity of water required for the Upper Kubusi Scheme, above that of the capacity of the current WTWs in Stutterheim, has been taken as a reduction in the quantity of water available from the Wriggleswade Dam for the Upper, Middle and Lower Buffalo schemes.

Water abstracted for Stutterheim and neighbouring towns from the run-of-river flow in the Upper Kubusi does not have an assurance of supply, which can be provided by suitable storage. Consequently, a supply from the Wriggleswade Dam provides greater assurance by virtue of the storage in the dam. The disadvantage of supplying water to Stutterheim from the Wriggleswade Dam, either directly or via the transfer scheme is that the water will have to be pumped over a distance of more that 20 km against a static head of close to 150 m. It is preferable, therefore, to abstract water from the Kubusi River and its tributaries to the maximum extent possible.

The Lower water requirement scenarios indicate that some 1.48 Mm³/a of water would be required from the run-of-river flow in the Upper Kubusi or from the Wriggleswade Dam (cells I31 and K31), while the Upper scenarios would require 4.82 Mm³/a from the run-of-river flow or from the Wriggleswade Dam (cells J31 and L31)

The full capacities of the existing WTWs at Stutterheim (1.39 Mm³/a) would be needed for the Upper and Lower water requirement scenarios (cells N30 to R30). In all the scenarios additional water purification capacity would be needed.

The additional water would be purified at Stutterheim's WTWs or possibly at the Kei Road WTW. Water for one of the Lower scenarios could be provided in the main by the additional capacity of 1.62 Mm³/a, which could be produced at the Kei Road WTW (cells O6 and O31) once the augmentation of the WTW (for which construction is shortly to commence) is completed. For the second of the Lower scenarios, the additional capacity could be provided by a further similar augmentation of the capacity of the Kei Road WTW, for which the design makes provision (cells Q6 and Q31). Otherwise the additional capacity would be provided at Stutterheim with or without the benefit of storage in the Wriggleswade Dam.

The additional water requirement of 5.26 Mm³/a for the Upper scenarios (cells P31 and R31) would be provided by the augmentation of the WTWs at Stutterheim or by means of a combination of additional water purification capacity at Stutterheim and at Kei Road.

7.2.5 Middle Kubusi - (Domestic and Industrial Uses)

As the Middle Kubusi refers to the Wriggleswade Transfer Scheme and as water required from the transfer infrastructure has been taken into account when considering the schemes along the Buffalo and Nahoon rivers as well as in the Upper Kubusi River, there are no further water requirements from the Middle Kubusi. However, the availability of water from the Wriggleswade Transfer Scheme that has not been taken into account needs to be considered.

Not all the water from the Wriggleswade Transfer Scheme would be required for the two Lower scenarios. In the first of the Lower scenarios 18.69 Mm³/a would be available (cells I33 and I34), while in the second Lower scenario 17.05 Mm³/a (cells K33 and K34) would be available. No spare water from the Wriggleswade Transfer Scheme would be available for either of the Upper scenarios (cells J33 and J34 and L33 and L34).

7.2.6 Middle Buffalo - Surplus Water - (Domestic and Industrial Uses)

Not all of the water available from the Laing Dam would be required for either of the Lower scenarios, taking into account the water requirement scenarios in the Upper, Middle and Lower Buffalo schemes. The surplus water would be some 5.03 Mm³/a in the first of the Lower scenarios (cells I36 and I37) and 5.88 Mm³/a for the second of the Lower scenarios (cells K36 and K37).

The surplus water would be available to contribute to the provision of an assurance of supply of 98% for the ABWSS as a whole.

There would be no spare water from the Laing Dam in either of the Upper scenarios.

7.2.7 Assurance of Supply - (Domestic and Industrial Uses)

As the assurances of supply of the Maden, Rooikrantz, Laing, Bridle Drift and Nahoon dams have been taken as 90% in the above example, it would be prudent to allow for additional storage if necessary to return the overall assurance of supply for the ABWSS to 98%.

In the two Lower scenarios, surplus water from the Wriggleswade Transfer Scheme and from Laing Dam would be adequate to return the assurance of supply in the ABWSS to 98%. In the two Upper scenarios some 9.37 Mm³/a of water would be required to reinstate the assurance of supply (cell H39).

Present indications are that this could be achieved by WC and WDM interventions (cells G42, J42 and L42).

Alternatively, in the event of WC/WDM interventions not being successful or not being implemented an alternative (larger) dam in the Keiskamma could be selected for cell J25, while an additional dam in the Gqunube/Kwelera could be selected in addition to the one shown in cell L23.

7.2.8 Summary of the Operation of the ABWSS as a System - (Domestic and Industrial Uses)

The following are salient aspects of the manner in which the ABWSS can be operated as a system:

- the dams from which water is abstracted for purification, and dams which are constructed to augment the supplies from those dams, would be operated at 90% assurance of supply with the overall assurance of supply of the ABWSS being returned to 98% through the Gubu, Wriggleswade and possibly by a further dam but more probably through WC/WDM interventions;
- the yield of the system at 98% assurance of supply is adequate for the Lower scenarios (including the supply to areas outside the current area of supply of the ABWSS) without the addition of further dams, and there could be surplus water. In the case of the Upper scenarios, additional dams would be needed to meet the water requirements in the Lower Buffalo, which together with the return to the rivers of treated wastewater, the use of treated wastewater and WC/WDM interventions would provide an assurance of supply of 98% for the ABWSS as a whole;
- preference would be given to meeting the water requirements of the Upper and Middle Buffalo as well as of the Upper Kubusi from dams in each of those schemes as well as from the Wriggleswade Transfer Scheme;
- preference could be given to dividing the water from the Wriggleswade Dam between the Upper Buffalo Scheme and the Lower Buffalo Scheme (the latter via the Nahoon River) so as to optimise the installed capacity of the WTWs before the remaining water is allocated to the Upper Kubusi Scheme and the Lower Buffalo Scheme via the Buffalo River;
- water requirements for the Upper scenarios in the Upper and Middle Buffalo scheme as well as in the Upper Kubusi Scheme would be met from the dams in each of those schemes, from the Wriggleswade Transfer Scheme as well as from the run-of-river flow in the Upper Kubusi River. Water requirements for the Upper scenarios in the Lower Buffalo would be met from the dams in that scheme, by the water from the Wriggleswade Transfer Scheme (which is not required by the Upper Buffalo, Middle Buffalo and Upper Kubusi schemes) as well as through new dams, the return of wastewater to the rivers and the use of the wastewater emanating from the Lower Buffalo Scheme;
- in all instances the water requirements should be reduced through WC and WDM measures, while the availability of water would be increased through the return of treated wastewater to the rivers or through the use of treated wastewater;
- with the possible exception of the Upper Kubusi (Stutterheim) there would be adequate water purification capacity in all the schemes for the Lower scenarios. The water requirements for the Upper Kubusi might be inflated as set out in Chapter 4 and would need careful review before the WTWs at Stutterheim are augmented;

- there would be adequate water purification capacity in the Upper and Middle Buffalo for the Upper scenarios, after the current augmentation of the Kei Road WTW is complete and
- the Umzonyana and possibly the Nahoon WTWs would have to be augmented to meet the needs of the Upper water requirement scenarios for the Lower Buffalo Scheme.

7.2.9 Operation of the ABWSS for Domestic, Industrial and Irrigation Uses

Table 7.4 summarises the water requirements and water resources for domestic, industrial and irrigation uses. The domestic and industrial requirements for each of the five schemes is taken from Table 7.3, while the irrigation requirements are taken from Chapter 4.

The method of providing water for domestic and industrial uses in each of the five schemes would be as set out above. For continuity, the description of the method of providing water for irrigation is handled in the same way in terms of each of the five schemes that make up the ABWSS and reference is made to the row and column numbers shown in Table 7.4.

The options selected to meet the water requirements in this example are not the only ones, which can meet the requirements. They serve to illustrate the manner in which the ABWSS can be operated as a system to fully utilize the dams and WTWs' assets, as well as to show the impact of the upper water use scenarios on the need for additional asset creation.

The Lower scenarios for irrigation in Table 7.4 (cells B3, B7, B11, B16 and B21) have been taken to represent what should be the current position. No water releases are made for irrigation from the dams in the Upper, Middle and Lower Buffalo. Water is released from Gubu Dam from time-to-time to augment the irrigation abstraction from the run-of-river flow in the Kubusi while the irrigation requirements around and downstream of the Wriggleswade Dam are taken as a requirement from that dam (cells B16 and B21).

The Upper scenarios have been taken to represent what would be the irrigation water requirements within each of the five schemes should the potential areas of irrigation be developed (cells C3, C7, C11, C16 and C21).

7.2.10 Upper Buffalo - (Domestic, Industrial and Irrigation Uses)

Currently no water is released for irrigation from the Rooikrantz Dam, (cell B3 in Table 7.4), as all the available water is required for domestic and industrial purposes. Water does not have to be released for irrigation from the Maden Dam.

The Upper irrigation water requirement for the Upper Buffalo would be 1.24 Mm³/a (cell C3).

The water for irrigation would be supplied from the Wriggleswade Transfer Scheme where the Lower domestic and industrial water requirement scenarios apply (cells I3 and K3). A more elegant arrangement would be for the irrigation water to be provided from the Rooikrantz Dam (which has a yield of 1.29 Mm³/a), with the domestic and industrial water being supplied from the Wriggleswade Transfer Scheme.

Where the Upper domestic and industrial water requirements apply, all of the water from the Wriggleswade Transfer Scheme would be allocated to domestic and industrial uses. Water for irrigation (cells J4 and L4) would be obtained from a new source, one of the promising ones being from the Sandile/Binfield Park water supply schemes (with a yield of 8.7 Mm³/a (cell H4)). The schemes are on tributaries of the Keiskamma River. Again a more elegant arrangement would be for the irrigation water to be provided from the Rooikrantz Dam (from its yield of 1.29 Mm³/a). The shortfall in the supply of domestic and industrial water would be made up from the Sandile/Binfield Park water supply schemes.

7.2.11 Middle Buffalo - (Domestic, Industrial and Irrigation Uses)

Currently no water is released for irrigation from the Laing Dam (cell B7 in Table 7.4), as all the available water is required for domestic and industrial purposes in the Upper, Middle and Lower Buffalo schemes.

The Upper irrigation water requirement for the Middle Buffalo would be 3.43 Mm³/a (cell C7).

The water for irrigation would be supplied from the Wriggleswade Transfer Scheme where the Lower domestic and industrial water requirement scenarios apply (cells I7 and K7).

Where the Upper domestic and industrial water requirements apply, all of the water from the Laing Dam and the Wriggleswade Transfer Scheme would be allocated to domestic and industrial uses in the five schemes. Water for irrigation (cells J8 and L8) would be obtained from a new source, one of the promising ones being the Sandile/Binfield Park water supply schemes, utilizing part of the yield of 8.7 Mm³/a that would not be needed for the Upper Buffalo. An option is to utilize treated wastewater for irrigation, either directly or by returning the treated wastewater to the Buffalo River.

Table 7.4 Options to meet Potable Water and Irrigation Requirements at 2030 Option 1 - Extend Current Arrangement

	A	B	C	D	E	F	G	H	I	J	K	L
	WATER REQUIREMENTS - 2030					WATER RESOURCES						
	NATURE	EXISTING SUPPLY AREA		ADDITIONAL AREAS		SOURCE	YIELDS FROM DAMS		POTENTIAL USE FROM DAMS		OPTIONS	
		LOWER	UPPER	LOWER	UPPER		LOWER	UPPER	LOWER	UPPER	LOWER	UPPER
		Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a		Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a	Mm^3/a
1	Upper Buffalo					Upper Buffalo						
2	Dom. & Ind.	5.90	11.99	0.00	0.50				5.90	12.49	6.69	12.49
3	Irrigation	0.00	1.24			Wriggleswade/Laing	32.82	35.65	1.24		1.24	
4						Sandile/Binfield	8.7	8.7		1.24		1.24
5	Middle Buffalo					Middle Buffalo						
6	Dom. & Ind.	6.07	10.46	0.00	0.00				6.07	10.46	6.07	10.46
7	Irrigation	0.00	3.43			Wriggleswade/Laing	32.82	35.65	3.43		3.43	
8						Sandile/Binfield	8.7	8.7		3.43		3.43
9	Lower Buffalo					Lower Buffalo						
10	Dom. & Ind.	31.76	70.77	3.30	10.40				35.06	85.71	35.06	81.21
11	Irrigation	0.00	2.54			Wriggleswade/Laing	32.82	35.65	2.54		2.54	
12						Sandile/Binfield	8.7	8.7		2.54		2.54
13												
14	Upper Kubusi					Upper Kubusi						
15	Dom. & Ind.	3.31	6.65	0.00	0.00				3.59	6.93	3.59	6.93
16	Irrigation	0.78	6.04			Wriggleswade/Laing	32.82	35.65	0.78		0.78	
17						Sandile/Binfield	8.7	8.7				
18						Thorn	3.4	3.4		0.78		0.78
19	Middle Kubusi					Middle Kubusi						
20	Dom. & Ind.	0.00	0.00	0.00	0.00				18.69	0.00	17.05	0.00
21	Irrigation	3.00	3.00			Wriggleswade/Laing	32.82	35.65	3.00		3.00	
22						Sandile/Binfield	8.7	8.7				
23						Thorn	3.4	3.4		3.00		3.00
24						Surplus from Wriggleswade/ Laing			12.73	0.00	11.94	0.00
25						Surplus from Sandile/Binfield				1.49		1.49
26						Surplus from Thorn				0.40		0.40
27	TOTAL	50.82	116.12	3.30	10.90							

7.2.12 Lower Buffalo - (Domestic, Industrial and Irrigation Uses)

Currently no water is released for irrigation from the Nahoon Dam, (cell B11 in Table 7.4), as all the available water is required for domestic and industrial purposes in the Lower Buffalo. Water does not have to be released for irrigation from the Bridle Drift Dam.

The Upper irrigation water requirement for the Lower Buffalo would be 2.54 Mm^3/a (cell C11).

The water for irrigation would be supplied from the Wriggleswade Transfer Scheme where the Lower domestic and industrial water requirement scenarios apply (cells I11 and K11).

Where the Upper domestic and industrial water requirements apply, all of the water from the Laing Dam and the Wriggleswade Transfer Scheme would be allocated to domestic and industrial uses in the five schemes. Water for irrigation (cells J12 and L12) would be obtained from a new source, one of the promising ones being the Sandile/Binfield Park water supply schemes, utilizing part of the yield of 8.7 Mm^3/a that would not be needed for the Upper and Middle Buffalo.

7.2.13 Upper Kubusi - (Domestic, Industrial and Irrigation Uses)

Currently water is released for irrigation from the Gubu Dam when there is need to augment the run-of-river flow used for irrigation along the Kubusi River between the Gubu and Wriggleswade dams (cell B16 in Table 7.4).

The Upper irrigation water requirement for the Upper Kubusi would be 6.04 Mm^3/a (cell C16). However 5.26 Mm^3/a of that requirement would be from run-of-river flow and could be excluded from the requirements from Gubu Dam. Hence the Upper irrigation water requirement has been taken as 0.78 Mm^3/a (cells J18 and L18).

The water for irrigation would be supplied from the Wriggleswade Transfer Scheme where the Lower domestic and industrial water requirement scenarios apply (cells I16 and K16).

Where the Upper domestic and industrial water requirements apply, all of the water from the Laing Dam and the Wriggleswade Transfer Scheme would be allocated to domestic and industrial uses in the five schemes. Water for irrigation (cells J18 and L18) would be obtained from a new source, one of the promising ones being a dam on the Thorn River, with a yield of 3.4 Mm^3/a (cell H18).

7.2.14 Middle Kubusi - (Domestic, Industrial and Irrigation Uses)

Currently water is released for irrigation from the Wriggleswade Dam when there is need to augment the run-of-river flow used for irrigation along the Kubusi River downstream of the Wriggleswade Dam as well as to provide water for irrigation at and below the dam (cell B21 in Table 7.4). An increase in the irrigation water requirement from the Wriggleswade Dam is not foreseen at this time and hence both the Lower and Upper irrigation water requirements have been taken as the compensation flow of 3 Mm^3/a (cells B21 and C21).

The water for irrigation would be supplied from the Wriggleswade Dam where the Lower domestic and industrial water requirement scenarios apply (cells I21 and K21).

Where the Upper domestic and industrial water requirements apply, all of the water from the Wriggleswade Dam would be allocated to domestic and industrial uses in the five schemes. Water for irrigation (cells J23 and L23) would be obtained from the new source such as a dam on the Thorn River, with a yield of 3.4 Mm^3/a (cell H18), together with the irrigation water required for the Upper Kubusi Scheme. Alternatively, dams on the Nahoon, Gqunube or Keiskamma rivers, could supply water for domestic and industrial purposes in the Lower Buffalo Scheme enabling irrigation water to be supplied from the Wriggleswade Dam.

7.2.15 Assurance of Supply - (Domestic, Industrial and Irrigation Uses)

For both the Lower scenarios, there would be adequate water from the existing dams in the five schemes to meet the requirements of domestic, industrial and irrigation users, provided the irrigation requirements of irrigators along the Kubusi River, between the Gubu and Wriggleswade dams, are met largely from the run-of-river flow in the Kubusi River.

For the Upper scenarios the increase in assurance of supply could be attained through WC/WDM interventions together with the return and use of treated wastewater as shown in Table 7.3.

7.2.16 Summary of the Operation of the ABWSS as a System - (Domestic, Industrial and Irrigation Uses)

The method of operating the ABWSS as a system for domestic, industrial and irrigation water uses would not differ markedly from that outlined above for domestic and industrial uses. The main difference might be to utilize the Rooikrantz Dam for irrigation and to supply domestic and industrial users from one of the other sources of supply.

Also, if significant irrigation occurs along the Nahoon River it would be beneficial to divert more of the water from the Wriggleswade Transfer Scheme to the Nahoon River and to make up a corresponding quantity for the Buffalo River from one of the possible augmentation schemes on the Keiskamma River or its tributaries.

Central to the operation of the ABWSS will be the ability to deliver water from sources such as those outlined above to where it is required, irrespective of the ownership of the assets. Should this not be possible, it would be difficult if not impossible to operate the ABWSS as a system. This aspect strengthens the need for the institutional arrangement outlined earlier in this chapter.

CHAPTER 8
Monitoring Indicators

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(NO APPENDICES FOR THIS CHAPTER)

8 MONITORING INDICATORS

8.1 BACKGROUND TO THE MONITORING INDICATORS

In order for the strategy to be implemented successfully, specific indicators need to be monitored regularly. The success or otherwise of the interventions must also be determined, possibly annually, to make the necessary adjustments to the strategy or to the interventions where necessary.

The purpose of the monitoring indicators is to provide the essential data to measure progress or otherwise in meeting goals or targets set by the strategy as well as to form a quantitative basis for corrective measures.

The schedule of indicators, containing the stakeholder who would be responsible for each indicator, is set out in Table 8.1.

The indicators are grouped into the following categories:

- bio-physical;
- raw water;
- water use;
- wastewater;
- water quality (rivers and dams) and
- land use and population changes.

The purpose of the indicators in each category is briefly outlined below.

8.1.1 Bio-physical

The bio-physical indicators address the rainfall-runoff parameters that form the basis of the hydrology together with the flows at EWR sites and changes, which might occur to marker flora and biota at those sites over time. The intention is to ascertain the appropriateness of the EWRs that have been adopted and to determine whether changes to the flow regime would be beneficial.

8.1.2 Raw Water

The raw water indicators record the water released from the dams in the ABWSS, together with the purpose for which the water is released. The indicators also reflect the quantity of water transferred from the Wriggleswade Dam to WTWs and other dams, together with the quantities of water received at those WTWs and dams.

Where water is transferred into the ABWSS from assets outside of the current ABWSS, the indicators reflect the quantity of water released from the dams and the quantity of water received into the ABWSS.

The results of the measurements of the transfer of water from the Wriggleswade Dam and from future assets outside of the current ABWSS give an indication of the pattern of the releases as well as of the transfer losses.

The indicators also reflect the extent to which groundwater is introduced into the ABWSS and the impact that the use of groundwater in the ABWSS will have on the sustainability of groundwater as a source of water for the ABWSS.

The indicators allow for a record to be maintained of the extent, if any, to which desalination would contribute to the water requirements of the ABWSS.

8.1.3 Water Use

The water use indicators reflect the water abstracted from the rivers for domestic, industrial and irrigation purposes, with the quantity of potable water delivered from the WTWs through the distribution and network systems as well as the quantity of potable water metered as having been used by consumers. Coupled with the indicators for raw water outlined above, the water use indicators would reflect the water requirements from source to end user and will give a good indication of losses throughout the system. The results are central to monitoring the scenarios identified for water requirements, water losses and water use efficiency.

8.1.4 Wastewater

The wastewater indicators reflect the quantities of wastewater received at the WWTWs, the quantities of treated wastewater returned to the rivers (return flow) and the quantities of treated wastewater supplied by the WSAs to water users for domestic, industrial or irrigation purposes. The indicators would reflect changes in the quantity of wastewater available as a result of interventions to reduce water requirements as well as the extent to which treated wastewater is available for indirect use (return flow) and for direct use.

8.1.5 Water Quality (Rivers and Dams)

The water quality indicators are intended to reflect changes in river and dam health and to identify the extent to which water in the rivers and dams complies with the water quality objectives. They have also been selected to assist the municipalities to identify and to correct the causes of pollution.

Similarly, the indicators would reflect changes in the quality of groundwater introduced into the ABWSS and give an indication of corrective measures that might be required.

8.1.6 Land-Use and Population Changes

The land-use indicators are intended to reflect changes in land-use, which could either increase or decrease the quantity of water available and the quantity of water required.

Due to the inherent difficulties of ascertaining population change, the population change indicators allow for the impact of population on water requirements to be determined by means of proxy indicators, namely zonal water use, homestead counts and census or demographic projections, which need to be undertaken for the compilation of IDPs.

Table 8.1: Indicators to Monitor Progress of the Strategy and the Success or Otherwise of Interventions

Indicators	Upper Buffalo	Middle Buffalo	Lower Buffalo	Upper Kubusi	Middle Kubusi	Quantity Measure	Quality Measure	Responsible Stakeholder
BIO-PHYSICAL ASPECTS								
Daily flows at streamflow gauges	✔	✔	✔	✔	✔	✔		DWAF
Daily rainfall	✔	✔	✔	✔	✔	✔		DWAF
Daily evaporation	✔	✔	✔	✔	✔	✔		DWAF
EWR sites:								
- Daily flow (from nearest streamflow gauge)	✔	✔	✔	✔	✔	✔		DWAF
- Change in marker flora	✔	✔	✔	✔	✔	✔	✔	DWAF
- Change in marker biota	✔	✔	✔	✔	✔	✔	✔	DWAF
RAW WATER								
Water released from dams for:								
- Domestic and industrial purposes								
- Maden	✔					✔		BCM
- Rooikrantz	✔					✔		AW

Indicators	Upper Buffalo	Middle Buffalo	Lower Buffalo	Upper Kubusi	Middle Kubusi	Quantity Measure	Quality Measure	Responsible Stakeholder
- Laing		✔				✔		AW
- Bridle Drift			✔			✔		BCM
- Nahoon			✔			✔		AW
- Gubu-				✔		✔		AW
- Wriggleswade					✔	✔		AW
- Irrigation purposes (including compensation releases)								
- Rooikrantz	✔					✔		AW
- Laing		✔				✔		AW
- Nahoon			✔			✔		AW
- Gubu				✔		✔		AW
- Wriggleswade					✔	✔		AW
- EWR								
- Maden	✔					✔		BCM
- Rooikrantz	✔					✔		AW
- Laing		✔				✔		AW

Indicators	Upper Buffalo	Middle Buffalo	Lower Buffalo	Upper Kubusi	Middle Kubusi	Quantity Measure	Quality Measure	Responsible Stakeholder
- Bridle Drift			✔			✔		BCM
- Nahoon			✔			✔		AW
- Gubu				✔		✔		AW
- Wriggleswade					✔	✔		AW
Water released from the Wriggleswade Dam to schemes and/or WTWs in the ABWSS					✔	✔	✔	AW
Water received from the Wriggleswade Dam by schemes and/or WTWs in the ABWSS	✔	✔	✔	✔		✔	✔	AW
Water transferred from assets outside of the ABWSS into the ABWSS	✔	✔	✔	✔		✔	✔	DWAF or AW
Water received in the ABWSS from assets outside of the ABWSS	✔	✔	✔	✔		✔	✔	DWAF or AW or BCM
Groundwater introduced into the ABWSS	✔	✔	✔	✔		✔		DWAF or AW
Drop/rise in the water table at points of abstraction of ground water for introduction into the ABWSS	✔	✔	✔	✔	✔	✔		DWAF or AW
Sea water desalinated and introduced into the ABWSS			✔			✔	✔	BCM

Indicators	Upper Buffalo	Middle Buffalo	Lower Buffalo	Upper Kubusi	Middle Kubusi	Quantity Measure	Quality Measure	Responsible Stakeholder
WATER USE								
Water abstracted from the rivers for:								
- Domestic and industrial purposes								
- Buffalo River	✔	✔	✔			✔		DWAF
- Nahoon River			✔			✔		DWAF
- Kubusi River				✔		✔		DWAF
- Irrigation purposes								
- Buffalo River	✔	✔	✔			✔		DWAF
- Nahoon River			✔			✔		DWAF
- Kubusi River				✔		✔		DWAF
Potable water:								
- delivered from WTWs to the distribution system	✔	✔	✔	✔		✔	✔	WSAs and AW
- received at distribution reservoirs	✔	✔	✔	✔		✔	✔	WSAs and AW
- discharged from distribution reservoirs to the reticulation	✔	✔	✔	✔		✔	✔	WSAs and AW
- flowing through zonal meters	✔	✔	✔	✔		✔		WSAs and AW

Indicators	Upper Buffalo	Middle Buffalo	Lower Buffalo	Upper Kubusi	Middle Kubusi	Quantity Measure	Quality Measure	Responsible Stakeholder
- flowing through user meters	✔	✔	✔	✔		✔		WSAs & AW
WASTEWATER								
Wastewater:								
- received at WWTWs	✔	✔	✔	✔		✔	✔	WSAs
Treated wastewater returned from WWTWs to the:								
- Buffalo River	✔	✔	✔			✔	✔	BCM
- Nahoon River			✔			✔	✔	BCM
- Kubusi River				✔		✔	✔	ADM
Treated wastewater delivered into the water distribution system for:								WSAs
- domestic and industrial purposes	✔	✔	✔	✔		✔	✔	WSAs
- irrigation	✔	✔	✔	✔		✔	✔	WSAs
WATER QUALITY (RIVERS AND DAMS)								
Water quality in rivers (E coli, electrical conductivity, nitrates and phosphates) at site:								

Indicators	Upper Buffalo	Middle Buffalo	Lower Buffalo	Upper Kubusi	Middle Kubusi	Quantity Measure	Quality Measure	Responsible Stakeholder
- of abstraction to WTWs	✔	✔	✔	✔			✔	DWAF or AW
- upstream and downstream of WWTW discharge points	✔	✔	✔	✔			✔	DWAF or AW
- upstream and downstream of industrial discharge points	✔	✔	✔	✔			✔	DWAF or AW
- river reaches upstream and downstream of settlements/urban areas/peri-urban areas	✔	✔	✔	✔			✔	DWAF or AW
- upstream and downstream of dams	✔	✔	✔	✔	✔		✔	DWAF or AW
Oxygen demand at various levels in the dams for:								
- Maden Dam	✔						✔	BCM
- Rooikrantz Dam	✔						✔	AW
- Laing Dam		✔					✔	AW
- Bridle Drift Dam			✔				✔	BCM
- Nahoon Dam			✔				✔	AW
- Gubu Dam				✔			✔	AW
- Wriggleswade Dam					✔		✔	AW
- Dams outside of the ABWSS supplying into the ABWSS	✔	✔	✔	✔			✔	DWAF or AW

Indicators	Upper Buffalo	Middle Buffalo	Lower Buffalo	Upper Kubusi	Middle Kubusi	Quantity Measure	Quality Measure	Responsible Stakeholder
Water quality of ground water introduced into the ABWSS (E coli, electrical conductivity, nitrates and phosphates)			✔				✔	DWAF or AW
LAND-USE AND POPULATION CHANGES								
Areas under irrigation (from satellite or aerial photography)	✔	✔	✔	✔	✔			DWAF
Areas under afforestation (from satellite or aerial photography)	✔	✔	✔	✔	✔	✔		DWAF
Area of invasive alien plants (from satellite or aerial photography)	✔	✔	✔	✔	✔	✔		DWAF
Number of homesteads (from satellite or aerial photography)	✔	✔	✔	✔		✔		Municipalities
Population change recorded through National census or through demographic studies commissioned for the IDP and NWRP processes	✔	✔	✔	✔		✔		Municipalities and DWAF

CHAPTER 9
Evaluation of Scenarios

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9 EVALUATION OF SCENARIOS

9.1 DECISION SUPPORT TOOL

DWAF developed a Decision Support Tool (DST) to assist in the selection of scenarios, as well as to illustrate graphically the consequences of adopting different courses of action.

The DST allows users to compare potential interventions, wastewater use options and the creation of surface water assets with one another, and with selected future water requirement scenarios. Appendix 9.1 contains the DST.

The DST was customised for the ABWSS.

9.2 APPLICATION OF THE DST FOR THE ABWSS

Initially, the DST was applied separately to each of the five schemes which make up the ABWSS. The process resulted, however, in a significant amount of work. In order to streamline the process, the operation of the ABWSS as outlined in Section 7.2 of this report was adopted. That operating model is based on the water requirements of the Upper and Middle Buffalo schemes as well as of the Upper Kubusi Scheme being met from existing surface water assets, while any shortfall in the supply of water would be addressed in the Lower Buffalo Scheme.

Such an arrangement results in the DST having to be applied only to the Lower Buffalo Scheme for the purposes of ascertaining the need for interventions, wastewater use options and new bulk surface water assets.

Interventions (such as WC and WDM) adopted in the Lower Buffalo Scheme would apply, however, to the other schemes as well.

The results of the analysis were presented graphically to DWAF managers on 29 June 2007. Concern was expressed by the managers that the graphical representation of only the Lower Buffalo Scheme gives a distorted representation of the system as a whole.

The Planning Team then applied the DST to the ABWSS as a whole.

9.3 SCENARIO SELECTION PROCESS

The scenario selection process considers the relationship between supply and demand-side options to determine appropriate combinations of interventions, wastewater use options and surface water/groundwater assets to reconcile water supply and water requirements in the ABWSS up to 2030.

The objective is not to select a "favoured scenario", but to identify which interventions and potential assets should be studied to allow for a range of possible options to be considered. This will provide flexibility to stakeholders when making informed decisions regarding the implementation of interventions and the planning as well as the possible construction of bulk water supply assets.

The result of the process is a list of interventions and bulk surface water/groundwater supply assets that should be studied, by specific dates, so that the stakeholders are able to implement the interventions or to construct the assets by the time the need for them arises.

9.4 SELECTION OF SCENARIOS

Eleven scenarios have been selected as outlined in Table 9.1.

The scenarios illustrate the consequences of certain courses of action being taken and have been grouped as follows:

- the upper water requirement scenario, with reductions in water requirements as a result of the implementation of the WC/WDM interventions that BCM has in hand as well as the WC/WDM interventions proposed in this study ("Full WC/WDM interventions") (Scenarios 1 to 4);
- the upper water requirement scenario, with reductions in water requirements as a result of the implementation of only the WC/WDM interventions BCM has in hand (Scenarios 5 and 6). Further interventions are necessary in order for those WC/WDM interventions which BCM has in hand, to be successful. They are an annual water audit; enhancement of meter, billing and debtor management; improvements to the user education programme as well as a structured response to issues related to water use and cost recovery. For purposes of comparison, these interventions are added to the interventions that BCM has in hand ("WC/WDM interventions BCM has in hand") (Scenarios 5 and 6);
- the upper water requirement scenario without WC/WDM interventions or the failure of the WC/WDM interventions that BCM has in hand and no wastewater use interventions (Scenario 7);
- the extent to which current surface water assets coupled with the WC/WDM interventions that BCM has in hand (and the interventions to support BCM's interventions) can meet the lower water requirement scenario (Scenario 8) and
- the impact that the introduction of the EWR will have on the interventions and surface water assets required to meet the upper and lower water requirement scenarios (Scenarios 9 to 11).

The scenarios are presented in a manner which illustrates the extent to which demand-side interventions reduce the need for the creation of new bulk water supply assets (supply-side).

In all the scenarios, return flow of treated wastewater from the Upper and Middle Buffalo schemes as well as from the Upper Kubusi Scheme has been taken as augmenting the yields from dams. The return flow is subject to change depending upon the water requirements for domestic and industrial use and the extent to which WC/WDM interventions are implemented and are successful.

The volumes of the return flow that have been adopted in the DST when determining the existing system yield for all the scenarios are based upon the wastewater treated within the Upper and Middle Buffalo as well as in the Upper Kubusi Scheme in 2005 and are as follows:

- "Full WC/WDM interventions" 3.4 Mm^3/a. (referred to as the Lower scenario for the return of treated wastewater due to WC/WDM);
- "WC/WDM interventions BCM has in hand" 4.5 Mm^3/a. (referred to as the Upper scenario for the return of treated wastewater due to WC/WDM) and
- "No WC/WDM interventions or the failure of the interventions BCM has in hand" 5.7 Mm^3/a. (referred to as the return of treated wastewater without reduction due to WC/WDM interventions).

A constant volume has been adopted for the full planning period in each scenario due to the complexity that arises by adopting variable quantities.

Table 9.1 Scenarios Evaluated by Means of the DST

No.	Scenario Title	Description	Purpose
Upper Water Requirement - Implementation of the WC/WDM Interventions BCM has in hand and those Proposed in this Study ("Full WC/WDM Interventions")			
1	"Full WC/WDM interventions with surface water asset creation"	• Upper water requirement scenario • Implement the full WC/WDM interventions (those which BCM has in hand and those proposed in this study) • Lower scenario for possible savings in water use • Lower scenario for the return of treated wastewater due to WC/WDM • Yield of dams at 98% assurance of supply without reduction for EWR • No return of treated wastewater	To show the extent to which all the WC/WDM interventions reduce the water requirements and the extent to which there is need for new surface water assets. The scenario also illustrates the impact of inadequately treated wastewater (which does not comply with the quality criteria for further use) being returned to the Buffalo River from Potsdam/Mdantsane/Reeston

No.	Scenario Title	Description	Purpose
		discharged below Bridle Drift and Nahoon dams to enhance the yield from dams or for use • Surface water assets selected according to URV	
2	"Full WC/WDM interventions with use of return flow otherwise discharged downstream of Bridle Drift and Nahoon dams"	• Upper water requirement scenario • Implement the full WC/WDM interventions (those which BCM has in hand and those proposed in this study) • Lower scenario for possible savings in water use • Lower scenario for the return of treated wastewater due to WC/WDM • Yield of dams at 98% assurance of supply without reduction for EWR • Use of treated wastewater from Potsdam/Mdantsane/Reeston • Use of treated wastewater from the East Bank and West Bank WWTWs • Surface water assets selected according to URV	To show the extent to which all the WC/WDM interventions reduce the water requirements, the impact of adequately treated wastewater (which complies with the quality criteria for further use) from all the WWTWs being used and the extent to which there is need for new surface water assets
3	"Full WC/WDM interventions with no surface water options"	• Upper water requirement scenario • Implement the full WC/WDM interventions (those which BCM has in hand and those proposed in this study) • Lower scenario for possible savings in water use • Lower scenario for the return of treated wastewater due to WC/WDM • Yield of dams at 98% assurance of supply without reduction for EWR • Use of treated wastewater from Potsdam/Mdantsane/Reeston • Use of treated wastewater from the East Bank, West Bank and Quinera (Gonubie) WWTWs (if necessary) • Desalination to make up the shortage of supply (if necessary)	To show the extent to which all the WC/WDM interventions reduce the water requirements and the extent to which the shortfall can be made up by the use of treated wastewater before having to resort to desalination as an option
4	"Full WC/WDM interventions with a more balanced approach"	• Upper water requirement scenario • Implement the full WC/WDM interventions (those which BCM has in hand and those proposed in this study) • Surface water assets, wastewater use or desalination according to all criteria and judgement to make up the shortage of supply	To show the extent to which WC/WDM interventions reduce the water requirements, as well as the extent to which the shortfall can be made up by suitable interventions and surface water assets

No.	Scenario Title	Description	Purpose
		• Lower scenario for possible savings in water use • Lower scenario for the return of treated wastewater due to WC/WDM • Yield of dams at 98% assurance of supply without reduction for EWR	
Upper Water Requirement - Implementation of only the WC/WDM Interventions BCM has in hand			
5	" WC/WDM interventions that BCM has in hand and the creation of surface water assets"	• Upper water requirement scenario • Implement only the WC/WDM interventions that BCM has in hand and those required for their success • Lower scenario for possible savings in water use • Upper scenario for the return of treated wastewater due to WC/WDM • Yield of dams at 98% assurance of supply without reduction for EWR • No return of treated wastewater discharged below Bridle Drift and Nahoon dams to enhance the yield from dams or for further use • Surface water assets selected according to URV	To show the extent to which surface water assets would be necessary in spite of the WC/WDM interventions that BCM has in hand and those required for their success, if resort is not made to further WC/WDM interventions identified in this study or to the use of treated wastewater
6	" WC/WDM interventions that BCM has in hand, the use of treated wastewater and the creation of surface water assets"	• Upper water requirement scenario • Implement only the WC/WDM interventions that BCM has in hand and those required for their success • Lower scenario for possible savings in water use • Upper scenario for the return of treated wastewater due to WC/WDM • Yield of dams at 98% assurance of supply without reduction for EWR • Use of treated wastewater from Potsdam/Mdantsane/ Reeston • Use of treated wastewater from the East Bank, West Bank and Quinera (Gonubie) WWTWs • Surface water assets selected according to URV	To show the extent to which surface water assets would be necessary in spite of the WC/WDM interventions that BCM has in hand, those required for their success and the use of treated wastewater
Upper Water Requirement - No WC/WDM Interventions or Failure of the WC/WDM Interventions that BCM has in Hand and no Wastewater Use Interventions			
7	"No WC/WDM interventions or failure of the WC/WDM	• Upper water requirement scenario • No WC/WDM • Yield of dams at 98% assurance of	To show the consequences of a "do nothing" strategy or failure of the WC/WDM interventions that BCM

No.	Scenario Title	Description	Purpose
	interventions that BCM has in hand, with surface water asset creation"	supply without reduction for EWR • Return of treated wastewater without reduction due to WC/WDM interventions • Surface water assets selected according to URV	has in hand and the extent to which surface water assets would need to be created
Lower Water Requirement Scenario			
8	"Impact of the lower water requirement with the interventions that BCM has in hand"	• Lower water requirement scenario • WC/WDM interventions that BCM has in hand and those required for their success • Lower scenario for possible savings in water use • Upper scenario for the return of treated wastewater due to WC/WDM • Yield of dams at 98% assurance of supply without reduction for EWR • Surface water assets, treated wastewater use and desalination selected according to URVs	To show the impact of the lower water requirement on the need for interventions and for the creation of surface water assets if the WC/WDM interventions that BCM has in hand are successful
Impact of the EWR			
9	"Impact of the EWR, with full WC/WDM interventions"	• Use the description of the "Full WC/WDM interventions with a more balanced approach" above to show earlier implementation, as well as changes in and additional interventions and surface water assets due to the introduction of the EWR. Use the category of the EWR as proposed by the Directorate: RDM	To show the impact of the EWR on the need to provide surface water assets as well as on the quantity of water required
10	"Impact of the EWR, with WC/WDM interventions that BCM has in hand"	• Use the description of the "WC/WDM interventions that BCM has in hand, the use of treated wastewater and the creation of surface water assets" scenario above to show earlier implementation as well as changes in and additional interventions and surface water assets, due to the introduction of the EWR. Use the category of the EWR as proposed by the Directorate: RDM	To show the impact of the EWR on the need to provide surface water assets as well as on the quantity of water required
11	"Impact of the EWR on	• Use the description of "Impact of lower	To show the impact of the EWR on

No.	Scenario Title	Description	Purpose
	the lower water requirement, with WC/WDM interventions that BCM has in hand"	water requirement with the interventions that BCM has in hand" above to show earlier implementation due to the introduction of the EWR. Use the category of the EWR as proposed by the Directorate: RDM	the need to provide surface water assets

In all the scenarios that contain demand-side interventions, the interventions that BCM has in hand and those required for their success are given priority, followed by the interventions proposed in this study where applicable. The reason for selecting such an arrangement is that the interventions that BCM has in hand have already commenced while the others need to be implemented to ensure the success of the interventions that have commenced.

The upper and lower water requirement scenarios have been adopted to reflect the highest and lowest expected water requirements. The "upper water requirement" is based on the dwelling count undertaken by BCM's Water Branch, while the "lower water requirement" is based on the high HIV prevalence population growth scenario prepared by demographers on behalf of BCM. Water requirement scenarios between the upper and lower scenarios will be addressed by implementing options which are selected to address the upper water requirement, at later times than those shown in the results of the DST.

Each scenario is illustrated in three parts. Two of the parts are shown as tables, while the third part is reflected as a figure.

The first table shows the interventions and asset creation options that have been selected for the scenario. The table records the supply-side measures, together with the demand-side measures.

The supply-side measures are:

- wastewater return flow;
- surface water/groundwater asset creation and
- treated wastewater use.

The demand-side measures are:

- WC/WDM interventions.

The interventions and bulk water supply asset options are numbered sequentially in the order in which they should be implemented.

The first five demand-side measures are water metering related interventions BCM has in hand to reduce the use of water, together with the interventions that are required for the success of the WC/WDM interventions that BCM has in hand for that purpose. This has been done as all five interventions are required for consumer metering, cost recovery and consumer water use management, which should result in water use reduction.

The remaining three interventions BCM has in hand (the management information system (MIS), area water meters and pressure reduction) are intended to reduce water lost from the network as well as from consumer installations.

The eight interventions outlined above are followed by those interventions proposed in this study to the extent that they are required.

The numbering for the supply-side interventions and assets follows the demand-side measures. Nevertheless, some of the supply-side measures might be implemented ahead of some of the demand-side measures.

The number allocated to each supply-side intervention or asset in the table which precedes the figure is reproduced on the figure. The number allocated to each demand-side intervention for which a reduction in water requirement is provided in Chapter 5 is reproduced in the figure. Where an intervention does not itself result in a water requirement reduction, but which is necessary to attain the water requirement reduction of another intervention, the number is not shown on the figure.

The figure illustrates graphically the impact that the demand-side measures would have on the requirement for bulk water supply in the ABWSS. The impact of each WC/WDM intervention is shown as a reduction in the water requirement. The lowest demand-side curve illustrates the water requirement after successful implementation of all the WC/WDM interventions under consideration.

The figure also illustrates graphically the impact that each supply-side intervention or asset would have on increasing the availability of bulk water in the ABWSS. The existing system yield of the dams in the ABWSS, together with the supply-side measures which are selected for the scenario, give the amount of water that would be available in the ABWSS in terms of the scenario under consideration.

The water balance is achieved where the lowest water requirement curve and a water availability bar correspond.

The second table for each scenario shows the interventions and assets selected for the scenario, the year the additional water or water saving is required, the yield adopted for each intervention or asset, the estimated lead time between commencement of the study for an intervention or asset and when water should first be available and the date by which the study for an intervention or asset should start.

The table is arranged to first reflect the WC/WDM interventions BCM has in hand as these interventions are already happening. The interventions required for the success of the interventions BCM has in hand are included with BCM's metering interventions as they relate in the main to those interventions.

The remaining interventions and surface water/groundwater assets are listed according to the sequence in which they would be required for the scenario under consideration.

9.5 THE SCENARIOS CONSIDERED

9.5.1 Scenario 1 : "Full WC/WDM Interventions with Surface Water Asset Creation"

The scenario illustrates the extent to which the WC/WDM interventions that BCM has in hand and those proposed in Chapter 5 could influence the need for surface water supply assets. The scenario also assumes that beneficial use is not made of the treated wastewater from Potsdam/Mdantsane West and Mdantsane East/Reeston (which is returned to the Buffalo River below the Bridle Drift Dam) nor of the treated wastewater from WWTWs between the Bridle Drift and Nahoon dams and the sea.

Tables 9.2 and 9.3 together with Figure 9.1 illustrate the sequence in which the interventions and asset creation could be implemented, and the estimated net present value (NPV) that would enable the water requirements to be met.

The existing system yield would be adequate to meet the water requirements to around 2017. A surface water asset, such as the transfer of water from the Sandile and Binfield Park dams, would be required by 2018 followed by a second surface water asset, such as a dam in the Nahoon River at Stone Island Farm in 2024.

Table 9.2 Scenario 1 - Full WC/WDM Interventions with Surface Water Asset Creation – Supply and Demand-side Measures

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
1				WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"
2				WC/WDM- WATER USE REDUCTION: Annual Water Audit
3				WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control
4				WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme
5				WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use
6				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)
7				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters
8				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction
9				WC/WDM- WATER USE REDUCTION: Support to private and public bodies to maintain water use installations
10				WC/WDM- WATER USE REDUCTION: Amendment to the current consumer tariff structure
11				WC/WDM- WATER USE REDUCTION: Use of " pour-flush" or other water efficient type sanitation systems in place of free flush systems
12				WC/WDM- WATER USE REDUCTION: Attend to water wastage at public facilities
13				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Water infrastructure asset management
14				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Improve the monitoring of the quality of construction of water use installations

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
15				WC/WDM- WATER LOSS AT WTWs AND UPSTREAM: Recovery of process water at the remaining 7 WTWs
16		AUGMENTATION OF WATER SUPPLIES - Keiskamma River: Transfer of water from Sandile and Binfield Park dams		
17		AUGMENTATION OF WATER SUPPLIES - Nahoon River: A dam at Stone Island Farm		

Figure 9.1 Scenario 1 - Full WC/WDM Interventions with Surface Water Asset Creation

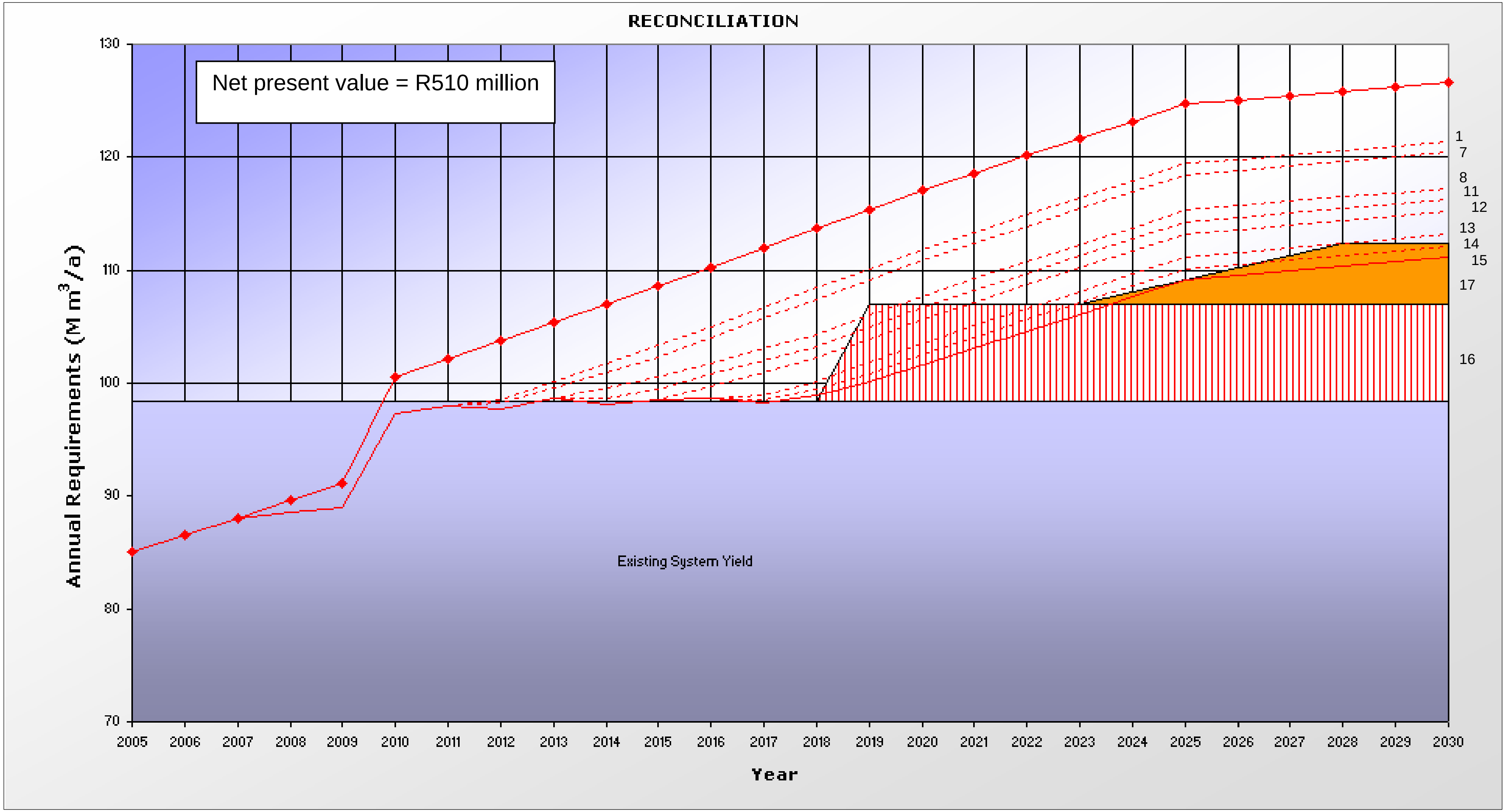

Table 9.3 Scenario 1 Full WC/WDM Interventions with Surface Water Asset Creation – Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"	2008	5.3		
2	WC/WDM- WATER USE REDUCTION: Annual Water Audit	2010	0	1	2009
3	WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control	2010	0	1	2009
4	WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme	2011	0	1	2010
5	WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use	2011	0	1	2010
6	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)	2012	0	4	2008
7	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters	2012	1	3	2009
8	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction	2012	3	4	2008
9	WC/WDM- WATER USE REDUCTION: Support to private and public bodies to maintain water use installations	2013	0	1	2012
10	WC/WDM- WATER USE REDUCTION: Amendment to the current consumer tariff structure	2013	0	1	2012
11	WC/WDM- WATER USE REDUCTION: Use of " pour-flush" or other water efficient type sanitation systems in place of free flush systems	2014	1	1	2013
12	WC/WDM- WATER USE REDUCTION: Attend to water wastage at public facilities	2014	1	1	2013
13	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Water infrastructure asset management	2016	2	1	2015
14	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Improve the monitoring of the quality of construction of water use installations	2017	1	1	2016
15	WC/WDM- WATER LOSS AT WTWs AND UPSTREAM: Recovery of process water at the remaining 7 WTWs	2017	1	1	2016
16	AUGMENTATION OF WATER SUPPLIES - Keiskamma River: Transfer of water from Sandile and Binfield Park dams	2018	8.7	4	2014
17	AUGMENTATION OF WATER SUPPLIES - Nahoon River: A dam at Stone Island Farm	2024	5.3	10	2014

9.5.2 Scenario 2 : "Full WC/WDM Interventions with Use of Return Flow otherwise Discharged Downstream of Bridle Drift and Nahoon Dams"

The scenario illustrates the extent to which the WC/WDM interventions that BCM has in hand and those proposed in Chapter 5 together with the use of treated wastewater from Potsdam/Mdantsane/Reeston as well as the treated wastewater from the East Bank and West Bank WWTWs could influence the need for surface water supply assets.

Tables 9.4 and 9.5 together with Figure 9.2 illustrate the sequence in which the interventions could be implemented, and the NPV that would enable the water requirements to be met.

The existing system yield would be adequate to meet the water requirements until around 2017. The use of treated wastewater from Potsdam/Mdantsane/Reeston and from the East and West Bank WWTWs by means of either direct or indirect use, and introduced progressively after 2017 as the need arises would be adequate till the end of the planning period. The wastewater use options would be introduced over the period 2017 to 2026.

The scenario makes provision for water for industrial/IDZ purposes to be made available from Mdantsane East/Reeston and not from the East Bank WWTW as is currently BCM's intention. The results are not materially affected if the source of supply for industrial/IDZ purposes is from the East Bank WWTW, with treated wastewater from Mdantsane East/Reeston being used for domestic purposes.

Water from the West Bank WWTW (which would have to be constructed) has been allocated to Industrial/IDZ use due to the nature of the source of wastewater being mainly from industrial users and the locality of the West Bank WWTW relative to the industrial area and to the IDZ.

Table 9.4 Scenario 2 - Full WC/WDM Interventions with Use of Return Flow Otherwise Discharged Downstream of Bridle Drift and Nahoon Dams - Supply and Demand-side Measures

No	Wastewater return flow	Surface/Ground water Asset Creation	Wastewater Use	WC/WDM Intervention
1				WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"
2				WC/WDM- WATER USE REDUCTION: Annual Water Audit
3				WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control
4				WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme
5				WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use
6				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)
7				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters
8				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction
9				WC/WDM- WATER USE REDUCTION: Support to private and public bodies to maintain water use installations
10				WC/WDM- WATER USE REDUCTION: Amendment to the current consumer tariff structure
11				WC/WDM- WATER USE REDUCTION: Use of " pour-flush" or other water efficient type sanitation systems in place of free flush systems

No	Wastewater return flow	Surface/Ground water Asset Creation	Wastewater Use	WC/WDM Intervention
12				WC/WDM- WATER USE REDUCTION: Attend to water wastage at public facilities
13				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Water infrastructure asset management
14				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Improve the monitoring of the quality of construction of water use installations
15				WC/WDM- WATER LOSS AT WTWs AND UPSTREAM: Recovery of process water at the remaining 7 WTWs
16			WASTEWATER USE- Mdantsane East & Reeston: IDZ/Industrial	
17			WASTEWATER USE- Mdantsane West/Potsdam: Domestic	
18			WASTEWATER USE- Central (From Reeston): Domestic	
19			WASTEWATER USE- East Bank: Domestic	
20			WASTEWATER USE- West Bank: IDZ/Industrial	

Figure 9.2 Scenario 2 - Full WC/WDM Interventions with Use of Return Flow Otherwise Discharged Downstream of Bridle Drift and Nahoon Dams

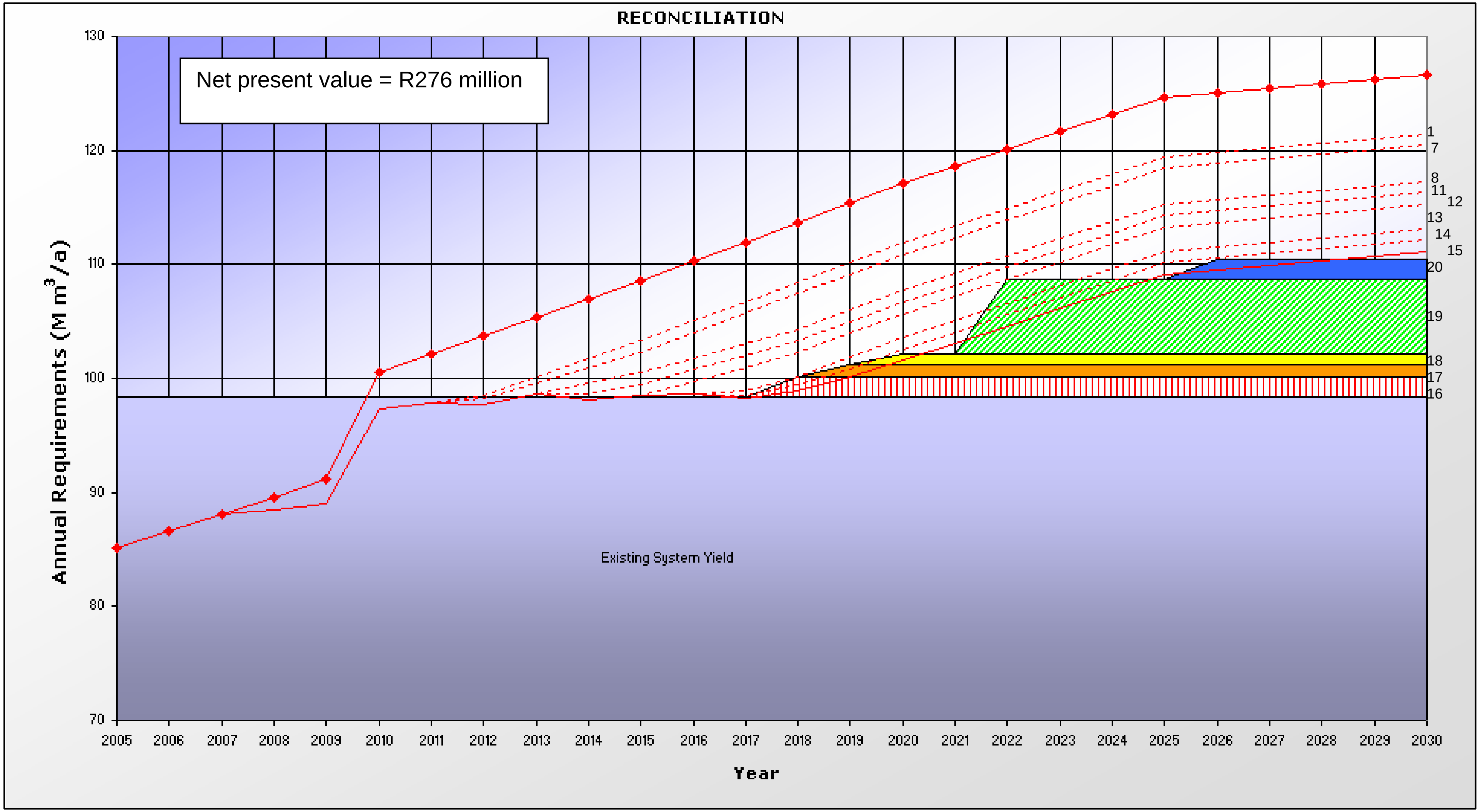

Table 9.5 Scenario 2 - Full WC/WDM Interventions with Use of Return Flow otherwise Discharged Downstream of Bridle Drift and Nahoon Dams– Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	WC/WDM- WATER USE REDUCTION: Water metering at " deemed-to-use households"	2008	5.3		
2	WC/WDM- WATER USE REDUCTION: Annual Water Audit	2010	0	1	2009
3	WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control	2010	0	1	2009
4	WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme	2011	0	1	2010
5	WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use	2011	0	1	2010
6	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)	2012	0	4	2008
7	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters	2012	1	3	2009
8	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction	2012	3	4	2008
9	WC/WDM- WATER USE REDUCTION: Support to private and public bodies to maintain water use installations	2013	0	1	2012
10	WC/WDM- WATER USE REDUCTION: Amendment to the current consumer tariff structure	2013	0	1	2012
11	WC/WDM- WATER USE REDUCTION: Use of " pour-flush" or other water efficient type sanitation systems in place of free flush systems	2014	1	1	2013
12	WC/WDM- WATER USE REDUCTION: Attend to water wastage at public facilities	2014	1	1	2013
13	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Water infrastructure asset management	2016	2	1	2015
14	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Improve the monitoring of the quality of construction of water use installations	2017	1	1	2016
15	WC/WDM- WATER LOSS AT WTWs AND UPSTREAM: Recovery of process water at the remaining 7 WTWs	2017	1	1	2016

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
16	WASTEWATER USE- Mdantsane East & Reeston: IDZ/Industrial	2018	1.8	4	2014
17	WASTEWATER USE- Mdantsane West/Potsdam: Domestic	2019	1	4	2015
18	WASTEWATER USE- Central (From Reeston): Domestic	2020	1	4	2016
19	WASTEWATER USE- East Bank: Domestic	2022	6.5	4	2018
20	WASTEWATER USE- West Bank: IDZ/Industrial	2026	1.8	4	2022

9.5.3 Scenario 3 : "Full WC/WDM interventions with no surface water options"

The scenario illustrates the extent to which the ABWSS would be able to meet the water requirements if the WC/WDM interventions that BCM has in hand and those proposed in this study are implemented and any shortfall in the availability of water is made-up by interventions without the creation of new surface water assets.

Tables 9.6 and 9.7 together with Figure 9.3 illustrate the sequence in which the interventions could be implemented and the NPV that would enable the water requirements to be met.

The existing system yield would be adequate to meet the water requirements until about 2017. The use of treated wastewater from the Mdantsane East/Reeston, Mdantsane West/Potsdam, East Bank and West Bank WWTWs for domestic and industrial purposes, by means of either direct or indirect use, would enable the water requirements to be met. The wastewater use options would be introduced over the period 2017 to 2026.

The reasons for the allocation to industrial/IDZ of treated wastewater from Mdantsane East/Reeston and from the West Bank WWTWs are as outlined in Scenario 2.

Table 9.6 Scenario 3 - Full WC/WDM Interventions with no Surface Water Options - Supply and Demand-side Measures

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
1				WC/WDM- WATER USE REDUCTION: Water metering at " deemed-to-use households"
2				WC/WDM- WATER USE REDUCTION: Annual Water Audit
3				WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control
4				WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme
5				WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use
6				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)
7				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters
8				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction
9				WC/WDM- WATER USE REDUCTION: Support to private and public bodies to maintain water use installations
10				WC/WDM- WATER USE REDUCTION: Amendment to the current consumer

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
				tariff structure
11				WC/WDM- WATER USE REDUCTION: Use of "pour-flush" or other water efficient type sanitation systems in place of free flush systems
12				WC/WDM- WATER USE REDUCTION: Attend to water wastage at public facilities
13				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Water infrastructure asset management
14				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Improve the monitoring of the quality of construction of water use installations
15				WC/WDM- WATER LOSS AT WTWs AND UPSTREAM: Recovery of process water at the remaining 7 WTWs
16			WASTEWATER USE- Mdantsane East & Reeston: IDZ/Industrial	
17			WASTEWATER USE- Mdantsane West/Potsdam: Domestic	
18			WASTEWATER USE- Central (From Reeston): Domestic	
19			WASTEWATER USE- East Bank: Domestic	
20			WASTEWATER USE- West Bank: IDZ/Industrial	

Figure 9.3 Scenario 3 - Full WC/WDM Interventions with no Surface Water Options

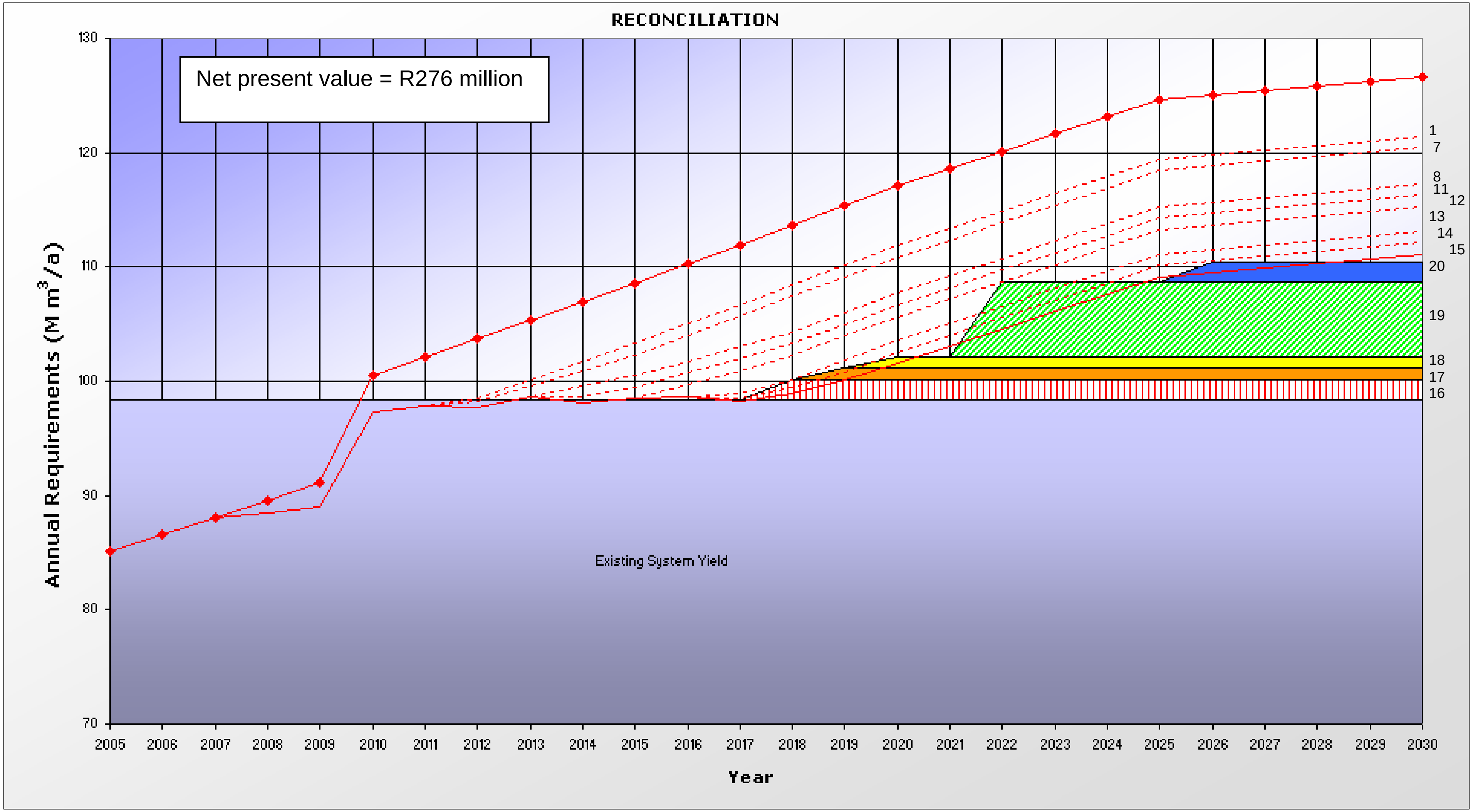

Table 9.7 Scenario 3 - Full WC/WDM Interventions with No Surface Water Options – Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	WC/WDM- WATER USE REDUCTION: Water metering at " deemed-to-use households"	2008	5.3		
2	WC/WDM- WATER USE REDUCTION: Annual Water Audit	2010	0	1	2009
3	WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control	2010	0	1	2009
4	WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme	2011	0	1	2010
5	WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use	2011	0	1	2010
6	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)	2012	0	4	2008
7	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters	2012	1	3	2009
8	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction	2012	3	4	2008
9	WC/WDM- WATER USE REDUCTION: Support to private and public bodies to maintain water use installations	2013	0	1	2012
10	WC/WDM- WATER USE REDUCTION: Amendment to the current consumer tariff structure	2013	0	1	2012
11	WC/WDM- WATER USE REDUCTION: Use of " pour-flush" or other water efficient type sanitation systems in place of free flush systems	2014	1	1	2013
12	WC/WDM- WATER USE REDUCTION: Attend to water wastage at public facilities	2014	1	1	2013
13	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Water infrastructure asset management	2016	2	1	2015
14	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Improve the monitoring of the quality of construction of water use installations	2017	1	1	2016
15	WC/WDM- WATER LOSS AT WTWs AND UPSTREAM: Recovery of process water at the remaining 7 WTWs	2017	1	1	2016
16	WASTEWATER USE- Mdantsane East & Reeston: IDZ/Industrial	2018	1.8	4	2014
17	WASTEWATER USE- Mdantsane West/Potsdam: Domestic	2019	1	4	2015
18	WASTEWATER USE- Central (From Reeston): Domestic	2020	1	4	2016
19	WASTEWATER USE- East Bank: Domestic	2022	6.5	4	2018
20	WASTEWATER USE- West Bank: IDZ/Industrial	2026	1.8	4	2022

9.5.4 Scenario 4: "Full WC/WDM Interventions with a more Balanced Approach"

The scenario illustrates the extent to which all the current and proposed WC/WDM interventions reduce the water requirements and the extent to which the shortfall can be made up by means of cost-effective interventions as well as surface water assets where necessary.

Tables 9.8 and 9.9 together with Figure 9.4 illustrate the sequence in which the interventions and asset creation could be implemented and the NPV that would enable the water requirements to be reduced and the water availability to be increased.

The existing system yield would be adequate to meet the water requirements until around 2017. The use of treated wastewater either directly or indirectly from the Mdantsane East/Reeston, Mdantsane West/Potsdam, Central, West Bank and East Bank WWTWs all introduced over the period 2017 to 2026, would be adequate to meet the water requirements till the end of the planning period.

In the event of the use of treated wastewater proving unacceptable or if a water reclamation plant at the West Bank is not feasible, it will be necessary to introduce one or more surface water assets.

Table 9.8 Scenario 4 - Full WC/WDM Interventions with a more Balanced Approach - Supply and Demand-side Measures

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
1				WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"
2				WC/WDM- WATER USE REDUCTION: Annual Water Audit
3				WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control
4				WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme
5				WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use
6				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs:

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
				Apply a management information system (MIS)
7				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters
8				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction
9				WC/WDM- WATER USE REDUCTION: Support to private and public bodies to maintain water use installations
10				WC/WDM- WATER USE REDUCTION: Amendment to the current consumer tariff structure
11				WC/WDM- WATER USE REDUCTION: Use of " pour-flush" or other water efficient type sanitation systems in place of free flush systems
12				WC/WDM- WATER USE REDUCTION: Attend to water wastage at public facilities
13				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Water infrastructure asset management
14				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Improve the monitoring of the quality of construction of water use installations
15				WC/WDM- WATER LOSS AT WTWs AND UPSTREAM: Recovery of process water at the remaining 7 WTWs
16			WASTEWATER USE- Mdantsane East & Reeston: IDZ/Industrial	
17			WASTEWATER USE- Mdantsane West/Potsdam: Domestic	
18			WASTEWATER USE- Central (From Reeston): Domestic	
19			WASTEWATER USE- East Bank: Domestic	
20			WASTEWATER USE- West Bank: IDZ/Industrial	

Figure 9.4 Scenario 4 - Full WC/WDM Interventions with a More Balanced Approach

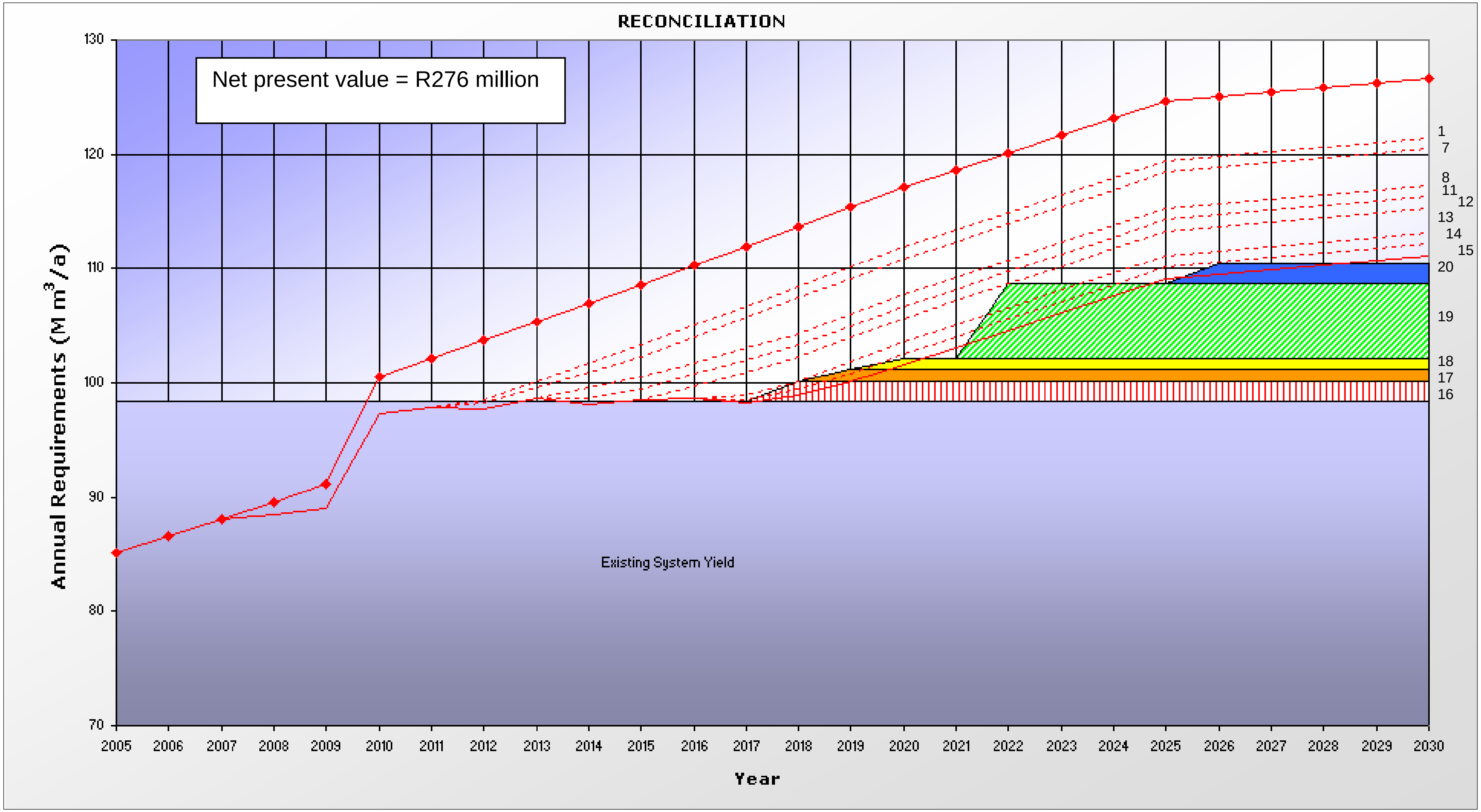

Table 9.9 Scenario 4 - Full WC/WDM Interventions with a more Balance Approach -– Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"	2008	5.3		
2	WC/WDM- WATER USE REDUCTION: Annual Water Audit	2010	0	1	2009
3	WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control	2010	0	1	2009
4	WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme	2011	0	1	2010
5	WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use	2011	0	1	2010
6	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)	2012	0	4	2008
7	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters	2012	1	3	2009
8	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction	2012	3	4	2008
9	WC/WDM- WATER USE REDUCTION: Support to private and public bodies to maintain water use installations	2013	0	1	2012
10	WC/WDM- WATER USE REDUCTION: Amendment to the current consumer tariff structure	2013	0	1	2012
11	WC/WDM- WATER USE REDUCTION: Use of " pour-flush" or other water efficient type sanitation systems in place of free flush systems	2014	1	1	2013
12	WC/WDM- WATER USE REDUCTION: Attend to water wastage at public facilities	2014	1	1	2013
13	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Water infrastructure asset management	2016	2	1	2015
14	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Improve the monitoring of the quality of construction of water use installations	2017	1	1	2016
15	WC/WDM- WATER LOSS AT WTWs AND UPSTREAM: Recovery of process water at the remaining 7 WTWs	2017	1	1	2016
16	WASTEWATER USE- Mdantsane East & Reeston: IDZ/Industrial	2018	1.8	4	2014
17	WASTEWATER USE- Mdantsane West/Potsdam: Domestic	2019	1	4	2015
18	WASTEWATER USE- Central (From Reeston): Domestic	2020	1	4	2016
19	WASTEWATER USE- East Bank: Domestic	2022	6.5	4	2018
20	WASTEWATER USE- West Bank: IDZ/Industrial	2026	1.8	4	2022

9.5.5 Scenario 5 : "WC/WDM Interventions that BCM has in Hand and the Creation of Surface Water Assets"

The scenario illustrates the extent to which the WC/WDM interventions that BCM has in hand, together with those interventions that are necessary to make BCM's interventions successful, could influence the need for surface water supply assets. The interventions that BCM has in hand are:

- the installation of domestic water meters, particularly for the "deemed-to-use" households;
- development and use of a management information system;
- the installation of area meters and
- pressure reduction in water reticulation networks.

The interventions that are necessary to make BCM's interventions successful and which have been taken into account are:

- an annual water audit;
- enhancement of meter, billing and debtor management;
- improvements to the user education programme and
- structured response to issues related to water use and cost recovery.

Tables 9.10 and 9.11 together with Figure 9.5 illustrate the sequence in which the interventions and asset creation could be implemented, and the NPV that would enable the water requirements to be met.

Until around 2013 the existing system yield would be adequate to meet the water requirements. The surface water asset with the lowest URV, which would be required by 2015, is the transfer of water from the Sandile and Binfield Park dams in tributaries of the Keiskamma River.

A further augmentation of the bulk water supply would be required 7 or 8 years later, at which time a dam on the Gqunube River at Mhalla's Kop would meet the requirements until the end of the planning period.

Table 9.10 Scenario 5 - WC/WDM Interventions that BCM has in Hand, and the Creation of Surface Water Assets - Supply and Demand-side Measures

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
1				WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"
2				WC/WDM- WATER USE REDUCTION: Annual Water Audit
3				WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control
4				WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme
5				WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use
6				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)
7				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters
8				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction
9		AUGMENTATION OF WATER SUPPLIES - Keiskamma River: Transfer of water from Sandile and Binfield Park dams		
10		AUGMENTATION OF WATER SUPPLIES - Gqunube River: A dam at Mhalla's Kop		

Figure 9.5 Scenario 5 - WC/WDM Interventions that BCM has in Hand and the Creation of Surface Water Assets

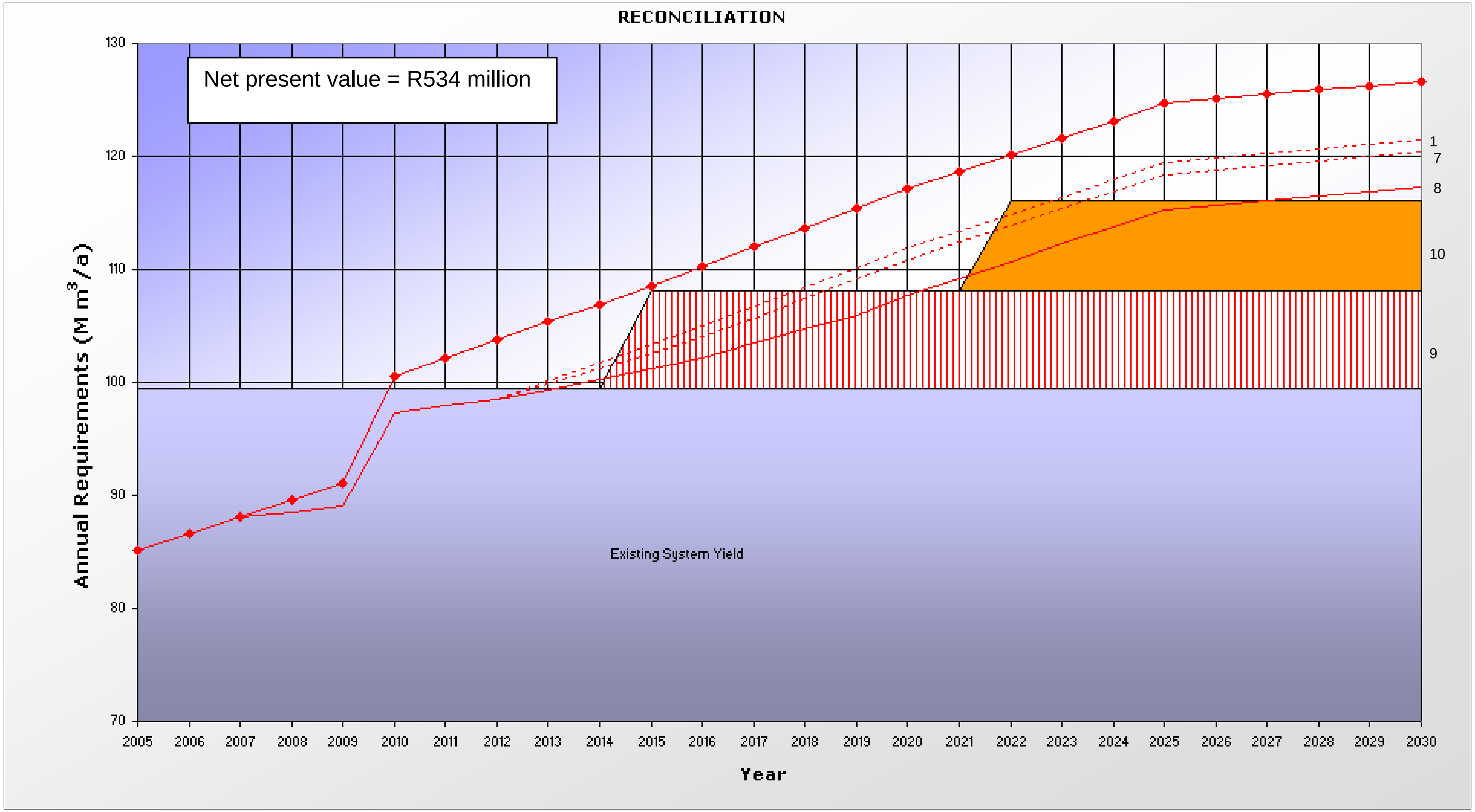

Table 9.11 Scenario 5 : WC/WDM Interventions that BCM has in Hand and the Creation of Surface Water Assets – Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"	2008	5.3		
2	WC/WDM- WATER USE REDUCTION: Annual Water Audit	2010	0	1	2009
3	WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control	2010	0	1	2009
4	WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme	2011	0	1	2010
5	WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use	2011	0	1	2010
6	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)	2012	0	4	2008
7	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters	2013	1	3	2010
8	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction	2013	3	4	2009
9	AUGMENTATION OF WATER SUPPLIES - Keiskamma River: Transfer of water from Sandile and Binfield Park dams	2015	8.7	4	2011
10	AUGMENTATION OF WATER SUPPLIES - Gqunube River: A dam at Mhalla's Kop	2022	7.9	10	2012

9.5.6 Scenario 6 : "WC/WDM Interventions that BCM has in Hand, the Use of Treated Wastewater and the Creation of Surface Water Assets"

The scenario illustrates the extent to which the WC/WDM interventions that BCM has in hand, together with the other interventions required for their success as set out in Scenario 5, could influence the need for surface water supply assets if treated wastewater is used in preference to the creation of surface water supply assets.

Tables 9.12 and 9.13 together with Figure 9.6 illustrate the sequence in which the interventions and asset creation could be implemented and the NPV that would enable the water requirements to be met.

Until around 2013 the existing system yield would be adequate to meet the water requirements.

Use of treated wastewater from the Mdantsane East/Reeston, Potsdam/ Mdantsane West, Central via Reeston, the East Bank, the West Bank and the Quinera (Gonubie) WWTWs would provide sufficient water for industrial as well as domestic purposes until around 2023.

A dam in the Nahoon River at Stone Island Farm would augment the supply to the end of the planning period.

In the event of it proving impracticable to use treated wastewater from the West Bank and the Gonubie WWTWs, construction of the surface water asset would be brought forward by some 2 years and a further surface water asset, such as the transfer of water from the Sandile and Binfield Park dams, would be necessary.

Table 9.12 Scenario 6 - WC/WDM Interventions that BCM has in Hand, the Use of Treated Wastewater and the Creation of Surface Water Assets - Supply and Demand-side Measures

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
1				WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"
2				WC/WDM- WATER USE REDUCTION: Annual Water Audit
3				WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control
4				WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme
5				WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use
6				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)
7				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters
8				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction
9			WASTEWATER USE- Mdantsane East & Reeston: IDZ/Industrial	
10			WASTEWATER USE- Mdantsane West/Potsdam: Domestic	
11			WASTEWATER USE- Central (From Reeston): Domestic	
12			WASTEWATER USE- East Bank: Domestic	
13			WASTEWATER USE- West Bank: IDZ/Industrial	
14			WASTEWATER USE- Quinera (Gonubie): Domestic	
15		AUGMENTATION OF WATER SUPPLIES - Nahoon River: A dam at Stone Island Farm		

Figure 9.6 Scenario 6 - WC/WDM Interventions that BCM has in hand, the Use of Treated Wastewater and the Creation of Surface Water Assets

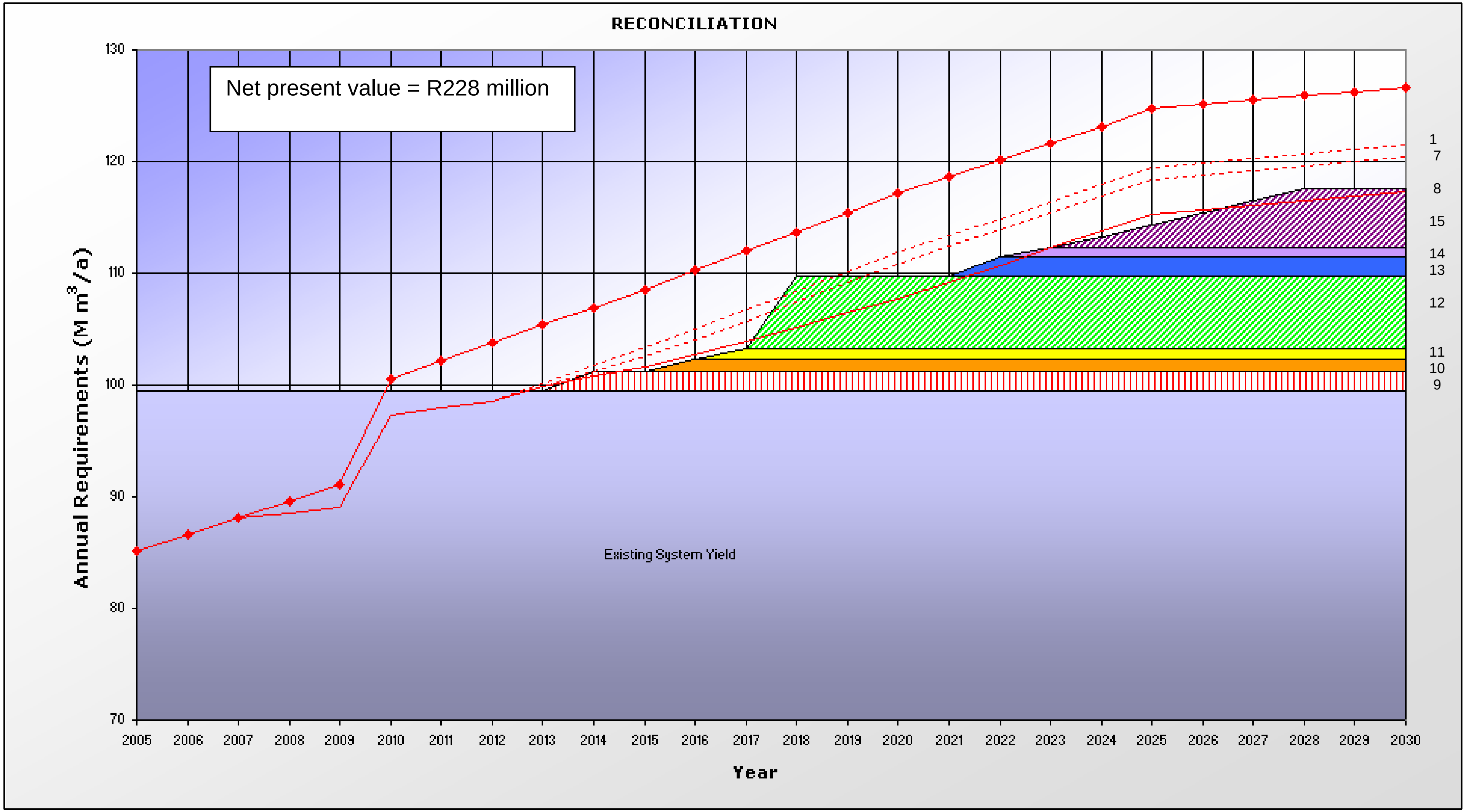

Table 9.13 Scenario 6 - WC/WDM Interventions that BCM has in Hand, the Use of Treated Wastewater and the Creation of Surface Water Assets – Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"	2008	5.3		
2	WC/WDM- WATER USE REDUCTION: Annual Water Audit	2010	0	1	2009
3	WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control	2010	0	1	2009
4	WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme	2011	0	1	2010
5	WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use	2011	0	1	2010
6	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)	2012	0	4	2008
7	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters	2013	1	3	2010
8	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction	2013	3	4	2009
9	WASTEWATER USE- Mdantsane East & Reeston: IDZ/Industrial	2014	1.8	4	2010
10	WASTEWATER USE- Mdantsane West/Potsdam: Domestic	2016	1	4	2012
11	WASTEWATER USE- Central (From Reeston): Domestic	2017	1	4	2013
12	WASTEWATER USE- East Bank: Domestic	2018	6.5	4	2014
13	WASTEWATER USE- West Bank: IDZ/Industrial	2022	1.8	4	2018
14	WASTEWATER USE- Quinera (Gonubie): Domestic	2023	0.7	4	2019
15	AUGMENTATION OF WATER SUPPLIES - Nahoon River: A dam at Stone Island Farm	2024	5.3	10	2014

9.5.7 Scenario 7 : "No WC/WDM Interventions or Failure of the WC/WDM Interventions that BCM has in Hand, with Surface Water Asset Creation"

This scenario illustrates the need for additional surface water assets if those WC/WDM interventions that BCM has in hand are not successful and if there are no further WC/WDM interventions. The scenario also assumes that the use of treated wastewater would not be acceptable to consumers and that interventions for the use of treated wastewater are not implemented.

Tables 9.14 and 9.15 together with Figure 9.7 illustrate the sequence in which the interventions and asset creation could be implemented, and the NPV that would enable the availability of surface water to be increased to meet the water requirements.

Initially, until around 2010, the existing system yield would be adequate. The surface water scheme with the lowest URV is a dam in the Nahoon River at Stone Island Farm, but the total lead time required for that dam is too long to enable water to be available by 2010. The asset with the next lowest URV is the transfer of water from the Sandile and Binfield Park dams. By accelerating the project, water could become available by 2011. Hence, the transfer of water from Sandile and Binfield Park dams would be the first asset creation intervention followed by a dam at Stone Island Farm, which would be required by 2016. The lead time for the dam is some 10 years, hence the dam would also have to be accelerated, which might not be possible.

By 2019 a further augmentation of the bulk water supply would be required. The surface water asset with the next lowest URV is a dam in the Gqunube River at Groothoek/Waterfall. The yield from the dam would increase the water available to be adequate for the water requirements at the end of the planning period.

Table 9.14 Scenario 7 - No WC/WDM Interventions or Failure of the WC/WDM Interventions that BCM has in Hand, with Surface Water Asset Creation - Supply and Demand-side Measures

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
1		AUGMENTATION OF WATER SUPPLIES - Keiskamma River: Transfer of water from Sandile and Binfield Park dams		
2		AUGMENTATION OF WATER SUPPLIES - Nahoon River: A dam at Stone Island Farm		
3		AUGMENTATION OF WATER SUPPLIES - Gqunube River: A dam at Groothoek/Waterfall		

Figure 9.7 Scenario 7 - No WC/WDM Interventions or Failure of the WC/WDM Interventions that BCM has in Hand and No Wastewater Use Interventions, with Surface Water Asset Creation

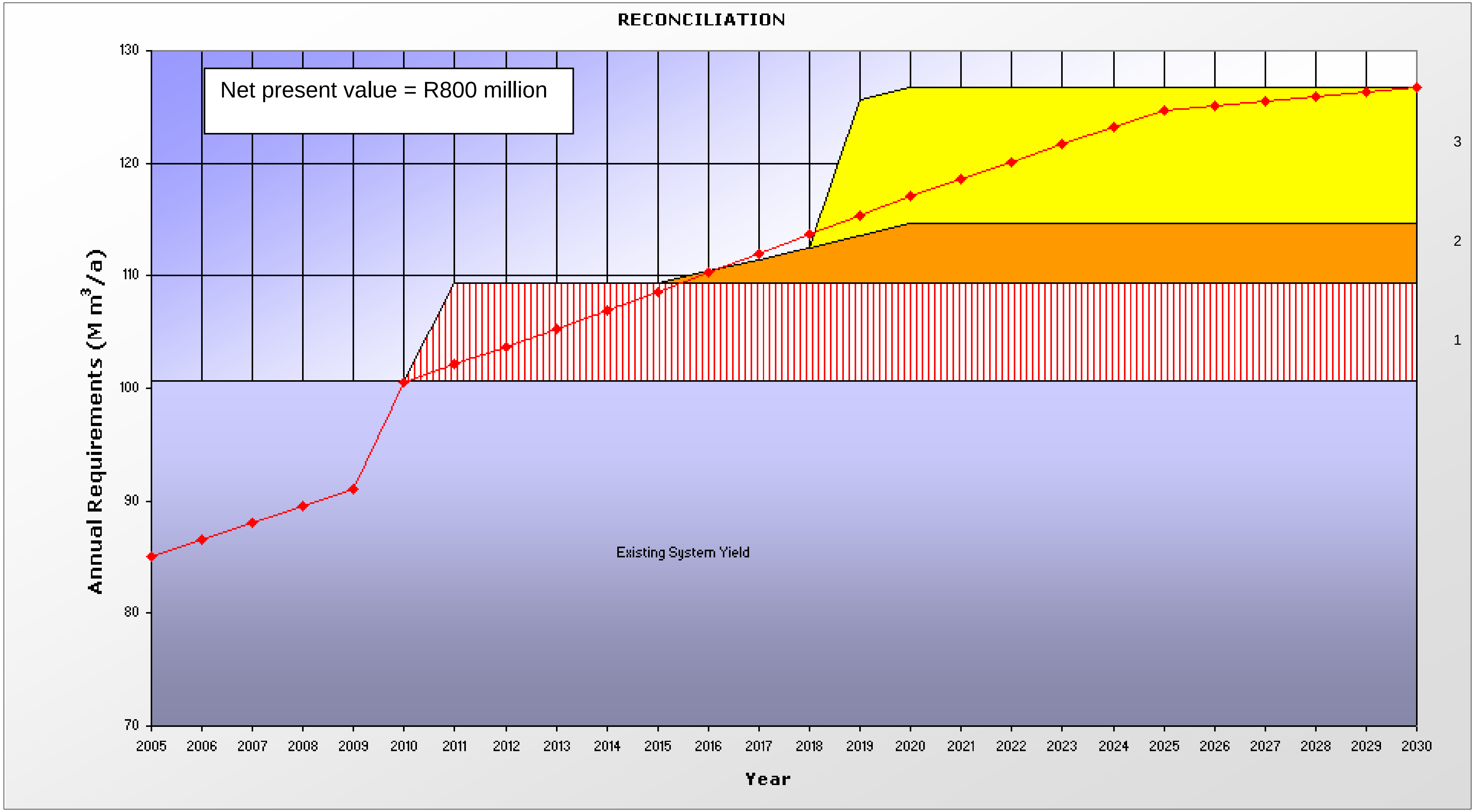

Table 9.15 Scenario 7 - No WC/WDM Interventions or Failure of the WC/WDM Interventions that BCM has in Hand, with Surface Water Asset Creation – Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	AUGMENTATION OF WATER SUPPLIES - Keiskamma River: Transfer of water from Sandile and Binfield Park dams	2011	8.7	4	2007
2	AUGMENTATION OF WATER SUPPLIES - Nahoon River: A dam at Stone Island Farm	2016	5.3	10	2006
3	AUGMENTATION OF WATER SUPPLIES - Gqunube River: A dam at Groothoek/Waterfall	2019	12.1	10	2009

9.5.8 Scenario 8 : "Impact of the Lower Water Requirement with the Interventions BCM has in Hand"

This scenario illustrates whether there is a need for asset creation or for interventions other than the WC/WDM interventions that BCM has in hand and those required to make BCM's interventions successful to meet the lower water requirement scenario.

Tables 9.16 and 9.17 together with Figure 9.8 illustrate that no additional interventions or asset creation would be necessary.

Table 9.16 Scenario 8 - Impact of the Lower Water Requirement with the Interventions BCM has in Hand - Supply and Demand-side Measures

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
1				WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"
2				WC/WDM- WATER USE REDUCTION: Annual Water Audit
3				WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control
4				WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme
5				WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use
6				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)
7				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters
8				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction

Figure 9.8 Scenario 8 - Impact of the Lower Water Requirement with the Interventions BCM has in Hand

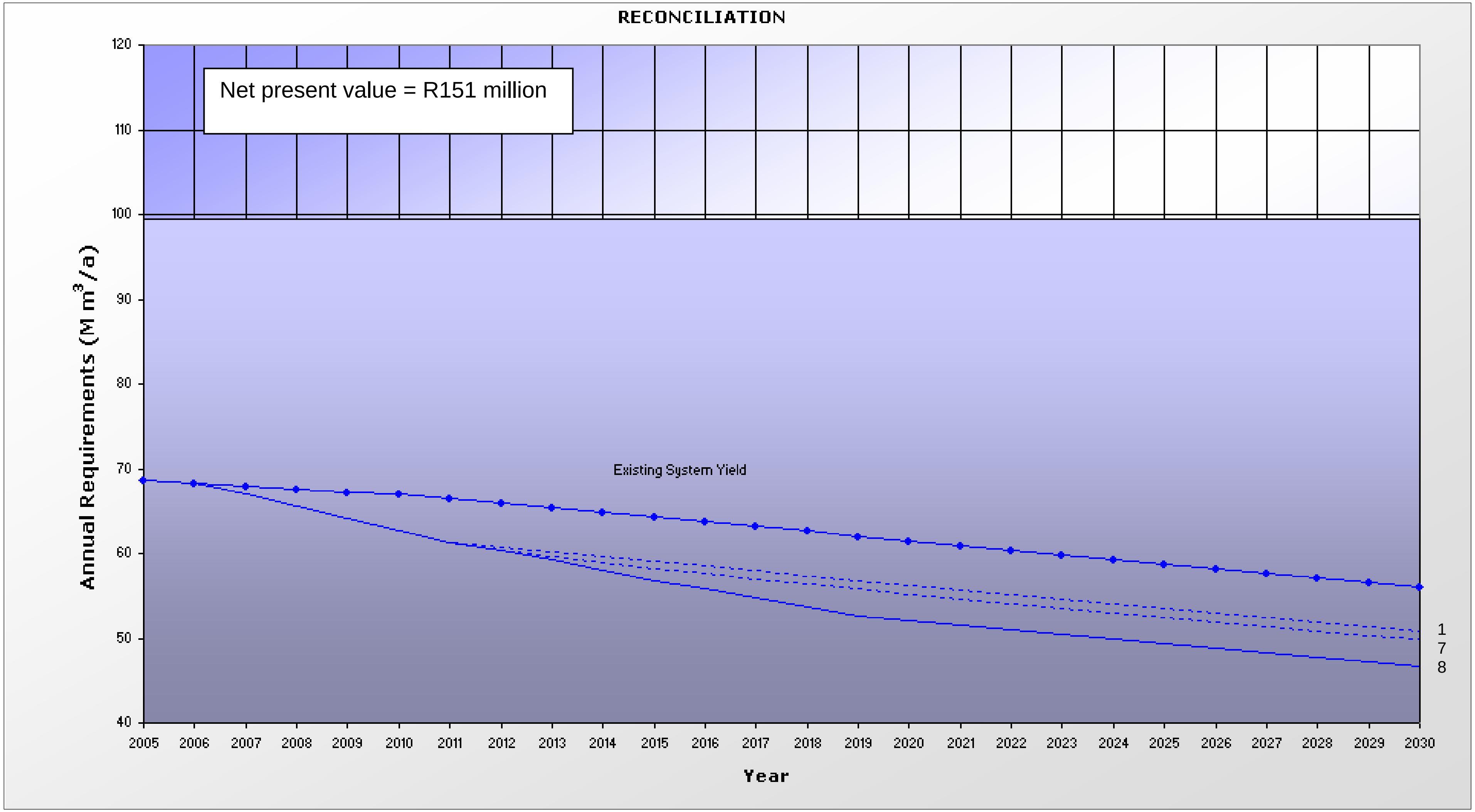

Table 9.17 Scenario 8 - Impact of the Lower Water Requirement with the Interventions BCM has in Hand – Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"	2008	5.3		
2	WC/WDM- WATER USE REDUCTION: Annual Water Audit	2010	0	1	2009
3	WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control	2010	0	1	2009
4	WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme	2011	0	1	2010
5	WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use	2011	0	1	2010
6	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)	2012	0	4	2008
7	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters	2012	1	3	2009
8	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction	2013	3	4	2009

9.5.9 Scenario 9 : "Impact of the EWR with full WC/WDM Interventions"

The scenario illustrates the impact of the water releases from the dams in the ABWSS for the EWR on the need for additional interventions and surface water assets to meet the water requirements should the full WC/WDM interventions proposed in this study be implemented.

Tables 9.18 and 9.19 together with Figure 9.9 illustrate the sequence in which the interventions and asset creation could be implemented and the NPV for the interventions and asset creation.

Stakeholders have flexibility as to the manner in which the EWR is to be introduced, but as the EWR has the "first right" to the water in a river, compliance with the legal requirements cannot be postponed indefinitely. The scenario illustrates the introduction of the EWR over a period of 5 years, starting around 2016. The delay in starting is to enable the WC/WDM interventions to be introduced and for the results to be monitored. The extended time in complying with the EWR is to enable corrective measures to be taken in the event of the WC/WDM interventions being less successful than provided for in the scenario. It also provides for a sufficient lead-time for the planning of the supply-side interventions related to the creation of surface water assets that would be necessary.

Successful implementation of the existing and proposed WC/WDM interventions together with the return of treated wastewater from the Mdantsane West/Potsdam, Mdantsane East/Reeston and Central WWTWs to meet part of the EWR requirements in the lower Buffalo River would enable the water requirements to be met by the existing system yield until around 2017.

Using treated wastewater from the East Bank, West Bank and Quinera (Gonubie) WWTWs could be the first interventions to enhance the available bulk water supply and to contribute towards the shortfall in the EWR requirements. Alternatively, the increase in the water available for the EWR could be postponed by about 2 years until the first surface water asset would be required. As wastewater from Mdantsane/Potsdam is discharged to the Buffalo River below the Bridle Drift Dam, it already contributes to meeting the EWR provided it is adequately treated to meet the quality requirements.

Augmentation of the surface water supply would require the three surface water assets with the lowest URVs (namely a dam in the Nahoon River at Stone Island Farm, the transfer of water from Sandile and Binfield Park dams in tributaries of the Keiskamma River and a dam in the Gqunube River at Groothoek/Waterfall) to be commissioned between 2018 and 2020. Such an arrangement would favour dual WTWs in the Lower Buffalo Scheme, namely one at Umzonyana and the other at Nahoon Dam. The transfer of water from Sandile and Binfield Park dams would be implemented first to allow some additional lead time for the dam in the Nahoon River at Stone Island Farm.

Alternatively, in place of a dam in the Nahoon River and one in the Gqunube River, a larger dam with a higher URV would be appropriate, such as a dam in the Keiskamma River at Ravenswood Farm, due to the latter's proximity to BCM's Umzonyana WTW. This option would strengthen the dominance of the Umzonyana WTW.

A decision on which of the surface water assets would be most appropriate would depend upon the manner in which BCM intends operating its system (a single WTW at Umzonyana or dual WTWs, one being at Umzonyana and the other at the Nahoon Dam) as well as upon the most favourable URVs.

Table 9.18 Scenario 9 - Impact of the EWR, with Full WC/WDM Interventions - Supply and Demand-side Measures

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
1				WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"
2				WC/WDM- WATER USE REDUCTION: Annual Water Audit
3				WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control
4				WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme
5				WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use
6				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)
7				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters
8				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction
9				WC/WDM- WATER USE REDUCTION: Support to private and public bodies to maintain water use installations
10				WC/WDM- WATER USE REDUCTION: Amendment to the current consumer tariff structure
11				WC/WDM- WATER USE REDUCTION: Use of " pour-flush" or other water efficient type sanitation systems in place of free flush systems
12				WC/WDM- WATER USE REDUCTION: Attend to water wastage at public facilities
13				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Water infrastructure asset

No	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
				management
14				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Improve the monitoring of the quality of construction of water use installations
15				WC/WDM- WATER LOSS AT WTWs AND UPSTREAM: Recovery of process water at the remaining 7 WTWs
16	WASTEWATER RETURN FLOW- Mdantsane West/Potsdam: Return Flow to contribute to the EWR			
17	WASTEWATER RETURN FLOW- Mdantsane East & Reeston: Return Flow to contribute to the EWR			
18	WASTEWATER RETURN FLOW- Central (From Reeston): Return Flow to contribute to the EWR			
19			WASTEWATER USE- East Bank: Domestic	
20			WASTEWATER USE- West Bank: IDZ/Industrial	
21			WASTEWATER USE- Quinera (Gonubie): Domestic	
22		AUGMENTATION OF WATER SUPPLIES - Keiskamma River: Transfer of water from Sandile and Binfield Park dams		
23		AUGMENTATION OF WATER SUPPLIES - Nahoon River: A dam at Stone Island Farm		
24		AUGMENTATION OF WATER SUPPLIES - Gqunube River: A dam at Groothoek/Waterfall		

Figure 9.9 Scenario 9 - Impact of the EWR, with Full WC/WDM Interventions

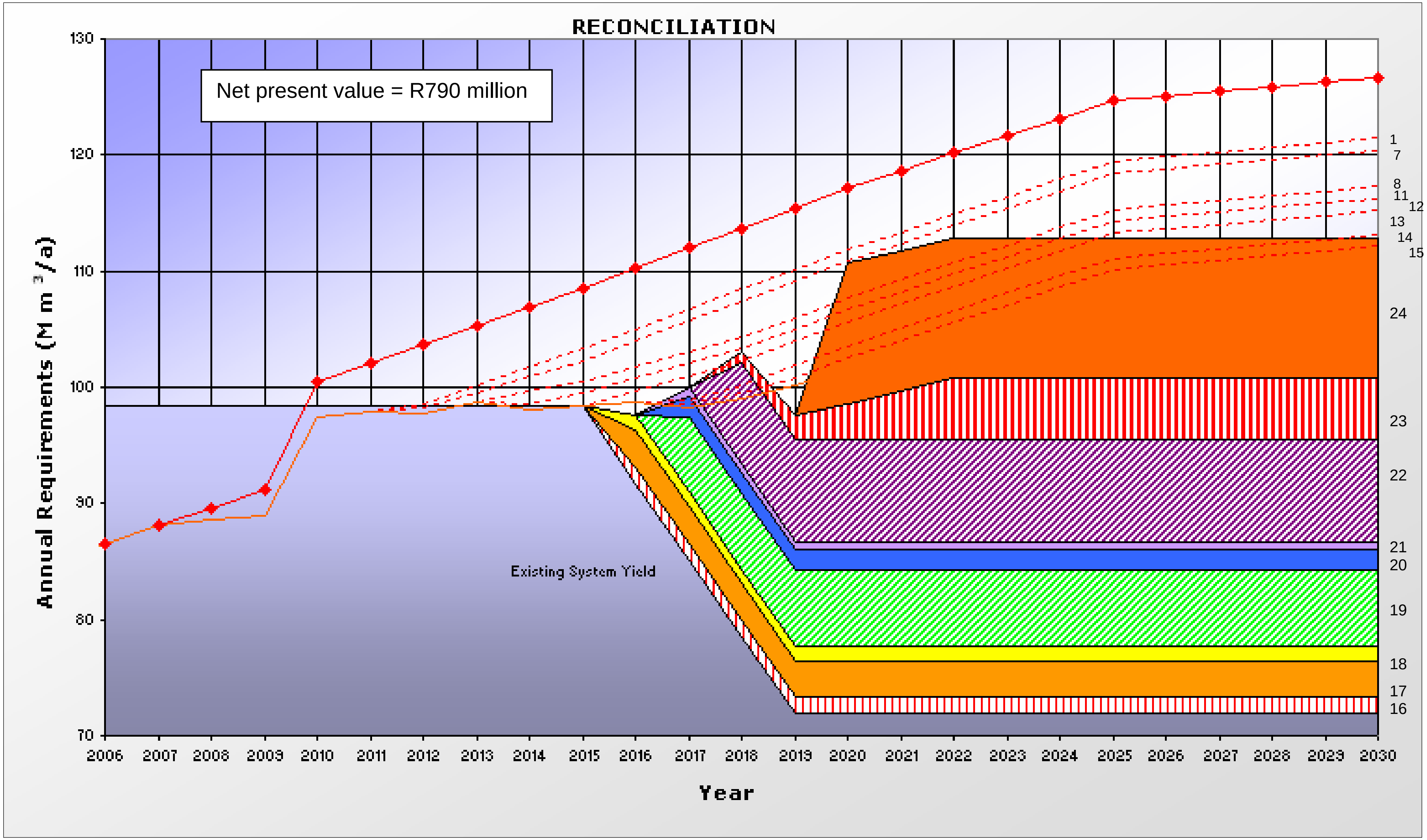

Table 9.19 Scenario 9 - Impact of the EWR with Full WC/WDM Interventions – Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"	2008	5.3		
2	WC/WDM- WATER USE REDUCTION: Annual Water Audit	2010	0	1	2009
3	WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control	2010	0	1	2009
4	WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme	2011	0	1	2010
5	WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use	2011	0	1	2010
6	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)	2012	0	4	2008
7	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters	2012	1	3	2009
8	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction	2012	3	4	2008
9	WC/WDM- WATER USE REDUCTION: Support to private and public bodies to maintain water use installations	2013	0	1	2012
10	WC/WDM- WATER USE REDUCTION: Amendment to the current consumer tariff structure	2013	0	1	2012
11	WC/WDM- WATER USE REDUCTION: Use of " pour-flush" or other water efficient type sanitation systems in place of free flush systems	2014	1	1	2013
12	WC/WDM- WATER USE REDUCTION: Attend to water wastage at public facilities	2014	1	1	2013
13	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Water infrastructure asset management	2016	2	1	2015
14	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Improve the monitoring of the quality of construction of water use installations	2017	1	1	2016
15	WC/WDM- WATER LOSS AT WTWs AND UPSTREAM: Recovery of process water at the remaining 7 WTWs	2017	1	1	2016
16	WASTEWATER RETURN FLOW- Mdantsane West/Potsdam: Return Flow to contribute to the EWR	2016	1.3	0	2016
17	WASTEWATER RETURN FLOW- Mdantsane East & Reeston: Return Flow to contribute to the EWR	2016	3.2	0	2016
18	WASTEWATER RETURN FLOW- Central (From Reeston): Return Flow to contribute to the EWR	2016	1.4	0	2016
19	WASTEWATER USE- East Bank: Domestic	2017	6.5	4	2013
20	WASTEWATER USE- West Bank: IDZ/Industrial	2017	1.8	4	2013

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
21	WASTEWATER USE- Quinera (Gonubie): Domestic	2017	0.7	4	2013
22	AUGMENTATION OF WATER SUPPLIES - Keiskamma River: Transfer of water from Sandile and Binfield Park dams	2018	8.7	4	2014
23	AUGMENTATION OF WATER SUPPLIES - Nahoon River: A dam at Stone Island Farm	2018	5.3	10	2008
24	AUGMENTATION OF WATER SUPPLIES - Gqunube River: A dam at Groothoek/Waterfall	2020	12.1	10	2010

9.5.10 Scenario 10 : "Impact of the EWR with the WC/WDM Interventions that BCM has in Hand"

The scenario illustrates the impact of the water released from the dams in the ABWSS for the EWR on the need for additional interventions and surface water assets to meet the water requirements if the WC/WDM interventions that BCM has in hand are successfully implemented.

Tables 9.20 and 9.21 together with Figure 9.10 illustrate the sequence in which the interventions and asset creation could be implemented and the NPV for the introduction of the EWR.

The scenario illustrates the introduction of the EWR over a period of 5 years, starting around 2016.

Successful implementation of the WC/WDM interventions that BCM has in hand together with return flows from the Potsdam/Mdantsane West, Mdantsane East/Reeston and Central WWTWs to meet part of the EWR requirements in the Lower Buffalo River would enable the water requirements to be met by the existing system until around 2016.

The interventions with the next lowest URVs are the use of treated wastewater whereafter surface water assets would be necessary. The first of such assets would have to be commissioned around 2017.

The surface water assets which lend themselves best to implementation are the transfer of water from the Sandile and Binfield Park dams, a dam in the Nahoon River at Stone Island Farm, a dam in the Gqunube River at Groothoek/Waterfall and possibly a dam in the Gqunube River at Mhalla's Kop. The surface water assets would need to be commissioned progressively between 2017 and 2025.

Alternatively, the transfer of water from the Sandile and Binfield Park dams together with a dam in the Keiskamma River at either Ravenswood Farm or Thornwood Farm would be appropriate.

The favoured alternative would depend upon the manner in which the water treatment capacity for BCM is configured between the Umzonyana and Nahoon WTWs.

Table 9.20 Scenario 10 - Impact of the EWR, with WC/WDM Interventions that BCM has in Hand - Supply and Demand-side Measures

No.	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
1				WC/DM- WATER USE REDUCTION: Water metering at "deemed-to-use households"
2				WC/WDM- WATER USE REDUCTION: Annual Water Audit
3				WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control
4				WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme
5				WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use
6				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)
7				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters
8				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction
9	WASTEWATER RETURN FLOW- Mdantsane West/Potsdam: Return Flow to contribute to the EWR			

No.	Wastewater return flow	Surface/Groundwater Asset Creation	Wastewater Use	WC/WDM Intervention
10	WASTEWATER RETURN FLOW- Mdantsane East & Reeston: Return Flow to contribute to the EWR			
11	WASTEWATER RETURN FLOW- Central (From Reeston): Return Flow to contribute to the EWR			
12			WASTEWATER USE- East Bank: Domestic	
13			WASTEWATER USE- West Bank: IDZ/Industrial	
14			WASTEWATER USE- Quinera (Gonubie): Domestic	
15		AUGMENTATION OF WATER SUPPLIES - Keiskamma River: Transfer of water from Sandile and Binfield Park Dams		
16		AUGMENTATION OF WATER SUPPLIES - Nahoon River: A dam at Stone Island Farm		
17		AUGMENTATION OF WATER SUPPLIES - Gqunube River: A dam at Groothoek/Waterfall		
18		AUGMENTATION OF WATER SUPPLIES - Gqunube River: A dam at Mhalla's Kop		

Figure 9.10 Scenario 10 - Impact of the EWR, with WC/WDM Interventions that BCM has in Hand

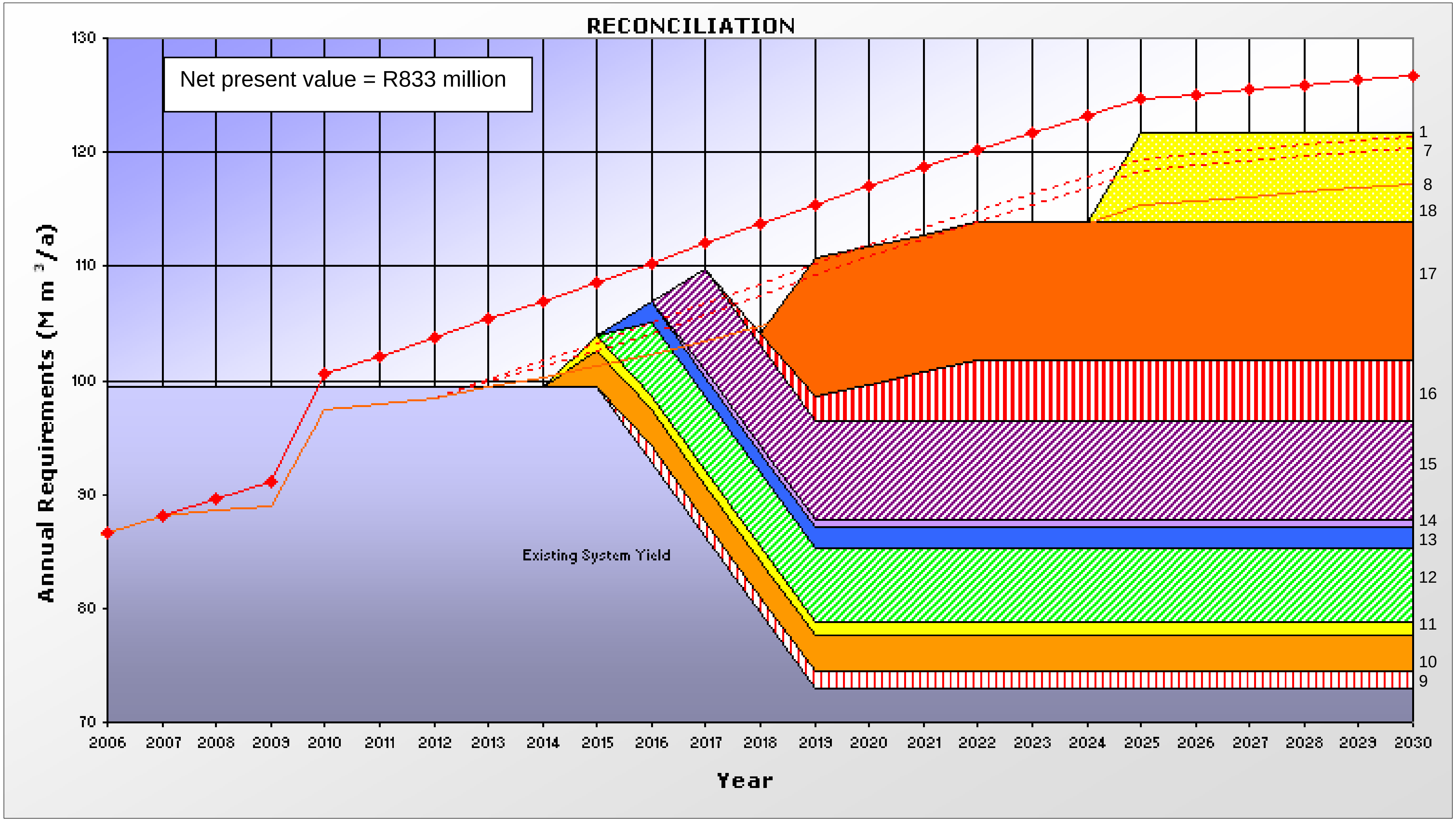

Table 9.21 Scenario 10 - Impact of the EWR with the WC/WDM Interventions that BCM has in Hand – Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	WC/DM- WATER USE REDUCTION: Water metering at "deemed-to-use households"	2008	5.3		
2	WC/WDM- WATER USE REDUCTION: Annual Water Audit	2010	0	1	2009
3	WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control	2010	0	1	2009
4	WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme	2011	0	1	2010
5	WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use	2011	0	1	2010
6	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)	2012	0	4	2008
7	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters	2013	1	3	2010
8	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction	2013	3	4	2009
9	WASTEWATER RETURN FLOW- Mdantsane West/Potsdam: Return Flow to contribute to the EWR	2015	1.3	0	2015
10	WASTEWATER RETURN FLOW- Mdantsane East & Reeston: Return Flow to contribute to the EWR	2015	3.2	0	2015
11	WASTEWATER RETURN FLOW- Central (From Reeston): Return Flow to contribute to the EWR	2016	1.4	0	2016
12	WASTEWATER USE- East Bank: Domestic	2016	6.5	4	2012
13	WASTEWATER USE- West Bank IDZ/Industrial	2016	1.7	4	2012
14	WASTEWATER USE- Quinera (Gonubie): Domestic	2017	0.7	4	2013
15	AUGMENTATION OF WATER SUPPLIES - Keiskamma River: Transfer of water from Sandile and Binfield Park dams	2017	8.7	4	2013
16	AUGMENTATION OF WATER SUPPLIES - Nahoon River: A dam at Stone Island Farm	2018	5.3	10	2008
17	AUGMENTATION OF WATER SUPPLIES - Gqunube River: A dam at Groothoek/Waterfall	2019	12.1	10	2009
18	AUGMENTATION OF WATER SUPPLIES - Gqunube River: A dam at Mhalla's Kop	2025	7.9	10	2015

9.5.11 Scenario 11 : "Impact of the EWR on the Lower Water Requirement with WC/WDM Interventions that BCM has in Hand"

The scenario illustrates the extent to which return flows need to be taken into account as contributors to the EWR as well as the need for asset creation or for interventions beyond those BCM has in hand and those required for the success of BCM's interventions.

Tables 9.22 and 9.23 together with Figure 9.11 illustrate the need, if any, for additional interventions beyond the WC/WDM interventions that BCM has in hand in order to meet the lower water requirement.

The scenario illustrates the introduction of the EWR over a period of 5 years, starting around 2015, in order to enable the actual water requirements to be monitored.

With or without the successful implementation of the WC/WDM interventions that BCM has in hand, the existing system yield would enable the water requirements, together with the EWR, to be met by the existing bulk water supply sources.

Table 9.22 Scenario 11 - Impact of the EWR on the Lower Water Requirement with WC/WDM Interventions that BCM has in Hand - Supply and Demand-side Measures

No.	Wastewater return flow	Surface/Ground--water Asset Creation	Wastewater Use	WC/WDM Intervention
1				WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"
2				WC/WDM- WATER USE REDUCTION: Annual Water Audit
3				WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control
4				WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme
5				WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use
6				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)
7				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters
8				WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction

Figure 9.11 Scenario 11 - Impact of the EWR on the Lower Water Requirement with the WC/WDM Interventions that BCM has in Hand

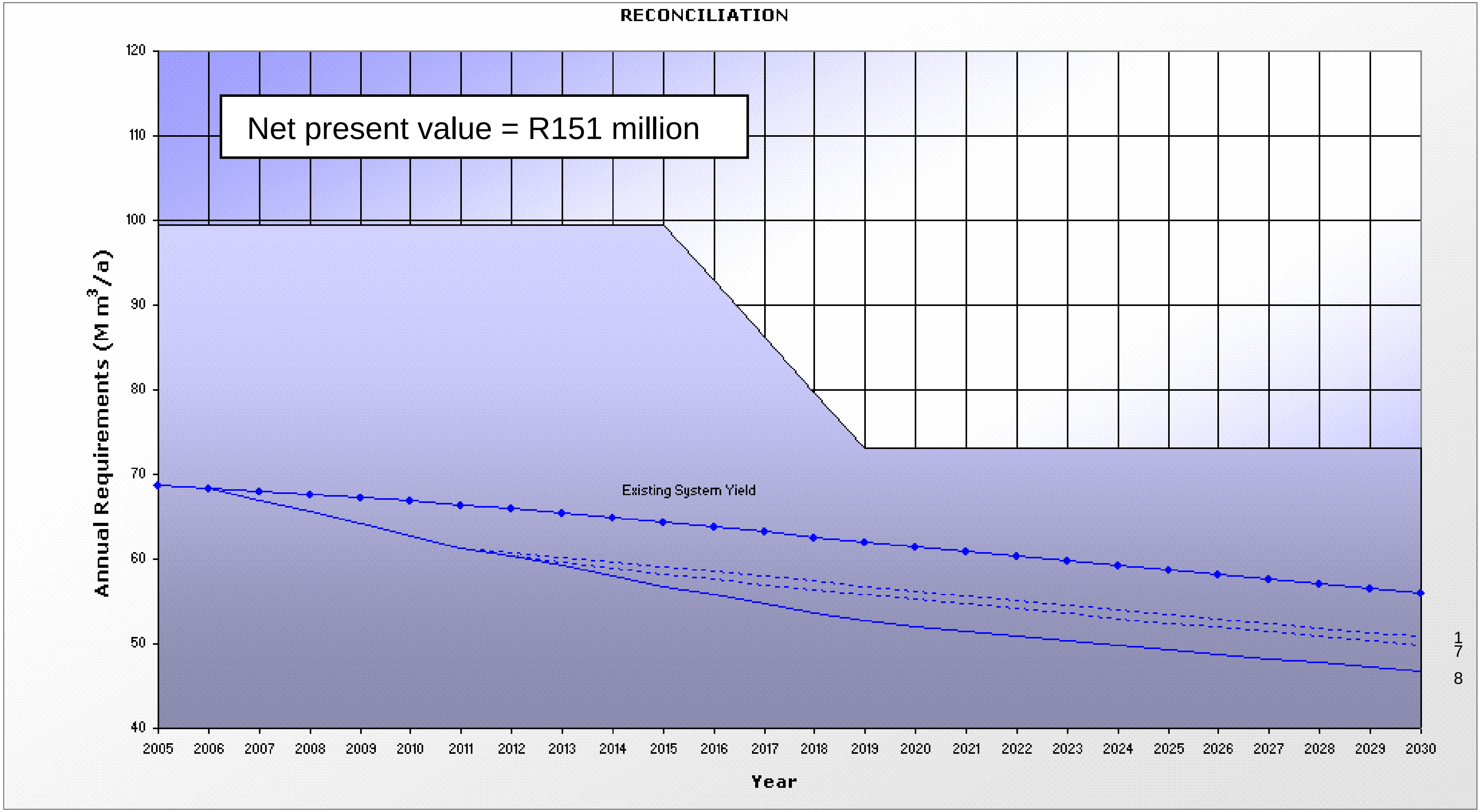

Table 9.23 Scenario 11 - Impact of the EWR on the Lower Water Requirement with WC/WDM Interventions BCM has in Hand – Intervention/Asset Selection and Study Start Date

No	Intervention/Asset	Year the Water or Saving is Required	Yield	Total Lead Time	Study Start Date
1	WC/WDM- WATER USE REDUCTION: Water metering at "deemed-to-use households"	2008	5.3		
2	WC/WDM- WATER USE REDUCTION: Annual Water Audit	2010	0	1	2009
3	WC/WDM- WATER USE REDUCTION: Comprehensive and effective metering, reading, billing and debt control	2010	0	1	2009
4	WC/WDM- WATER USE REDUCTION: Enhancement to the current water use education programme	2011	0	1	2010
5	WC/WDM- WATER USE REDUCTION: Structured response in respect of defaults in water payment or excessive use	2011	0	1	2010
6	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Apply a management information system (MIS)	2012	0	4	2008
7	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Installation of area meters	2012	1	3	2009
8	WC/WDM- WATER LOSS DOWNSTREAM OF WTWs: Pressure reduction	2013	3	4	2009

9.5.12 Net Present Values

The NPV calculated by means of the DST for each scenario is shown on the figure illustrating the scenario. The results are summarised in Table 9.24.

Table 9.24 NPVs for the Scenarios

Scenario Number	Scenario Title	NPV (R million)
1	Full WC/WDM interventions with surface water asset creation	510
2	Full WC/WDM interventions with use of return flow otherwise discharged downstream of Bridle Drift and Nahoon dams	276
3	Full WC/WDM interventions with no surface water options	276
4	Full WC/WDM interventions with a more balanced approach	276
5	WC/WDM interventions that BCM has in hand and the creation of surface water assets	534
6	WC/WDM interventions that BCM has in hand, the use of treated wastewater and the creation of surface water assets	228
7	No WC/WDM interventions or failure of the WC/WDM interventions that BCM has in hand, with surface water asset creation	800

Scenario Number	Scenario Title	NPV (R million)
8	Impact of the lower water requirement with the interventions that BCM has in hand	151
9	Impact of the EWR, with full WC/WDM interventions	790
10	Impact of the EWR, with WC/WDM interventions that BCM has in hand	833
11	Impact of the EWR on the lower water requirement, with WC/WDM interventions that BCM has in hand	151

The most favourable interventions are the demand-side measures, particularly those that BCM has in hand (together with the intervention necessary for the success of the interventions BCM has in hand), followed by the return of treated wastewater to the rivers or the use of the treated wastewater. The least favourable scenarios are those that require the creation of further surface water assets.

9.6 OTHER ASPECTS THAT COULD BE TAKEN INTO ACCOUNT IN THE WATER BALANCE

In addition to the interventions and the surface water assets taken into account in the scenarios analysed by means of the DST, there are other aspects which could influence the water requirements as well as the ability of the ABWSS to meet those requirements. These aspects are considered below.

9.6.1 Developments Outside of the Area of Supply of the ABWSS

Developments outside of the current area of supply of the ABWSS have been considered as options in the study and have been included in the upper water requirement scenario analysed by means of the DST.

Three areas of possible inclusion are the:

- coastal area north east of East London;
- coastal area south west of East London and
- Amahlati South Water Scheme.

The upper water requirement scenario analysed using the DST makes allowance for all three areas to be incorporated into the ABWSS during 2009-2010, due to the urgent need for improved water supplies to communities as well as for coastal property development.

The first phase of the Amahlati South Water Scheme is being implemented and the Kei Road WTW is being augmented for that purpose. Consequently, the Amahlati South Water Scheme should be viewed as an integral part of the ABWSS with new consumers adding to the change in water requirements supplied from the ABWSS.

Should the coastal areas not be included in the ABWSS, or should their inclusion be delayed beyond 2009-2010, the water requirements reflected in the upper water requirement scenario would reduce by about 6 Mm^3/a initially, increasing to a saving of about 10 Mm^3/a by the end of the planning period.

The ABWSS is the most appropriate source of supply of bulk water for the coastal developments, however, and the implementation of such a supply should be delayed no longer than would be necessary to obtain an adequate assurance of supply.

9.6.2 Assurance of Supply

The upper water requirement scenario analysed by means of the DST shows that the water requirements would be met from the existing system yield at an assurance of supply of 98% for some 3 to 5 years, depending upon whether or not the additional areas are incorporated in the ABWSS. Maden, Rooikrantz and Bridle Drift dams, however, are being operated at an assurance of supply well below 98%. Also due to the Wriggleswade Transfer Scheme not being fully operational, the ABWSS is operating at an assurance of supply less than 98%.

Time will be required to properly integrate the five schemes into a fully functioning system that can operate at a system assurance of supply of 98% as well as to implement WC/WDM interventions or to plan and construct assets which are necessary to provide for an increase in water requirements.

During that transition period an option would be to operate the dams from which water is drawn at 90% assurance of supply, with the Wriggleswade Dam which is currently not being used to supply the ABWSS, other than in severe droughts, at an assurance of supply of 98%. Gubu Dam is in essence the only storage for Stutterheim and should also be operated at a 98% assurance of supply.

In the event of the system being operated in this fashion, almost 8 Mm^3/a more water could be abstracted temporarily from the system than that provided for in the scenarios analysed by means of the DST. The additional yield from the system, made up as shown in Table 9.25, would be viewed as a temporary measure until the necessary interventions are implemented and assets are created to operate the ABWSS at an assurance of supply of 98% on a sustainable basis.

Table 9.25 Additional Yield if the ABWSS is Operated at a Yield with an Assurance of Supply Below 98%

Dam	Assurance of Supply 98% Mm³/a	Possible Operating Assurance of Supply		Possible Additional Yield Mm³/a
		98% Mm³/a	90% Mm³/a	
Maden	0.48		0.60	0.12
Rooikrantz	3.70		4.10	0.40
Laing	18.27		21.03	2.76
Bridle Drift	29.41		32.87	3.46
Nahoon	8.41		9.55	1.14
Gubu	2.87	2.87		0
Wriggleswade	31.80	31.80		0
Total	94.94	34.67	68.15	7.88

9.6.3 Irrigation

Currently little water is released for irrigation from the dams in the ABWSS, other than in dry periods when water is released from Gubu Dam for irrigation of the scheduled area along the Kubusi River down to the Wriggleswade Dam. Water is also released from the Wriggleswade Dam for the scheduled area and limited irrigation downstream of the dam. Together the water requirements amount to some 9 Mm³/a.

The upper water requirement makes provision for irrigation along the Buffalo and Nahoon rivers from the outset of the planning period. Licensing of irrigation use could be delayed, however, pending the implementation of WC/WDM interventions and the construction of assets if necessary to attain an assurance of supply of 98%. In that event some 4 Mm³/a less water would be required than that reflected by the upper water requirement scenario adopted for analysis by means of the DST.

9.6.4 Possible Impact of the Aspects on the Water Balance

Should it prove practicable and expedient to delay the introduction of the coastal areas to the north east and south west of East London into the ABWSS, to accept an assurance of supply of 90% for the dams from which water is abstracted for domestic and industrial requirements as well as to limit irrigation to the current scheduled areas, then the yield from the system should be adequate till around 2015, but could even extend the need for supply-side measure until after the end of the planning period, depending upon the success of the WC/WDM interventions and when the EWR is to be introduced. Preferably, any postponement of the introduction of additional areas, lowering of the assurance of supply or delay in providing additional water for irrigation should be viewed as being interim measures to be introduced for the purposes of gaining time to obtain greater understanding of the water requirements, for the necessary studies and investigations to be undertaken, for the selected interventions to be put in place and for the essential assets to be constructed. The measures should be limited to the shortest possible times.

9.7 INTERVENTIONS AND POTENTIAL ASSETS THAT SHOULD BE STUDIED

9.7.1 Studies Arising from the Interventions and Assets Identified in the Analysis undertaken using the DST

The scenarios evaluated by means of the DST have identified the interventions and assets that should be further investigated. They, together with the start dates for the studies/investigations, are summarised in Table 9.26. The stakeholders that should be responsible for the studies/investigations are also given in the table.

An indication is also given in Table 9.26 as to whether or not it would be necessary to delay the incorporation of one or more of the coastal areas to the north east and south west of East London; whether an assurance of supply less than 98% for the ABWSS would need to be adopted as an interim measure and whether or not the issuing of additional irrigation licences should be postponed.

Some of the interventions or bulk water supply assets identified in the scenarios analysed by means of the DST might not be suitable, might not be practicable, the estimated reductions in water requirements might be less than those adopted in the scenarios or the increase in water availability from new assets might be lower than that adopted in the scenarios. Consequently, appropriate interventions and bulk water supply assets which have been identified in this study, but which are not included in the scenarios, are added to the list.

The earliest study start dates reflect the requirements that result from the scenarios that were analysed using the DST. It will be prudent to start certain of the studies at dates earlier than those identified through the use of the DST in order to cater for eventualities that could result in earlier study/investigation start dates being necessary. The study start dates viewed by the Planning Team as being “advisable” are also included in Table 9.26.

Table 9.26 Summary of Dates for the Start of Studies for Interventions and Asset Creation

Intervention/Asset Creation	Scenarios 1 to 4	Scenarios 5 to 6	Scenarios 7	Scenarios 9 and 10	Earliest Study Start Date		Need for Delay in Introducing New Areas and/or Introducing Irrigation and/or Adopting a Lower Assurance of Supply	Responsible Stakeholder
	Upper Water Requirements with Full WC/WDM Interventions	Upper Water Requirement with WC/WDM Interventions that BCM has in Hand	Upper Water Requirement with No WC/WDM Interventions	Upper Water Requirement with the Introduction of the EWR	as per the DST	advisable		
WC/WDM								
Installation of water metres at "deemed-to-use households"	Started	Started		Started	Started		Yes	BCM
Annual Water Audit	2009	2009		2009	2009	2009	No	ADM/AW/BCM
Enhancement of effective meter reading, billing, and debtor control	2009	2009		2009	2009	2009	No	ADM/BCM
Enhancement to the current water use education programme	2010	2010		2010	2010	2009	No	ADM/AW/BCM
Structured response in respect of default in water payment or excessive use	2010	2010		2010	2010	2009	No	ADM/BCM
Apply a management information system (MIS)	2008	2008		2008	2008	2008	No	ADM/BCM
Installation of area meters	2009	2010		2009	2009	2009	No	ADM/BCM
Reduce pressures in reticulations during off-peak periods	2008	2009		2008	2008	2008	No	ADM/BCM
Support to private and public bodies to	2012			2012	2012	2009	No	ADM/BCM

Intervention/Asset Creation	Scenarios 1 to 4	Scenarios 5 to 6	Scenarios 7	Scenarios 9 and 10	Earliest Study Start Date		Need for Delay in Introducing New Areas and/or Introducing Irrigation and/or Adopting a Lower Assurance of Supply	Responsible Stakeholder
	Upper Water Requirements with Full WC/WDM Interventions	Upper Water Requirement with WC/WDM Interventions that BCM has in Hand	Upper Water Requirement with No WC/WDM Interventions	Upper Water Requirement with the Introduction of the EWR	as per the DST	advisable		
maintain water use installations								
Amendment to the current consumer tariff structure	2012			2012	2012	2011	No	ADM/BCM
Use of "pour-flush" type sanitation systems in place of free flush systems	2013			2013	2013	2008	No	ADM/BCM
Attend to water wastage at public facilities	2013			2013	2013	2009	No	ADM/BCM
Water infrastructure asset management	2015			2015	2015	2010	No	ADM/AW/BCM
Improve the monitoring of the quality of construction of water installations	2016			2016	2016	2010	No	ADM/BCM
Recovery of process water at the 8 WTWs	2016			2016	2016	2016	No	ADM/AW/BCM
Reduction in abstraction losses					+2030	+2015	No	ADM/AW/BCM
Wastewater Return Flow								
Lower Buffalo - Mdantsane East & Reeston: Return Flow to contribute to the EWR				2015	2015	2008	No	BCM
Lower Buffalo - Mdantsane West/Potsdam: Return Flow to contribute to the EWR				2015	2015	2008	No	BCM

Intervention/Asset Creation	Scenarios 1 to 4 Upper Water Requirements with Full WC/WDM Interventions	Scenarios 5 to 6 Upper Water Requirement with WC/WDM Interventions that BCM has in Hand	Scenarios 7 Upper Water Requirement with No WC/WDM Interventions	Scenarios 9 and 10 Upper Water Requirement with the Introduction of the EWR	Earliest Study Start Date as per the DST	Earliest Study Start Date advisable	Need for Delay in Introducing New Areas and/or Introducing Irrigation and/or Adopting a Lower Assurance of Supply	Responsible Stakeholder
Lower Buffalo - Central (From Reeston): Return Flow to contribute to the EWR				2016	2016	2008	No	BCM
Wastewater Use								
Lower Buffalo - Mdantsane East & Reeston: Domestic		2015			2015	2008	No	BCM
Lower Buffalo - Mdantsane East & Reeston: IDZ/Industrial	2014	2010			2010	2008	No	BCM
Lower Buffalo - Mdantsane West/Potsdam: Domestic	2015	2012			2012	2008	No	BCM
Lower Buffalo - Central (From Reeston): Domestic	2016	2013			2013	2008	No	BCM
Lower Buffalo - East Bank: Domestic	2018	2014		2012	2012	2008	No	BCM
Lower Buffalo - West Bank: IDZ/Industrial	2022	2018		2012	2012	2008	No	BCM
Lower Buffalo - Quinera (Gonubie): Domestic		2019		2013	2013	2008	No	BCM
Surface/Groundwater Assets								
Wriggleswade Transfer Scheme -	2008	2008	2008	2008	2008	2008	Yes	DWAF

Intervention/Asset Creation	Scenarios 1 to 4	Scenarios 5 to 6	Scenarios 7	Scenarios 9 and 10	Earliest Study Start Date		Need for Delay in Introducing New Areas and/or Introducing Irrigation and/or Adopting a Lower Assurance of Supply	Responsible Stakeholder
	Upper Water Requirements with Full WC/WDM Interventions	Upper Water Requirement with WC/WDM Interventions that BCM has in Hand	Upper Water Requirement with No WC/WDM Interventions	Upper Water Requirement with the Introduction of the EWR	as per the DST	advisable		
completion of the conveyance system								
Wriggleswade Transfer Scheme - distribution of water to WTWs	2008	2008	2008	2008	2008	2008	Yes	DWAF
Nahoon River - Stone Island Farm	2014	2014	2008	2008	2008	2008	No	DWAF
Keiskamma River - transfer of water from the Sandile and Binfield Park dams	2014	2011	2008	2013	2008	2008	Yes	DWAF
Gqunube River - A dam at Groothoek/Waterfall			2009	2010	2009	2009	No	DWAF
Gqunube River - A dam at Mhalla's Kop		2012		2015	2012	2012	No	DWAF
Keiskamma River – a dam at Ravenswood Farm				2008	2008	2008	No	DWAF
Keiskamma River – a dam at Thornwood Farm				2008	2008	2008	No	DWAF
Thorn River – A dam at Blackpool (Clachlan) (Identified in Chapter 7 as a potential source to augment the supply to the Upper Kubusi Scheme)					+2012	+2012	No	DWAF
Groundwater - pilot investigation along the Nahoon River						2010	No	DWAF

Scenarios 8 and 11 do not require any interventions nor the creation of any assets.

9.7.2 Surface Water Assets and the Manner in which BCM Operates its Network

The bulk surface water assets which prove to be the most favourable will depend very much on the manner in which BCM develops its supply and distribution network.

An investigation into the "mothballing" of the Nahoon WTW and the transfer of raw water from Nahoon Dam to the Umzonyana WTW has been proposed by BCM. This study should be expanded, however, to also consider the benefits of augmenting the Nahoon WTW and to supply water from there to the northern parts of East London as well as to the coastal developments north east of East London.

In the event of a single WTW at Umzonyana proving to be the most advantageous and BCM further developing the Umzonyana WTW as the main plant for the purification of water, (with the possibility of the Nahoon WTW ceasing to provide purified water to BCM as has been mooted by BCM) the options of augmenting the supply from the Keiskamma and its tributaries would be the most advantageous. However, should a dual treatment arrangement be adopted, with the Umzonyana WTW and an enhanced Nahoon WTW operating in tandem, then the options of augmenting the bulk water supply from the Nahoon and the Gqunube rivers would be the more advantageous course of action.

Irrespective of which option for treatment is adopted by BCM, transfer of water from the Sandile and Binfield Park dams would be beneficial, as such a transfer can fit into either bulk water treatment arrangement.

Changes are occurring in the water requirements outside of the ABWSS, which could have an impact on the availability of water from the proposed surface water assets in the Keiskamma River (and its tributaries), in the Gqunube River and possibly in the Nahoon River.

Consequently, it would be prudent to study the surface water assets in all three rivers as proposed in Table 9.26, which will provide the flexibility to BCM to develop its water network in the most advantageous manner.

9.7.3 Studies for Water Quality

Central to the options of returning treated wastewater to enhance the yields of dams, for a contribution towards supplying the EWR and for further use is the quality of the treated wastewater coupled with measures to reduce pollution of rivers and streams from point and diffuse sources. These aspects are not covered in the scenarios analysed by means of the DST.

Water quality interventions are proposed in Chapter 5. These studies and interventions need to go hand in hand with the water quantity studies, interventions and asset development. To this end, provision needs to be made for studies as summarised in Table 9.27. For ease of reference the interventions are listed according to the start dates for the studies rather than in the same sequence as they are set out in Chapter 5.

Table 9.27 Summary of Dates for the Start of Studies for Water Quality

Intervention	Start Date	Responsible Stakeholder
Improve solid waste disposal	Started	ADM/BCM
Reduce the TDS in WW from the Da Gama Textiles plant	Started	Da Gama Textiles
Management information system (MIS)	2008	ADM/BCM
Model the system	2008	DWAF
Reduce the TDS in WW from Sentrachem's herbicide factory	2008	Sentrachem
Enforce controls on settlements along water courses	2008	ADM/BCM
Enhance the current sanitation education programme	2009	ADM/BCM
Support to households to maintain sanitation and sewerage installations	2009	ADM/BCM
Support to public bodies to maintain sanitation and sewerage installations	2009	ADM/BCM
Improve solid waste collection and refuse/waste picking in open spaces	2009	ADM/BCM
Improve wastewater treatment at the WWTWs at:		
King William's Town	2009	BCM
Bhisho	2009	BCM
Breidbach	2009	BCM
Ilitha	2009	BCM
Potsdam/Mdantsane West	2009	BCM
Mdantsane East	2009	BCM
Berlin	2009	BCM
Stutterheim	2009	ADM
Reeston	2010	BCM
Enhance sewerage infrastructure asset management	2010	ADM/BCM
Improve monitoring of the quality of construction of sanitation and sewerage installations	2010	ADM/BCM

9.7.4 Interventions that Impact on the Quantity and Quality of the Available Water

Economies of scale and a greater return on effort can be attained if certain interventions for WC/WDM and those for water quality are undertaken concurrently. They are:

- the development, introduction and implementation of water and sanitation MISs;
- enhancement to the current water and sanitation education programmes;
- support to households and public bodies to maintain water, sanitation and sewerage installations;
- enhancement of water and sewerage infrastructure asset management and
- improvement to the monitoring of the quality of construction of water, sanitation and sewerage installations.

The dates shown in Table 9.27 for the studies in respect of the five water quality interventions listed above correspond with the "advisable dates" in Table 9.26 for the five water quantity interventions namely:

- apply a management information system;
- enhance the current water use education programme;
- support to private and public bodies to maintain water use installations;
- water infrastructure asset management and
- improve the monitoring of the quality of construction of water installations.

Once the water quality parameters for the EWR and the water quality objectives for the rivers in the ABWSS are set, it might be necessary to bring forward the dates for the water quality interventions to times earlier than those shown in Table 9.27. In that event the water quantity interventions should also be brought forward.

9.7.5 Level of Study

Apart from the intervention to provide water meters for the "deemed-to-use households" (for which pilot measurements of potential reductions in water requirements have been made), improvements to solid waste disposal and the recycling of wastewater at the Da Gama Textiles' plant in Zwelitsha, none of the interventions or asset creation proposals have been studied beyond desktop or preliminary level.

Each intervention and asset creation proposal should initially be studied to pre-feasibility level to ascertain whether or not it should be included amongst the options which should be studied further.

Those interventions and asset creation proposals that are found to be promising should then be studied at feasibility level. If they are found to be feasible, terms of reference for their implementation should then be prepared and held in reserve pending the need to implement the intervention or to construct the asset.

The list of potential bulk water supply assets that the analysis by means of the DST has indicated are the most suitable, is not exhaustive. Should one or more of the interventions or assets have a fatal flaw, alternative assets which have been identified in Chapter 5 and which are currently viewed as less attractive should be selected for further study.

CHAPTER 10
The Reconciliation Strategy for the ABWSS

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APPENDICES

(NO APPENDICES FOR THIS CHAPTER)

10 THE RECONCILIATION STRATEGY FOR THE ABWSS

10.1 FOUNDATION FOR THE STRATEGY

The approach which has been adopted in this study is not to select a “favoured scenario” but to identify which interventions and potential assets should be studied to allow for a range of possible water requirement scenarios to be met through a combination of:

- interventions that would reduce water requirements;
- interventions that would result in treated wastewater being returned to the watercourses to augment the yields of the dams or to contribute towards meeting the EWR;
- interventions that would result in treated wastewater being used and
- the creation of surface water/groundwater supply assets that would increase the availability of bulk water.

The strategy, therefore, is the selection of the interventions and potential surface water/groundwater supply assets (collectively referred to as the options) that would contribute towards addressing the largest number of the scenarios analysed by means of the DST and described in Chapter 9, coupled with the other needs of the ABWSS identified in the earlier chapters of this report, such as:

- quality of the wastewater returned to the watercourses in the ABWSS;
- risks to the ABWSS and
- the operation of the ABWSS as a system.

The strategy covers a number of elements related to the options. They are:

- the earliest date at which each intervention or asset is required;
- the advisable or latest date at which the study/investigation for each intervention or asset creation should start;
- what would “trigger” the study/investigation;
- the responsible stakeholder for the study/investigation for each intervention or asset creation and
- the priority assigned to the study/investigation for each intervention or asset creation.

The emphasis of the strategy is, therefore, on the studies/investigations as well as the preparatory work that would be necessary to enable a desired intervention or asset to be implemented by the earliest date identified in this study as being necessary to meet one or more of the 11 scenarios analysed by means of the DST as discribed in

Chapter 9. In the case of interventions which are not included in the scenarios analysed by means of the DST, the priority allocated to each intervention has been used to select a date by which the study/investigation should start and by when the first benefits of each intervention should be attained.

The options are divided into 9 categories as follows:

- water conservation and water demand management interventions...... (WC/WDM);
- return flow of treated wastewater to enhance the yields of dams .... (RF);
- use of treated wastewater (for domestic, industrial or irrigation purposes) .. .. (U);
- surface water asset creation .... (SWA);
- groundwater asset creation.. (GWA);
- water quality improvements .... (WQ);
- ecological water requirements .... (EWR);
- mitigation of risk .... (MoR) and
- institutional/management arrangements .... (I and M).

The priority for each intervention or asset creation has been selected on the basis of when the intervention or asset is or might be required, how frequently the option is reflected in the scenarios analysed by the DST, the impact that the intervention would have on the management of the ABWSS as a system as well as on the lead time between commencing a study/investigation and when the first benefit from the intervention or asset might be required. Three categories of priority have been adopted, namely:

- high for those interventions and assets which are in hand or which are necessary for the sustainability of interventions/assets that are in hand or which have an important/critical impact upon reconciling the bulk water availability and the bulk water requirements................. (H);
- medium for those interventions and assets, which have a significant but not critical impact upon reconciling the availability of bulk water and the bulk water requirements... (M) and
- low for those interventions and assets, which would be held in reserve in the event of one or more of the interventions with a higher priority not being practicable or if the benefits should be less than those provided for when the scenarios were produced................ (L).

10.2 THE STRATEGY

Various ways of presenting the strategy have been considered. For ease of reference, the strategy has been set out in tabular form in Table 10.1, arranged according to the categories of interventions/assets outlined above, with reference to the chapter in which each intervention or asset is described.

The earliest start date for commencement of the studies is given as 2008 in Table 10.1 even where studies have been undertaken in part. Also, the latest study start date for each intervention and asset creation listed in Table 10.1, has been taken as the earlier of the "earliest study start date" as per the scenarios analysed by means of the DST (see Table 9.26) and the "advisable" study start date recommended by the Planning Team also as shown in Table 9.26 for the interventions and asset creation activities considered in the scenarios covered by the analyses using the DST.

Table 10.1 Strategy

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
WATER CONSERVATION AND WATER DEMAND MANAGEMENT									
Install domestic water meters, particularly for the 20 000 "deemed-to-use households" and for all registered indigent households	WC/WDM	2008	2008	Excessive use of water by domestic consumers particularly by the "deemed-to-use" and registered indigent households. BCM already has the intervention in hand	BCM (Extend to ADM and AW)	Sound measurement of the quantity of water used by each household (Saving of 5 Mm^3/a to 8 Mm^3/a)	Reduce the quantity of water used by each household to that for which the household can pay, coupled with a reduction in the quantity of water used by registered indigent households to that provided as free basic water	H (In hand by BCM)	5
Develop and apply a management information system (MIS)	WC/WDM	2012	2008	Need for improved management information. BCM already has the intervention in hand	ADM, AW and BCM	A management information system that will assist the WSAs and WSP to manage the water infrastructure and to attain the expected reduction in water requirements	Improve the manner in which the water assets are managed. (Needed to achieve the allowances for the reduction in water requirements)	H (In hand by BCM)	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
Reduce pressure in water reticulation networks	WC/WDM	2012	2008	Significant base night flows in the sewers and at WWTWs. BCM already has the intervention in hand	ADM, AW and BCM	Pressure reduction during off-peak periods resulting in less water being lost due to leaks and through consumer fittings (Saving of 3 Mm^3/a to 5 Mm^3/a)	Reduce the water loss through leaks in the network and in consumer fittings due to unnecessarily high pressures during times of low consumer demand	H (In hand by BCM)	5
Use "pour-flush" or other water efficient type sanitation systems in place of "free-flush" systems	WC/WDM	2012	2008	Sanitation improvement programmes	ADM and BCM	Water efficient sanitation systems at least for new installations. (Saving of 1 Mm^3/a to 2 Mm^3/a)	Reduce the quantity of water required for sanitation purposes, particularly for households registered as indigent	M	5
Undertake an annual water audit	WC/WDM	2010	2009	Requirement of SANS	ADM, AW and BCM	Statistical information of the water and sanitation network that provides a base-line and annual data on improvements/ deterioration of the infrastructure	Improvement in managing the water and sanitation assets, reduction in water losses and enhancement to the level of service delivery. (Needed to achieve the allowances for the reduction in water requirements)	H	5
Enhance effective	WC/WDM	2010	2009	Installation of meters for the	ADM, AW and	Accurate and	Provide the institutional	H	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
meter reading, billing and debtor control				"deemed-to-use households" and meters for other consumers	BCM	comprehensive reading of meters, sound billing and strict debtor control	support without which the benefit of metering will not be obtained. (Needed to achieve the allowances for the reduction in water requirements)		
Enhance the current water use education programme	WC/WDM	2011	2009	The need to reduce the water requirements due to constraints on the availability of water	ADM, AW and BCM	Consumers who are aware of the consequences of wasting water, the benefits of reducing the requirements for bulk water and who change their behaviour to use water wisely	Change the behaviour of consumers to reduce water requirements. (Needed to achieve the allowances for the reduction in water requirements)	H	5
Strengthen the structured response in respect of default in water payment or excessive use of water	WC/WDM	2011	2009	The need to reduce the water requirements due to constraints on the availability of water	ADM, AW and BCM	Firm action to attain payment for water used and to take action in the event of the excessive use of water	Change the behaviour of consumers and managers to reduce water requirements. (Needed to achieve the allowances for the reduction in water requirements)	H	5
Install area meters	WC/WDM	2012	2009	Need to know the extent to	AW and BCM	A network divided	Ascertain where	H	5

Intervention/ Asset	Category	Dates: Earliest Benefit Required	Dates: Advisable/ Latest Study Start Date	"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
				which water is lost in potable water distribution systems and networks	(Extend to ADM)	into discrete areas in which water supply and water use can be correlated. (Saving of 1 Mm³/a to 2 Mm³/a)	excessive use or loss of water could be occurring in a distribution system or network so that corrective measures can be taken	(In hand by AW and BCM)	
Support private and public bodies to maintain water use installations (particularly registered indigent households)	WC/WDM	2013	2009	The need to reduce the water requirements due to constraints on the availability of water	ADM and BCM	No unnecessary loss of water from public and private water installations	Change the behaviour of consumers and public bodies so as to reduce water wasted from installations on private and public properties (Needed to achieve the allowances for the reduction in water requirements)	H	5
Attend to water wastage at public facilities	WC/WDM	2014	2009	Obvious signs of water wastage at public facilities, particularly those owned and operated by the municipalities	ADM and BCM	No unnecessary water wastage at public facilities. (Saving of 1Mm³/a to 2 Mm³/a)	Reduce unnecessary water wastage and to set an example to consumers	M	5
Introduce water infrastructure asset management in line with best practice	WC/WDM	2013	2010	Need to reduce conveyance and distribution losses	ADM, AW and BCM	Structured system in line with best practice to manage water infrastructure	Reduce water loss and extend the life of assets with internationally accepted levels of	M	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
						as a valuable asset. (Saving of 2 Mm³/a to 4 Mm³/a)	water loss		
Improve the monitoring of the quality of construction of water installations	WC/WDM	2017	2010	Need to reduce conveyance, distribution and consumer losses	ADM, AW and BCM	Reduction in water loss due to inadequacies in the construction of water use and water conveyance / reticulation infrastructure. (Saving of 1 Mm³/a to 2 Mm³/a)	Enhance the capacity of the public bodies to monitor the quality of construction of water use and water conveyance/ reticulation infrastructure	M	5
Investigate the potential increase in the yield of the dams in the ABWSS as a result of the reduction in afforestation	WC/WDM	2013	2010	Need to increase the yields of the dams	DWAF	Increased yield(s) of one or more of the dams in the ABWSS	Reduce the extent of stream flow reductions and the consequential increase in the yields of the dams in the ABWSS due to a reduction in afforestation	L	5
Investigate the potential increase in the yield of the dams in the ABWSS as a result of the	WC/WDM	2013	2010	Need to increase the yields of the dams	DWAF	Increased yield(s) of one or more of the dams in the ABWSS	Reduce the extent of stream flow reductions and the consequential increase in the yields of the dams in the	L	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
reduction in IAP							ABWSS due to a reduction in the infestation of IAP		
Amend the current consumer tariff structure (if necessary)	WC/WDM	2012	2011	The need to reduce the water requirements due to constraints on the availability of water	BCM (Extend to ADM)	No unnecessary use of water from public and private water installations (particularly by large consumers)	Change the behaviour of consumers and public bodies so as to reduce water used unnecessarily from installations on private and public properties (Needed to achieve the allowances for the reduction in water requirements)	M	5
Recover process water at the 8 WTWs	WC/WDM	2017	2016	Need to reduce the quantity of water required from the dams	ADM, AW and BCM	Reduction in the quantity of process water required per unit of water treated at WTWs. (Saving of 2 Mm^3/a to 3 Mm^3/a)	Reduce water loss in the water treatment process	L	5
Reduce abstraction losses	WC/WDM	+2030	+2016	Need to reduce the quantity of water released from dams to meet the water requirements	AW and BCM	Reduction in water losses between the dams and the WTWs. (Saving of 1 Mm^3/a to 2 Mm^3/a)	Reduce the amount of water that needs to be released from the dams to meet the water requirements	L	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
RETURN FLOW AND USE OF TREATED WASTEWATER									
Utilize the treated wastewater from the Upper and Middle Buffalo as well as from the Upper Kubusi schemes to enhance the yields of dams	RF	(Benefit already attained and taken into account in the yield of the ABWSS)	(Not required)	Treated wastewater already enhancing the yields of the dams in the Upper and Middle Buffalo as well as in the Upper Kubusi schemes	ADM, BCM and DWAF	All treated wastewater from the WWTWs in the Upper and Middle Buffalo as well as in the Upper Kubusi schemes returned to the Buffalo and Kubusi rivers (3.4 Mm^3/a to 5.7 Mm^3/a available)	Enhancement of the yields of the dams	H	5
Utilize the treated wastewater from Mdantsane West/Potsdam, Mdantsane East/ Reeston and Central WWTWs as return flow to contribute to meeting the EWR in the Lower Buffalo River	RF	2015	2008	Agreed date to implement the EWR	BCM and DWAF	(3.9 Mm^3/a to 6.3 Mm^3/a available)	Reduce the need to release water from the Bridle Drift Dam to meet the EWR below the dam	H	5
ALTERNATIVELY Use the treated	U	2014	2008	Inadequate surface water supply to meet the domestic	BCM	Beneficial use of a source of bulk water	Augment the surface water supplies and to	H	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
wastewater from Mdantsane West/Potsdam, Mdantsane East/ Reeston and Central WWTWs to augment the domestic or Industrial water supply				and/or industrial water requirements. Need to beneficially use the treated wastewater that otherwise would be discharged to the sea		currently not being used (2.9 Mm³/a to 4.4 Mm³/a available)	avoid water emanating from surface water resources being lost unnecessarily from the ABWSS		
Use treated wastewater that is currently discharged to the sea from the East Bank WWTW in order to contribute to meeting the water requirements for domestic purposes and possibly for industrial purposes (most likely at the IDZ)	U	2016	2008	Inadequate surface water supply to meet the domestic and possibly the industrial water requirements in East London and the coastal area to the north east. Need to beneficially use the treated wastewater discharged to the sea	BCM	Beneficial use of a source of bulk water currently not being used (3.3 Mm³/a to 6.5 Mm³/a available)	Augment the surface water supplies and to avoid water emanating from surface water resources being lost unnecessarily from the ABWSS	M	5
Treat and use wastewater that is currently discharged to the sea through	U	2016	2008	Inadequate surface water supply to meet the industrial and possibly the domestic water requirements. Need to	BCM	Beneficial use of a source of bulk water currently not being used (0.8 Mm³/a to	Augment the surface water supplies and to avoid water emanating from surface water	M	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
the marine outfall at the West Bank WWTW in order to contribute to meeting the water requirements for industrial purposes (most likely at the IDZ) and possibly for domestic purposes				beneficially use the treated wastewater discharged to the sea		1.8 Mm³/a available)	resources being lost unnecessarily from the ABWSS		
Use treated wastewater that is currently discharged to the sea from the Quinera (Gonubie) WWTW in order to contribute to meeting the water requirements for domestic purposes in the north eastern parts of East London and possibly for the coastal areas to the north east	U	2017	2008	Inadequate surface water supply to meet the domestic water requirements in East London and the coastal area to the north east. Need to beneficially use the treated wastewater discharged to the sea	BCM	Beneficial use of a source of bulk water currently not being used (0.4 Mm³/a to 0.7 Mm³/a available)	Augment the surface water supplies and to avoid water emanating from surface water resources being lost unnecessarily from the ABWSS	L	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
SURFACE WATER ASSETS									
Complete the conveyance infrastructure for the Wriggleswade Transfer Scheme	SWA	2008	2008	The risk of the water in the Wriggleswade Dam not being available for the ABWSS when it is required	DWAF	The ability to transfer water through the Wriggleswade Transfer Scheme safely, within the desired environmental parameters and in the desired quantities when it is required	Integrate the Wriggleswade Transfer Scheme into the ABWSS in order to attain the full yield from all the dams in the ABWSS when it is required	H	5
Determine and agree the best way to distribute the water from the Wriggleswade Transfer Scheme	SWA	2008	2008	The need to operate the ABWSS as a system and to utilize the assets of DWAF as well as of the WSAs and WSP to best effect	ADM, AW, BCM and DWAF	The most favourable way of distributing water from the Wriggleswade Transfer Scheme to maximise the benefit of the assets belonging to ADM, AW, BCM and DWAF	Obtain the best distribution pattern of the water from the Wriggleswade Dam to supply the internal networks of the WSAs and to operate the ABWSS as a system	H	5 and 7
Potential dam in the Nahoon River at	SWA	2019	2008	Need for additional surface water assets to augment the	DWAF	Additional water available to augment	Augment the water supply in the ABWSS,	H	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
Stone Island Farm				supply of water to the Nahoon WTW		the current water that is available in the ABWSS (Available yield of 5.3 Mm³/a)	should a surface water asset be required, through the construction of a surface water asset (Lowest URV)		
Possible transfer of water from the Sandile and Binfield Park dams in tributaries of the Keiskamma River	SWA	2011	2008	Need for additional surface water assets	DWAF	Additional water available to augment the current water that is available in the ABWSS (Available yield of 8.7 Mm³/a)	Augment the water supply in the ABWSS, should a surface water asset be required, through the greater utilization of existing surface water assets (Second lowest URV)	H	5
Potential dam in the Keiskamma River at Ravenswood Farm	SWA	2018	2008	Need for additional surface water assets to augment the supply of bulk water to the Umzonyana WTW	DWAF	Additional water available to augment the current water that is available in the ABWSS (Available yield of 21.3 Mm³/a)	Augment the water supply in the ABWSS, should a surface water asset be required, through the construction of a surface water asset (Seventh lowest URV)	H	5
Potential dam in the Keiskamma River at Thornwood Farm	SWA	2018	2008	Need for additional surface water assets to augment the supply of bulk water to the Umzonyana WTW	DWAF	Additional water available to augment the current water that is available in	Augment the water supply in the ABWSS, should a surface water asset be required,	M	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
						the ABWSS (Available yield of 29.5 Mm³/a)	through the construction of a surface water asset (Eighth lowest URV)		
Potential dam in the Gqunube River at Groothoek/ Waterfall Farm	SWA	2019	2009	Need for additional surface water assets to augment the supply of bulk water to the Nahoon WTW	DWAF	Additional water available to augment the current water that is available in the ABWSS (Available yield of 12.1 Mm³/a)	Augment the water supply in the ABWSS, should a surface water asset be required, through the construction of a surface water asset (Third lowest URV)	M	5
Potential dam in the Gqunube River at Mhalla's Kop	SWA	2022	2012	Need for additional surface water assets to augment the supply of bulk water to the Nahoon WTW	DWAF	Additional water available to augment the current water that is available in the ABWSS (Available yield of 7.9 Mm³/a)	Augment the water supply in the ABWSS, should a surface water asset be required, through the construction of a surface water asset (Fourth lowest URV)	M	5
Potential dam in the Thorn River at Blackpool (Clachlan)	SWA	+2022	+2012	Need for additional surface water resources to meet the domestic, industrial and irrigation water requirements in the Upper Kubusi Scheme	DWAF	Additional water available to augment the current water that is available in the ABWSS (available yield of	Provide additional bulk water supply in the Upper Kubusi Scheme in the event of the upper domestic, industrial and irrigation	M	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
						3.4 Mm³/a)	requirements being realised		
Desalination of sea water	SWA	+2030	+2020	Unsuccessful WC/WDM interventions, inadequate treated wastewater for use, rejection of the use of treated wastewater by decision makers or users, significant drop in the cost of desalination relative to other water assets or surface water assets proving more expensive and yielding less water than currently expected	BCM	Sea water treated to meet potable or industrial water use requirements	Augment the water supply in the ABWSS through the construction of a water asset if the other water augmentation assets prove to be impracticable or inadequate	L	5
GROUNDWATER ASSETS									
Pilot groundwater asset at the potential R30E-Middle aquifer	GWA	2025 (Depends upon the yield of the potential aquifer and the URV)	2010	Need to establish whether or not there are adequate groundwater resources for integration into the ABWSS, which can be operated conjunctively with surface water from the Wriggleswade Transfer Scheme	DWAF	Groundwater with a potential of at least 0.2 Mm³/a that can be operated conjunctively with water releases from the Wriggleswade Transfer Scheme	To establish whether or not there is sufficient groundwater to be incorporated into the ABWSS	M	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
WATER QUALITY IMPROVEMENT									
Improve solid waste disposal	WQ	2008	Started	Need to reduce pollution of the rivers in the ABWSS	ADM and BCM	No solid waste in the rivers and water courses of the ABWSS	Maintain or restore the health of the rivers in the ABWSS and reduce the cost of treating water abstracted from the dams in the ABWSS	H	5
Set and agree the quality parameters for the EWR and the water quality objectives for the rivers in the ABWSS	WQ	2008	2008	Uncertainty of what the quality parameters of the EWR should be and what are the water quality objectives	ADM, AW, BCM and DWAF	Clear water quality parameters for the EWR and water quality objectives for the rivers in the ABWSS	Obtain clarity on what the minimum requirements are for treated wastewater returned to the rivers as well as for the retention or improvement of the health of the rivers in the ABWSS	H	5
Develop and apply a management information system (MIS) for water quality	WQ	2012	2008	Need for improved management information in respect of sanitation and wastewater. BCM already has the intervention in hand	BCM and DWAF (Extend to ADM)	A management information system that is used by the WSAs to manage sanitation and wastewater and for DWAF to monitor	Improve the manner in which sanitation assets are managed in order to have no unnecessary egress of sewage/wastewater from	H	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
						water quality parameters.	sanitation/wastewater systems and to have the desired quality of treated wastewater for return flow, for further use or for a contribution to the EWR as the case may be.		
Model the ABWSS to ascertain the impacts of and requirements for specific interventions to maintain or preferably improve the quality of water in the rivers and streams of the ABWSS	WQ	2010	2008	Need to establish the manner in which WWTWs should be upgraded and operated to attain the water quality objectives/ EWR requirements	DWAF	Quality objectives and interventions that need to be implemented to comply with the quality objectives and to meet the EWR quality requirements	Maintain or restore the health of the rivers in the ABWSS and reduce the cost of treating water abstracted from the dams in the ABWSS	H	5
Reduce phosphates and TDS returned by industry to the rivers in the ABWSS	WQ	2010	2008	Eutrophication of the dams in the ABWSS and costs of treating the water abstracted from the dams	ADM, BCM and DWAF	Discharges from industries that comply with permits and bylaws as appropriate	Maintain or restore the health of the rivers in the ABWSS and reduce the cost of treating water abstracted from the dams in the ABWSS	H (in hand by Da Gama Textiles)	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
Enforce controls along the rivers and water courses in the ABWSS	WQ	2010	2008	Deterioration of water quality due to diffuse run-off from settlements along rivers and water courses	ADM and BCM	Improved quality of water in rivers and water courses as well as retention of the quality of water in the Wriggleswade Dam and of the water transferred by means of the Wriggleswade Transfer Scheme	Maintain or restore the health of the rivers in the ABWSS and reduce the cost of treating water abstracted from the dams in the ABWSS	H	5
Enhance the current sanitation education programme	WQ	2011	2009	Need to reduce pollution of the rivers in the ABWSS	ADM and BCM	Consumers who are aware of the consequences of the misuse of sanitation, sewerage and wastewater systems and who have sound sanitation / wastewater disposal habits.	Change the behaviour of consumers so as to reduce pollution from point and diffuse sources	H	5
Support households to maintain sanitation and sewerage installations (particularly	WQ	2013	2009	Need to reduce pollution of the rivers in the ABWSS	ADM and BCM	No unnecessary egress of sewage from sanitation and sewerage installations on	Change the behaviour of consumers to reduce diffuse pollution arising from sewage overflows and leaks on private	M	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
registered indigent households)						private properties	properties		
Support public bodies to maintain sanitation and sewerage/ installations	WQ	2013	2009	Need to reduce pollution of the rivers in the ABWSS	ADM and BCM	No unnecessary egress of sewage from sanitation and sewerage installations on public properties	Change the behaviour of public bodies to reduce diffuse pollution arising from sewage overflows and leaks on public properties as well as to set an example to households	L	5
Improve solid waste collection and refuse/waste picking in open spaces	WQ	2010	2009	Need to reduce pollution of the rivers in the ABWSS	ADM and BCM	No solid waste in the rivers and water courses of the ABWSS	Maintain or restore the health of the rivers in the ABWSS and reduce the cost of treating water abstracted from the dams in the ABWSS	H	5
Improve wastewater treatment at the 10 WWTWs to meet the river water quality objectives	WQ	2012	2009	Finalization of the water quality model	ADM, BCM	Treated wastewater that complies with the water quality objectives, with the EWR and with the proposed use of the treated wastewater	Maintain or restore the health of the rivers in the ABWSS and to have treated wastewater that can be used where appropriate or which can be used to meet the EWR in whole or in part.	H	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
Introduce infrastructure asset management in line with best practice	WQ	2016	2010	Need to reduce point and diffuse sources of pollution	ADM and BCM	Structured system to manage sanitation/ wastewater infrastructure as a valuable asset	Reduce sewage/wastewater spillage and seepage as well as to extend the life of assets with internationally accepted levels of egress of sewage/wastewater from sanitation/wastewater systems	H	5
Improve the monitoring of the quality of construction of sanitation and sewerage wastewater installations	WQ	2018	2010	Need to reduce pollution of the rivers in the ABWSS	ADM and BCM	No unnecessary egress of sewage/ wastewater from installations on private and public properties nor from the sewage/wastewater conveyance systems	Reduce sewage/wastewater spillage, blockages and seepage as a result of inadequacy in design and construction as well as to extend the life of assets with internationally accepted levels of egress of sewage/ wastewater from sanitation/sewerage/ wastewater systems	L	5

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
ECOLOGICAL WATER REQUIREMENTS									
Finalize the water quantity for each EWR and when it should be introduced	EWR	2015	2008	Legal requirement and the need for certainty about the quantum of the EWR and when it should be introduced for each river reach	ADM, AW, BCM and DWAF	Agreed EWR classification for each river reach, as well as when and how the EWR would be introduced	Obtain clarity on the quanta of and timing for the introduction of the EWR for each river reach	H	3 and 9
Construct a weir and a gauging station just upstream of the Nahoon estuary	EWR	2012	2008	Need to determine flows entering the estuary and the extent to which the estuarine flow requirement (EFR) is met from run-of-river flow	DWAF	Sound record of flows entering the estuary and the extent to which the EFR is being met	Remove uncertainty regarding flows from the Nahoon River entering the estuary	M	3
MITIGATION OF RISK									
Investigate and evaluate a single source of supply of potable water for East London, Mdantsane, Reeston and the coastal areas from the Umzonyana WTW compared with a dual source of supply of	MoR	2009	2008	Need to know how best to distribute water from the Wriggleswade Transfer Scheme, the need to determine which surface water asset studies should receive precedence, whether to "mothball" or to further develop the Nahoon WTW, the extent to which the Umzonyana WTW should be	BCM	Most advantageous bulk potable water supply for East London, Mdantsane, Reeston and the coastal areas	Ascertain the best way of providing potable water to East London, Mdantsane, Reeston and the coastal areas so as to plan and develop the most beneficial bulk water augmentation and distribution arrangement	H	6

Intervention/ Asset	Category	Dates: Earliest Benefit Required	Dates: Advisable/ Latest Study Start Date	"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
potable water from the Umzonyana and the Nahoon WTWs				augmented as well as to ascertain the feasibility of the conjunctive use of surface and groundwater in the catchment of the Nahoon River					
Determine the implications of increasing the storage capacities of dams in the ABWSS to cater for possible changes in rainfall patterns and weather due to climate and weather change	MoR	+2025	+2020	Measurements that show the intensity of rainfall is increasing, that rainfall is later in summer, that dry periods are lengthening and that the periods between extreme events in the weather could be reducing	DWAF	Increased storage capacity to accommodate more intensive rainfall later in the summer and more frequent as well as more severe droughts than is currently the case	Allow for possible changes in extreme weather events due to climate change	L	6
INSTITUTIONAL/MANAGEMENT ARRANGEMENTS									
Convert the Steering Committee for this study (The Development of a Reconciliation Strategy for the ABWSS) into a body that will manage the	I and M	2008	2008	Completion of this strategy and acceptance by the stakeholders	ADM, AW, BCM and DWAF	A body which is sufficiently powerful to manage, to assure compliance with and to assist stakeholders to fulfil their obligations in terms of the strategy	Create a body which will be able to assist/manage stakeholders to address their disparate interests and to ensure that there is adequate water for the ABWSS	H	7

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
implementation of the strategy and a body that will co-ordinate the operations of the ABWSS							well into the future		
Select the most favourable option for the ownership, operation and management of assets in the ABWSS (Removal of shortcomings in the current arrangements seems to be the most practicable option at this time)	I and M	2009	2008	Disharmony that currently exists amongst the stakeholders and the absence of the ABWSS being operated as a system	ADM, AW, BCM and DWAF	An institutional arrangement that will enable the ABWSS to operate as a system delivering the best yields of good quality water	Removal of disharmony amongst stakeholders, maximization of the yield from the ABWSS, reduction in water requirements together with the optimum use of return flows and/or treated wastewater	H	7
Resolve the disagreements concerning water pricing, subsidisation and the manner in which water tariffs are determined	I and M	2008	2008	Disharmony that currently exists amongst the stakeholders and the absence of an agreed pricing structure for water availability and water use	ADM, AW, BCM and DWAF	An equitable pricing/tariff arrangement that will enable the ABWSS to be operated as a system with the most advantageous	Removal of disharmony amongst stakeholders, maximization of the yield from the ABWSS, optimisation of the use of assets and recovery of costs to the extent	H	7

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
						use being made of all the assets and of the water that is available	possible		
Agree on the best way to operate the ABWSS as a system	I and M	2010	2008	Disharmony that currently exists amongst the stakeholders and the absence of the ABWSS being operated as a system	ADM, AW, BCM and DWAF	The ABWSS being operated as a system, in accordance with operating aids such as the Water Resources Planning Model (WRPM), water quality models and sound operating rules, with the best use of assets resulting in the lowest cost for bulk water supply	Maximization of the yield from the ABWSS, limitation of water requirements to the extent reasonably possible, optimization of the use of assets and recovery of costs to the extent possible	H	5 and 7
Align the population growth scenarios with those of the IDPs	I and M	2008	2008	Need for consistency in statutory plans (IDP and the WSDP) and this strategy	ADM, BCM and DWAF	Consistent population growth scenarios for the purposes of planning and resource allocation	Attain consistency of population growth scenarios in this strategy and in the WSDP, IDP and other statutory plans in time for the first up-date of	H	4

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
							this strategy and the up-date of the statutory plans		
Determine the extent to which provision should be made for irrigation water and when licences could/should be issued	I and M	2009	2008	Current applications for water use licences for irrigation and the need to provide guidelines for the provision of irrigation water to resource poor farmers	DWAF	Policy/guidelines for the issuing of irrigation licences for water from the ABWSS (Water requirements could be reduced by some 4 Mm^3/a if irrigation water is made available only for the scheduled irrigation areas)	Determine when water can be made available from the ABWSS for irrigation (other than for the scheduled areas) and to provide DWAF's officials with a policy/guideline document for use when evaluating licence applications	H	4
Determine when and if the coastal areas to the north east and south west of East London need to be incorporated into the ABWSS to enable the service delivery requirements of BCM and ADM to be met	I and M	2010	2008	Township applications for coastal developments	ADM and BCM	Bulk water services agreements and the provision of water from the ABWSS when it is required (Reduction in water requirement of 6 Mm^3/a to 10 Mm^3/a if the areas are not incorporated into the ABWSS)	Enable bulk water supply infrastructure to be provided for coastal developments and for the upgrading of rural water supplies	H	4

Intervention/ Asset	Category	Dates		"Trigger"	Responsible Stakeholder	Deliverable as a Result of the Intervention/Asset	Purpose of the Intervention/ Asset	Priority	Chapter
		Earliest Benefit Required	Advisable/ Latest Study Start Date						
Adopt a 90% assurance of supply for dams from which water is abstracted for domestic and industrial purposes as a temporary measure until the results of interventions are known or until the benefits of interventions as well as the creation of bulk water supply assets can be realised. Retain an assurance of supply of 98% for the ABWSS as a whole	I and M	2007	2008	Certain dams, particularly the Maden, Rooikrantz and Bridle Drift dams, are being utilized at assurances of supply below 90%	BCM and DWAF	Increased yield from the ABWSS as an interim measure (The potential increase in yield is 8 Mm^3/a)	To "buy time" until interventions and asset creation enable an assurance of supply of 98% for the ABWSS to be attained	H	3

10.3 MONITORING THE RESULTS OF THE STRATEGY

The strategy is strongly influenced by "triggers" which indicate when the study for an intervention or for the construction of an asset should be undertaken.

In Chapter 8 monitoring indicators are proposed that should provide the information to enable the "triggers" to be identified.

Monitoring of the ABWSS on an annual or bi-annual basis in terms of the indicators is a key intervention for the strategy, which has high priority and which should commence from the outset of the implementation of the strategy.

10.4 KEY INTERVENTIONS AND ASSET CREATION OPTIONS

Certain of the interventions and asset creation options are key to the implementation of the strategy. Without those interventions and asset creation options, the strategy cannot be implemented or the implementation will be only partially successful. Also, the interventions and decisions regarding the creation of assets tend to be interdependent, with the key ones preceding the less critical ones. The key interventions and asset creation options are set out below.

10.4.1 WC/WDM Interventions that BCM has in Hand

BCM currently has four interventions in hand, while a further four interventions are required to make BCM's interventions successful and sustainable.

The interventions that BCM has in hand are:

- the installation of domestic water meters, particularly for the "deemed-to-use" households;
- pressure reduction in water reticulation networks;
- the installation of area meters and
- development and use of a management information system.

The interventions that are necessary to make BCM's interventions successful, are:

- an annual water audit;
- enhancement of meter, billing and debtor management;
- improvements to the user education programme and
- a structured response to issues related to water use and cost recovery.

These eight interventions are the most cost effective water use efficiency measures and could account for 50% of the potential reduction in water requirements due to WC/WDM interventions.

10.4.2 Other Water Use Efficiency Measures

Water infrastructure asset management undertaken in a structured manner in accordance with best-practice manuals recently introduced into South Africa will reduce conveyance and distribution losses.

Interventions are proposed to reduce water requirements through the use of water efficient type sanitation systems, support to households (particularly registered indigent households) and public bodies to maintain water use installations as well as to improve the monitoring of the quality of construction of water installations. These interventions are less cost effective than the ones BCM currently has in hand, but all contribute towards water use efficiency as well as to reducing the water requirements.

Similar interventions should be introduced by ADM for the other LMs for which it is the WSA.

10.4.3 Connections from the Wriggleswade Transfer Scheme

The most critical asset creation activity is the protection of the water courses into which water from the Wriggleswade Transfer Scheme is discharged as well as the construction of the connections from the transfer scheme to WTWs so that water can be transferred from the Wriggleswade Dam to the various parts of the ABWSS when that water is needed.

The yield from the Wriggleswade Dam has been taken into account when determining the system yield.

Currently the Maden, Rooikrantz and Bridle Drift dams are being operated at assurances of supply less than 90% and reliance is placed, therefore, on the water from the Wriggleswade Dam. There is a risk that the water in the Wriggleswade Dam will not be readily available on a sustainable basis to augment the supply to the Maden, Rooikrantz, Laing and Bridle Drift dams when it is required.

The connections from the Wriggleswade Transfer Scheme to the WTWs must be completed as soon as possible.

10.4.4 Water Distribution to WSAs

The operation of the ABWSS as a system is dependent upon a clear definition of where the water from the Wriggleswade Dam is required, how the water will reach the WTWs and the circumstances under which water will be transferred between the five schemes that make up the ABWSS.

A proposal for the operation of the system with a view to optimising the use of water supply, distribution and treatment assets is made in Chapter 7. Relevant stakeholders need to agree as a matter of urgency on the manner in which the water from the Wriggleswade Dam will be distributed so that the necessary distribution infrastructure from the Wriggleswade Transfer Scheme to WTWs can be planned, designed and constructed.

Linked to this aspect is a decision that is required as to whether BCM will treat all the water for the Lower Buffalo Scheme at a single WTW (the Umzonyana WTW) or whether the water will be treated at both the Umzonyana and Nahoon WTWs. The latter could play an increasingly important role of supplying potable water to the northern parts of East London and the coastal area to the north east of East London. This decision impacts upon the way water from the Wriggleswade Transfer Scheme will be distributed, the future of the Nahoon WTW and the selection of the most cost-effective surface water assets for investigation.

10.4.5 Water Pricing

Water pricing and the determination of charges between stakeholders is an aspect that could act either in favour of or against the ABWSS being operated as a system. The issues surrounding water pricing are described in Chapter 7 and a recommendation is made to improve the manner in which costs can be recorded and shared more transparently than is currently the case.

Linked to water pricing is the manner in which charges are levied for storage that is provided by one stakeholder for the benefit of another stakeholder. An example is the manner in which DWAF is compensated for providing storage in the Wriggleswade Dam for the benefit of ADM and BCM.

It is critical that the issues surrounding water pricing, as well as the storage and supply of bulk water, are addressed.

10.4.6 Service Delivery Agreements

While there are agreements between parties, they do not cover all the aspects required to manage the ABWSS as a system and for the true cost of water to be taken into account. SDAs are urgently required between the parties to cover aspects such as “rules of engagement” between the parties, the quantity of water to be supplied by one party to another, the costs of the water and the method of calculating the price of the water, the conditions governing the provision of an asset by one party for the benefit of another, the manner in which assets of each party can be optimized, responsibility for the augmentation of assets and the recourse that a party will have in the event of another party failing to fulfil its obligations.

The existing agreements need to be reviewed and be included in comprehensive SDAs in a manner that will attain equity amongst the stakeholders and that will enable the ABWSS to be operated as a system.

10.4.7 Ecological Water Requirements

The EWRs for different ecological categories are set out in Chapter 3 for the various river reaches in the area of supply of the ABWSS. The implications of the introduction of the EWRs on the need for the creation of surface water assets are shown in scenarios 9 to 11 in Chapter 9.

Also, the options for the use of treated wastewater emanating from Potsdam, Mdantsane and Reeston, are strongly influenced by the extent to which the treated wastewater will be allocated to meeting the EWR requirements in part or in whole in the Buffalo River downstream of the Bridle Drift Dam.

Decisions are required as a matter of urgency regarding the ecological categories that will be adopted for each river reach, the manner in which and the time when the EWR will be introduced as well as the extent to which treated wastewater will be released to the rivers in order to meet the EWRs.

Investigations into options for the use of treated wastewater and for the creation of surface water assets are dependent upon these decisions. The decisions also influence the potential yields of the dams and the manner in which the ABWSS would be operated as a system.

The EWR for the estuary of the Nahoon River and the extent to which the run-of-river flow can meet the EWR are uncertain at this time and could have a significant impact on the water available from the Nahoon River for other uses. A study is required into the estuarine reserve requirement and a measuring weir and gauging station at the estuary are necessary to measure the flow regime.

10.4.8 Water Quality

The best manner in which to maintain or improve the quality of water in the rivers is by addressing pollution at the source of the pollution. This applies to the water quality aspects of the EWRs as well as the quality of the raw water that is treated for domestic and industrial purposes.

Water quality management targets and objectives have been proposed in the past for the river reaches in the ABWSS. Modelling is urgently required to finalise the water quality management targets and objectives in order to finalise the EWRs, to define discharge parameters with which the WWTWs that discharge treated wastewater to the rivers in the ABWSS must comply and to set criteria for the management of diffuse pollution sources such as sewerage networks, agricultural runoff, solid waste management and settlements along watercourses.

Interventions for water quality improvement must be added to relevant interventions for WC/WDM and for infrastructure asset management.

10.4.9 Yield of the System

The yield of the system, which has been adopted for the scenarios described in Chapter 9, has been taken at 98% assurance of supply. The ABWSS is currently at risk due to the quantities of water being abstracted from the Maden, Rooikrantz and Bridle Drift dams, without the certainty that water from the Wriggleswade Dam can be safely transferred on a sustainable basis when the need arises.

A decision is required as to the process that will be adopted to operate the ABWSS at an assurance of supply of 98%. To this end, operating rules for each dam and for the ABWSS as a whole must be determined in the first update of the strategy, while the analysis of the ABWSS, which was done by means of the Water Resources Planning Model (WRPM) must be updated to reflect the operating arrangements for the ABWSS agreed to by the stakeholders.

10.4.10 Inclusion into the ABWSS of Additional Areas Requiring Supply

Stakeholders have indicated that there is a need to supply water from the ABWSS to areas outside the current area of supply of the ABWSS. The areas are the coastal zones and associated rural settlements to the north east and south west of East London and the rural settlements in the vicinity of Kei Road, Bhisho and Stutterheim (known as the Amahlati South Water Supply Scheme).

The latter scheme will abstract water from the Wriggleswade Transfer Scheme for treatment at the Kei Road WTW and would automatically become part of the ABWSS.

The other two areas could be supplied with water from the ABWSS or through the more expensive option of desalinating seawater.

A decision is urgently required as to whether or not the coastal areas will be supplied with bulk water from the ABWSS and if so when as well as how the supply would be provided. This decision has a material influence on decisions regarding the surface water assets that need to be investigated, the manner in which bulk water will be delivered to and from WTWs and the potential use of treated wastewater emanating from the East Bank and Gonubie WWTWs.

10.4.11 Water for Irrigation

Water made available for irrigation from the dams in the ABWSS would have a notable influence on the manner in which water is distributed to users as well as on the surface water assets that would have to be constructed.

Stakeholders have expressed different views. The lower water requirement for irrigation would be the releases of water from the Gubu and Wriggleswade dams together with the run-of-river flow in the Kubusi River required for the area of 1068 ha which is currently scheduled. The upper water requirement for irrigation would be the dam-releases and the run-of-river flow outlined above, together with the compensation releases from the dams in the ABWSS that could irrigate a further 650 ha, plus an allowance to irrigate an additional 370 ha along the Buffalo and Nahoon rivers.

Decisions regarding the extent to which water from the dams and rivers in the ABWSS would be made available for irrigation are urgent as the decisions influence the manner in which water from the Wriggleswade Transfer Scheme will be distributed, which new surface water assets would have to be investigated and by when such investigations/studies should start.

10.4.12 Studies for the Creation of Surface Water Assets

Through the analysis in Chapter 7 of the manner in which the ABWSS can be operated as a system and the scenario-analysis in Chapter 9, seven surface water assets have been identified as being worthy of further investigation.

The ones that should receive priority attention and by when the investigations should be started, are dependent on decisions taken in respect of matters outlined above, particularly the manner in which the EWRs would be introduced, how water would be distributed to and within the WSAs, inclusion or otherwise of additional areas into the area of supply of the ABWSS and the extent to which water would be made available for irrigation.

Time is of the essence for the decisions to be taken so that the potential surface water assets that need to be studied can be agreed upon.

10.4.13 Groundwater Pilot Investigation

The extent to which groundwater can be integrated into the ABWSS is uncertain at this time. Present indications are that groundwater sources are limited in the ABWSS.

Potential aquifers have been identified along the Nahoon River, one of which has been recommended for a pilot investigation to evaluate the aquifer as a potential source of water for the ABWSS and to determine the potential for the conjunctive use of surface and groundwater. Should the results of the pilot investigation prove favourable, the further development of groundwater as a component of the ABWSS could follow.

10.4.14 Monitoring

The scenarios summarised in Chapter 9 show the impact of water requirements and interventions to reduce water requirements as well as the use of treated wastewater upon the need for the creation of new surface water assets.

Stakeholders face the risk of creating assets prematurely or with excessive capacity. They also face the risk of water requirements exceeding the quantity of water available.

Monitoring water requirements and water availability in the light of population change, the implementation of interventions and the creation of assets is a central part of the implementation of the strategy in order to take remedial measures timeously or to amend the strategy during the regular (possibly annual) update of the strategy.

Monitoring of each indicator by the most appropriate stakeholder, coupled with remedial measures, are central to the management of the strategy and to maintain the strategy's relevance.

10.4.15 Operating the ABWSS as a System

Currently the ABWSS is not operated as a system. Also, the disparate interests of stakeholders have a negative effect on the ABWSS being operated as a system.

Much emphasis is placed in the proposals on the ABWSS being operated as a system with a view to the advantageous use of the assets of each stakeholder and to limit the extent to which additional assets are required in order to balance the water requirements and the water that is available.

A priority of the bodies that will be established to manage the implementation of the strategy must be to address the issues that work against the ABWSS being operated as a system.

10.4.16 Strategy Steering and Operations Co-ordination Committees

The key interventions and asset creation proposals identified in the study and summarised above, coupled with the current fragmentation of the institutional arrangement, require one or more bodies to take custodianship of the strategy; to oversee the implementation, monitoring and updating of the strategy and to facilitate/co-ordinate the decision making/implementation process.

Alternative management arrangements have been considered and the following two committees have been decided upon by stakeholders:

- Amatole System Strategy Steering Committee (ASSSC) and
- Amatole System Operations Co-ordination Committee (ASOCC)

The ASSSC would be the custodian of the strategy, and would oversee the strategy, its implementation, its relevance, as well as its periodic updating.

The ASOCC would facilitate/co-ordinate inter-stakeholder relations where necessary, would assist stakeholders to operate the ABWSS as a system and would co-ordinate the activities between stakeholders at an operational level.

The two committees need to be established as a matter of urgency and a Professional Service Provider (PSP) should be appointed to provide technical assistance and support to the two committees.

10.4.17 Priority Actions

The advisable/latest study start dates are listed in Table 10.1. Those that are required to start during 2008 and 2009 are the foundation of the strategy and are summarised in Table 10.2.

Table 10.2 Actions Required in 2008 and 2009

Latest Study Start Date	Category	Intervention/Asset	Responsible Stakeholder
2008	Water Conservation and Water Demand Management (WC/WDM) and Water Quality (WQ)	Develop and apply a management information system (MIS)	ADM and BCM
	WC/WDM	Reduce pressure in water reticulation networks	ADM and BCM
	WC/WDM	Determine water efficient sanitation systems that are acceptable to users for inclusion in sanitation improvement programmes	ADM and BCM
	Return flow (RF) and use (U) of treated wastewater	Determine the best way in which treated wastewater from all the WWTWs can be utilised	ADM, AW, BCM and DWAF
	Surface Water Assets (SWA)	Complete the connections from the Wriggleswade Transfer Scheme (has started)	DWAF
	SWA	Possible transfer of water from the Sandile and Binfield Park dams (in tributaries of the Keiskamma River) to the Buffalo River	DWAF
	SWA	Potential dam in the Keiskamma River at Ravenswood Farm	DWAF
	SWA	Potential dam in the Keiskamma River at Thornwood Farm	DWAF
	SWA	Potential dam in the Nahoon River at Stone Island Farm	DWAF
	SWA	Determine and agree the best way to distribute the water from the Wriggleswade Transfer Scheme	ASOCC
	WQ	Improve solid waste disposal (has started)	ADM and BCM
	WQ	Enforce development controls along the rivers and watercourses in the ABWSS	ADM and BCM
	WQ	Reduce phosphates and total dissolved solids (TDS) returned by WWTWs and industries to the rivers in the ABWSS (partly in hand)	ADM, BCM and DWAF
	WQ	Set and agree the quality parameters for the EWR and the water quality objectives for the rivers in the ABWSS	DWAF
	WQ	Model the ABWSS to ascertain the impacts of and requirements for specific interventions to maintain or preferably to improve the quality of water in the rivers and streams of the ABWSS	DWAF

Latest Study Start Date	Category	Intervention/Asset	Responsible Stakeholder
2008	Ecological Water Requirement (EWR)	Finalise the water quantity for each EWR and when the EWR should be introduced	DWAF
	EWR	Construct a weir and a gauging station just upstream of the Nahoon estuary	DWAF
	Mitigation of Risk (MoR)	Investigate and evaluate a single source of supply of potable water for East London, Mdantsane, Reeston and the coastal areas from the Umzonyana WTW compared with a dual source of supply of potable water from the Umzonyana and the Nahoon WTWs	BCM
	Institutional/ Management arrangements (I and M)	Convert the Steering Committee for this study (The Development of a Reconciliation Strategy for the ABWSS) into a body that will manage the implementation of the strategy (the ASSSC) and strengthen the ASOCC	ADM, AW, BCM, and DWAF
	I and M	Resolve the disagreements concerning water pricing, subsidisation and the manner in which water tariffs are determined	ADM, AW, BCM and DWAF
	I and M	Select the most favourable option for the ownership, operation and management of assets in the ABWSS. (Removal of shortcomings in the current arrangement seems to be the most practicable option at this stage)	ADM, AW, BCM and DWAF
	I and M	Align the population growth scenarios with those of the IDP	ADM, BCM and DWAF
	I and M	Determine when and if the coastal areas to the north east and south west of East London need to be incorporated into the ABWSS to enable the service delivery requirements of BCM and ADM to be met	ADM and BCM
	I and M	Determine the extent to which provision should be made for irrigation water and when licences could/should be issued	DWAF
	I and M	Adopt a 90% assurance of supply for dams from which water is abstracted for domestic and industrial purposes as a temporary measure (already happening) until the results of the interventions are known or until the benefits of interventions as well as of the creation of bulk water supply assets can be realised. Retain a 98% assurance of supply for the ABWSS as a whole	ASOCC
2009	WC/WDM	Undertake an annual water audit	ADM and BCM
	WC/WDM	Enhance effective meter reading, billing and debtor control	ADM and BCM
	WC/WDM	Strengthen the structured response in respect of default in water payment or excessive use of water	ADM and BCM

Latest Study Start Date	Category	Intervention/Asset	Responsible Stakeholder
2009	WC/WDM	Install area water meters	ADM and BCM
	WC/WDM and WQ	Enhance support to users to maintain water, sanitation and sewerage installations	ADM and BCM
	WC/WDM and WQ	Enhance the water and sanitation education programmes	ADM and BCM
	SWA	Potential dam in the Gqunube River at Groothoek/Waterfall	DWAF
	WQ	Improve solid waste collection and refuse/waste picking in open spaces	ADM and BCM
	WQ	Improve wastewater treatment at the 10 WWTWs to meet the river water quality objectives	ADM and BCM
	I and M	Agree on the best way to operate the ABWSS as a system, monitor the ABWSS, apply the WRPM and establish operating rules	ADM, ASOCC, AW, BCM and DWAF