ORANGE - SENQU RIVER COMMISSION
BOTSWANA LESOTHO NAMIBIA SOUTH AFRICA
ORASECOM
Established 2000

Botswana | Lesotho | Namibia | South Africa

The Orange-Senqu River Commission (ORASECOM)

Sharing the Water Resources of the Orange-Senqu River Basin

Contract No.: P-Z1-EAZ-048/CS/01

Preparation of Climate Resilient Water Resources Investment Strategy & Plan and Lesotho-Botswana Water Transfer Multipurpose Transboundary Project

BASIN WIDE INVESTMENT PLAN

Component I and II

June 2023

FINAL REPORT

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PREPARATION OF CLIMATE RESILIENT WATER RESOURCES INVESTMENT STRATEGY & PLAN AND LESOTHO-BOTSWANA WATER TRANSFER MULTIPURPOSE TRANSBOUNDARY PROJECT

COMPONENT I AND II

BASIN WIDE INVESTMENT PLAN

Prepared for

Orange-Senqu River Commission (ORASECOM)

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PREPARATION OF CLIMATE RESILIENT WATER RESOURCES INVESTMENT STRATEGY & PLAN AND LESOTHO-BOTSWANA WATER TRANSFER MULTIPURPOSE TRANSBOUNDARY PROJECT

COMPONENT I AND II

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EXECUTIVE SUMMARY

The Orange-Senqu River Basin is one of the largest river basins south of the Zambezi with a catchment area of approximately 1 million km^2. It encompasses all of Lesotho, as well as a significant portion of South Africa, Botswana and Namibia. In terms of spatial coverage, about 64.2% of the basin lies in South Africa, 24.5% in Namibia, 7.9% in Botswana and 3.4% in Lesotho. The Orange-Senqu River originates in the Lesotho Highlands and flows in a westerly direction approximately 2 300 km to the west coast of South Africa and Namibia where the river discharges into the Atlantic Ocean.

The Orange-Senqu River Basin is a highly complex and integrated water resource system. It is characterised by a high degree of regulation and several major inter-basin transfer schemes to manage the resource availability between areas of relatively abundant precipitation and the areas of greatest water requirements. The existing infrastructure involves most of the largest water storage reservoirs in Southern Africa, as well as the associated water conveyance infrastructure, transmitting water to more than 250 major demand centres that are in some cases located outside of the Orange-Senqu River Basin, through Intra and inter-basin transfers. There are also several inter-basin transfer schemes, which augment the water resource in the Basin from other neighbouring river catchments.

Water scarcity is an important challenge in the Orange-Senqu River Basin and requires coordinated efforts for the development, management and conservation of the water resources in the Basin. Much of the Basin is semi-arid to hyper-arid. A decrease in precipitation due to climate variability and change will have a huge impact on various sectors of the economy that are dependent on the resource. There is a high level of inter and intra-annual variability in precipitation.

The Basin is of major economic importance to South Africa and the entire SADC region, contributing to South Africa's Gross Domestic Product (GDP) from the Vaal and the Orange Rivers' water resource developments for agriculture, mining, energy production and manufacturing. In Lesotho, all the economic activities (agriculture, livestock and manufacturing) lie within the Orange-Senqu River Basin, as the country is located entirely within the Basin. The Basin also contributes to the GDP of Botswana and Namibia, where mining and agriculture are the main water users.

To coordinate and facilitate the water resources development and management in the Basin, the Orange–Senqu River Commission (ORASECOM) was established in November 2000. This led to the development of a basin level Integrated Water Resources Management (IWRM) Plan, adopted in February 2015, by the ORASECOM State Parties. The IWRM Plan provides a strategic transboundary water resources management framework and action targets and serves as a guiding and planning tool for achieving the long-term development goals in the Basin.

The IWRM Plan identified the absence of an integrated transboundary water resources investment strategy and plan, as one of the key challenges for achieving the sustainable development of the Basin's water resources. The need for joint projects and their implementation was identified as a requirement for providing mutually inclusive transboundary benefits.

The objective of the current study is to assist the Orange Sengu River Commission (ORASECOM) and its member States in operationalizing the IWRM plan developed in 2015.

The study is divided into two main modules:

- A climate-resilient investment plan, based on the updated Water Resources Yield and Planning Model and the updated Core Scenario (Components I & II of the study); and
- The Lesotho-Botswana Water Transfer Project Pre-feasibility and Feasibility Study (Components III & IV of the study)

This report is the main deliverable of Component I, namely the Climate Resilient Water Resources Investment Plan. The Investment Plan comprises of all existing and feasible future water infrastructure developments, which are likely to be developed to meet the growing water demands in the future, in the Basin. These developments have been consolidated into what is known as "the Core Scenario".

The development of the Core Scenario included the following tasks:- reviewing/updating of the water requirements for the whole basin; inclusion of the Lesotho-to-Botswana Water Transfer Project (L-BWT) project and other identified future likely projects; assessment of the potential for better utilizing the groundwater in the basin to reduce the pressure on surface water; assessment of the water savings that can be expected from water conservation and water demand management (WC/WDM) measures; assessment of the potential for waste water recycling and reuse; and assessment of additional multipurpose dams in Lesotho to increase the basin yield through multi-annual storage capacity.

The following further studies were also undertaken as part of the development of the Investment Plan and the Core Scenario:- assessment of the climate change effects on the water resources of the Basin and the developed Core Scenario (report No. ORASECOM 003/2019); optimisation of the Core Scenario through an economic approach (report No.

ORASECOM 009/2019); development of a financing strategy; and assessment of existing policies, institutional arrangements and structures at regional, national, bilateral, trilateral, multilateral and basin level, that are responsible for water resources development and management.

Core Development Options and analysis

Planned future projects from the basin countries have been evaluated. Those that are likely to be implemented in the foreseeable future by one or more member states and that have been investigated to at least a pre-feasibility level, in that a basic costing has been done were selected to form part of the core future developments. From these studies, the indication should be that the specific project is likely to be feasible. As part of the WRPM system analysis, a core scenario was analysed which includes all these core future developments.

The costs included in this report are taken from the most recent reports and have not been determined by this team. Consequently this team cannot vouch for the feasibility of the core projects.

The URVs, while not directly comparable, do show that some of the core projects are relatively much more expensive per cubic meter of water delivered than the others. These relatively expensive projects should be compared to internal options, such as wastewater desalination, in order to determine whether there are options that could serve to delay or replace the project.

The core projects which form part of the basin-wide investment plan have been consolidated into 9 clusters as shown in **Table 1**.

Table 1: Clusters and List of projects included in the basin-wide investment plan

	Project Name
Cluster 1	**Orange River Project (ORP) Scheme future improvements**
1.1	Utilise the lower-level storage in the Vanderkloof Dam
1.2	Real-Time flow modelling and monitoring in the Lower Vaal downstream of Bloemhof Dam and the Orange River downstream of Vanderkloof Dam to the Orange River mouth
1.3	Building of the Verbeeldingskraal Dam upstream of Gariep Dam
1.4	Formally agree on Orange River Environmental Water Requirements (EWRs) and implement Reserve/EWR releases (River Mouth of high importance)
1.5a	Noordoewer/Vioolsdrift Dam (used to compensate for the Polihali Dam impact on the ORP and Flow Re-regulation for the Orange River Mouth)
1.5b	Noordoewer/Vioolsdrift Dam (used as a resource to increase system yield and provide water for future irrigation in Namibia)
1.6	Development of 12 000 ha of irrigation for Resource-poor farmers (RSA) of which ±30% was completed

1.7	Polihali Dam (Lesotho Highlands Water project (LHWP) Phase ll and connecting tunnel to Katse Dam; using revised operating rules still to be agreed for both phases of the LHWP)
Cluster 2	**L-BWT Scheme**
2.1	Makhaleng Dam and possible irrigation developments in Lesotho
2.2	L-BWT water transfer system (pipeline and possible canal sections) to Gaborone/Lobatse
Cluster 3	**Lesotho Lowlands Water Project**
3.1	Hlotse Dam: Urban/rural demands plus irrigation developments
3.2	Ngoajane Dam: Urban/rural demands plus irrigation developments
Cluster 4	**Integrated Vaal River System (IVRS) intervention options**
4.1	Thukela-Vaal transfer further phases
4.2	Desalination and re-use of mine water effluent in RSA
4.3	Utilise Crocodile Return Flows in Tshwane to reduce demand from Rand Water via the Vaal River.
Cluster 5	**Caledon to Greater Bloemfontein transfer**
5.1	Tienfontein pump station capacity increase to 7 m^3/s;
5.2	Increase Tienfontein pumping capacity to 3.87 m^3/s, Novo Transfer scheme capacity to 2.2 m^3/s; to Rusfontein Dam
Cluster 6	**Greater Bloemfontein internal resource improvements**
6.1	Raise Mockes Dam to increase storage capacity
6.2	Increase Maselspoort Water Treatment Works (WTW) capacity to 130 Ml/d
6.3	Planned indirect re-use from Bloem Spruit Wastewater Treatment Works (WWTW) (±16 million m^3/a)
6.4	Planned direct re-use from Bloem Spruit WWTW (±11 million m^3/a)
Cluster 7	**Gariep to Greater Bloemfontein Transfer**
7.1	Pump station and pipeline from Gariep Dam to Bloemfontein Phase 1
7.2	Pump station and pipeline from Gariep Dam to Bloemfontein Phase 2
Cluster 8	**Neckartal Dam Scheme**
8.1	Neckartal irrigation scheme development and water requirement
8.2	Neckartal Dam hydro-power generation and related releases
Cluster 9	**Integrated Water management actions (add other soft issues)**
9.1	Removal of unlawful irrigation
9.2	Water Conservation and Water Demand Management (WC/WDM): Irrigation
9.3	WC/WDM: Urban and Industrial
9.4	Increase permit licence coverage
9.5	Improve assessments of aquifers (storage capacities, recharge rates, sustainable yields and other characteristics)
9.6	Manage salinity
9.7	Manage eutrophication
9.8	Manage and control alien and invasive species and problem pests
9.9	Set water quality objectives/standards
9.10	Identify priority water needs to support economic development at basin level
9.11	Set out guidelines and procedures to improve equitable utilisation and benefit-sharing at the basin level
9.12	Harmonize policy, legal and institutional frameworks

Table 2 provides a summary of all of the core projects and key information such as dam wall height, yield, capital cost and annual operating costs.

Table 3 provides a summary of the inputs and results of a URV and cost-benefit analysis for the clustered proposed future options. It is evident that the L-BWT Scheme has an extremely high URV of about R53.17/m^3 and is the most expensive future investment with capital costs of around R54 billion. The lowest URV was obtained for the utilization of the Vanderkloof lower level storage, determined as R0.18/m^3. A typical average URV value of R 14.7/m^3 was obtained for the Gariep to Greater Bloemfontein transfers.

Institutional arrangements have been proposed for each of the core options, including the L-BWT. In most cases, existing institutions are suitable and have been proposed to implement and manage the projects.

Table 2: Summary of the core projects and related key information

	Scheme Description	Project Type	Capital Cost (2018 - R Million)	Operational Cost (2018 - R Million)	Yield or Impact on Yield (million m^3/annum)	Operational Period
Cluster 1: Orange River Project Scheme future improvements			**39 822**	**131**	**804**	
1	Utilise the lower-level storage in Vanderkloof Dam	Dam	180	10	137	20
2	Real-Time flow modelling and monitoring in the Lower Vaal downstream of Bloemhof Dam and the Orange River downstream of Vanderkloof Dam to the Orange River mouth;	Dam operating rule	6	1	80	20
3	Building of the Verbeeldingskraal Dam upstream of Gariep Dam. Dam wall height 67 m to spill level. Gross storage 1 363 million m^3;	Dam	4 082	12	200	50
4	Formally agree Environmental Water Requirements & release to River Mouth	Integrated Water Management	20	-	0 to minus 434	20
5	Noordoewer/Vioolsdrift Dam used as an individual resource. Medium size dam, 36 m dam wall height to spill level and gross storage of 650 million m^3.(dam size still to be optimised and finalised)	Dam	4 397	13	280	50
6	Development of 12 000 ha irrigation for resource-poor farmers of which ± 30% was already developed	Integrated Water Management	-	-	-	20
7	Polihali Dam (Lesotho Highland Water project (LHWP) Phase II and connecting tunnel to Katse Dam; using new operating rule (net yield). Dam wall height to spill level is 150 m with gross storage of 2 322 million m^3.	Dam	31 137	96	107 net (391 gross)	50
Cluster 2: L-BWT Scheme			**54 257**	**861**	**162/334**	
8	Makhaleng Dam, dam wall height to spill level 120 m. Gross storage 1 382 million m^3	Dam	6 006	23	334	50
9	L-BWT pipeline, transfer pipe to Gaborone/Lobatse	Pipeline/Pumping Scheme	48 251.	838	162	30
Cluster 3: Lesotho Lowlands			**1 381**	**6**	**65**	
10	Hlotse Dam, dam wall height to spill level 51 m and gross storage of 105 million m^3: Urban/rural demands plus irrigation developments	Dam	884	3	54	50
11	Ngoajane Dam, dam wall height to spill level 47.5m and gross storage of 36 million m^3: Urban/rural demands plus irrigation developments	Dam	497	3	11	50
Cluster 4: IVRS intervention options			**32 739**	**1 603**	**1 078**	
12	Thukela – Vaal transfer further phase	Pipeline/Pumping Scheme	22 492	172	522	50

	Scheme Description	Project Type	Capital Cost (2018 - R Million)	Operational Cost (2018 - R Million)	Yield or Impact on Yield (million m^3/annum)	Operational Period
13	Desalination and re-use of mine water effluent;	Wastewater Treatment	8 773	1 304	500	30
14	Utilise Crocodile basin Return Flows in Tshwane to reduce demand supplied from Rand Water via Vaal	Pipeline/Pumping Scheme	1 474	127	56	30
Cluster 5: Caledon to Greater Bloemfontein transfer			**267**	**11**	**11**	
15	Tienfontein pump station capacity increase to 7 m3/s;	Pipeline/Pumping Scheme	180	7	6	30
16	Increase Tienfontein pumping capacity to 3.87 m^3/s Novo Transfer scheme capacity to 2.2 m^3/s; to Rusfontein Dam	Pipeline/Pumping Scheme	87	4	5	30
Cluster 6: Greater Bloemfontein internal resource improvements			**1 563**	**167**	**31**	
17	Raise Mockes Dam to increase storage capacity	Dam	120	1	3	50
18	Increase Maselport WTW Capacity to 130 Ml/d	Wastewater Treatment	944	68	31	30
19	Planned indirect reuse from the Bloem Spruit WWTW (± 16 million m3/a); Maselspoort	Wastewater Treatment	322	62	16	30
20	Planned direct reuse from the Bloem Spruit WWTW (± 11 million m3/a); Maselspoort	Wastewater Treatment	252	43	11	30
Cluster 7: Gariep to Greater Bloemfontein Transfer			**4 300**	**230**	**43**	
21	Pump station and pipeline from Gariep Dam to Bloemfontein Phase 1	Pipeline/Pumping Scheme	3 800	171	32	30
22	Pump station and pipeline from Gariep Dam to Bloemfontein Phase 2	Pipeline/Pumping Scheme	500	59	11	30
Cluster 8: Neckartal Scheme			**500**	**14**	**195**	
23	Neckartal Dam irrigation demands (large schemes)	Dam	500	14	90	50
24	Neckartal Dam hydropower releases	Dam	-	-	105	50
Cluster 9: Integrated Water management options			**6 394**	**1 276**	**308**	
25	Removal of unlawful irrigation	Integrated Water Management	4	-	120	20
26	WCDM Irrigation	Integrated Water Management	199	2	73	20
27	WCDM Urban and Industrial	Integrated Water Management	6 115	1 274	155	20

	Scheme Description	Project Type	Capital Cost (2018 - R Million)	Operational Cost (2018 - R Million)	Yield or Impact on Yield (million m^3/annum)	Operational Period
28	Increase permit/ licence coverage	Integrated Water Management	8	-	0	20
29	Improve assessments of aquifers (storage capacities, recharge rates, sustainable yields and other characteristics)	Integrated Water Management	5	-	40	20
30	Manage salinity	Integrated Water Management	9	-	-	20
31	Manage eutrophication	Integrated Water Management	8	-	-	20
32	Management and control of alien and invasive species and problem pests	Integrated Water Management	13	-	20	20
33	Set water quality objectives/standards	Integrated Water Management	5	-	-	20
34	Consolidation of climate data and extreme event data at Basin level	Integrated Water Management	15	-	-100	20
35	Identify priority water needs to support economic development at basin level	Integrated Water Management	2	-	-	20
36	Set out guidelines and procedures to improve equitable utilisation and benefit-sharing at the basin level	Integrated Water Management	7	-	-	20
37	Harmonize policy, legal and institutional frameworks	Integrated Water Management	5	-	-	20
	Total		**152 577**	**4 290**		

Table 3: Summary of Clustered Scheme URVs

	Discount Rates			Investment Cost	Yield
	8%				
	URV	PV Costs	PV Water		
Cluster Name	**R/m^3**	**R millions**	**Million m^3**	**R millions**	**Million m^3/a**
Cluster 1 ORP intervention options*	**6.52**	35,869	5,501	39,808	724
Cluster 2 L-BWT Scheme	**53.17**	54,775	1,030	54,257	162/334
Cluster 3 Lesotho Lowlands	**1.60**	1,290	806	1,381	65
Cluster 4 IVRS intervention options (includes the Thukela transfer option)	**6.55**	44,476	6,792	32,739	578
Cluster 5 Caledon to Greater Bloemfontein transfer	**4.08**	253	62	180	6
Cluster 6 Greater Bloemfontein internal resource improvements	**10.79**	3,592	333	1,638	30
Cluster 7 Gariep to Greater Bloemfontein Transfer	**14.71**	6,582	448	4,300	43
Cluster 9 Integrated Water management options **	**9.74**	22,422	2,302	6,314	228

Notes: * - Includes Polihali and associated net yield.
** - Only includes the WC/WDM intervention options

The currently proposed institutional arrangements are summarised below:

L-BWT Scheme: Subject to a final recommendation in later phases of the project, it is thought that LHDA, TCTA, Botswana WUC, and a South African water board could have roles and functions. Alternatively, if a PPP route is followed then a single corporation alternative could be established. A Lesotho-RSA-Botswana Commission, perhaps with key members shared with LHWP would also be required.

CRIDF has procured separate studies on the institutional arrangements and funding for the L-BWT.

Regarding the Financing and Development of the L-BWTS, the CRIDF findings are that the financing and development" of the L-BWTS could be done by an unincorporated JV, a bilateral JV SPV between two countries or a tri-partite JV SPV.

In the unincorporated JV model, each country finances its portion of the project and this may be managed as an EPC contract under an implementing agent within each country. The critical aspect would be that each country is liable for its own financing and repayment of its debt on the asset (even where this is deemed an intangible asset located in another country), linked to the off-take agreements and funding between the countries.

A critical finding of CRIDF is that "*At the scale of the L-BWT Project, the financial obligations will extend beyond the capacity of any one of the host countries. Accordingly, multiple pools* *of funding will be required to be accessed in order to finance the envisaged capital expenditure. Bankability of the L-BWT Project will be the key financial driver to achieve successful financing.*"

In addition, the CRIDF study suggested key considerations for accessing the bankability of the project include "*the commitments of the host governments to underpin the debt financing obligations of the borrower; and the ability of the host countries' fisci to assume additional debt obligations.*"

Orange River Project Scheme future improvements and Vanderkloof Dam would stay with DWS-RSA.

Real-Time flow modelling (Vaal and Orange River System Models) would be operated by DWS-RSA and further development coordinated by ORASECOM.

Verbeeldingskraal Dam will be owned by DWS and perhaps funded through TCTA.

Polihali Dam will be owned by GoL, governed by LHWC and implementation will be by LHDA with funding possibly arranged through TCTA.

Large dams in the Lesotho Lowlands could be operated by LHDA who already have the expertise. (SMEC, 2017)

Thukela Transfers would remain with RSA-DWS.

AMD currently resides with RSA-DWS, but Design-Build-Operate and PPP models are being explored.

Crocodile and other major Return Flow re-use plants would be owned by Johannesburg Water and the Cities of Tshwane and Mangaung, while smaller towns should be encouraged to utilise PPP expertise and arrangements.

Caledon to Greater Bloemfontein transfer and Gariep to Greater Bloemfontein transfer comprises national infrastructure which would be owned by RSA-DWS and bulk and municipal infrastructure which could be operated by Bloemwater or City of Mangaung.

Greater Bloemfontein internal resource improvements would be within the domain of the City of Mangaung.

Neckartal Dam has recently been constructed by DWA-Namibia in cooperation with the Namibia Department of Agriculture, Planning, Extension & Engineering Services. The irrigation scheme and related water distribution infrastructure still need to be developed.

Integrated water management options: ORASECOM should have an oversight and monitoring responsibility, however, the implementation would need to be done at a local level by municipalities under the regulation of the respective national government departments and other regulating authorities.

The funding arrangements follow the institutional arrangements set out above.

The funding arrangements are supported by an analysis of the water budgets of the SADC countries as well as a financial analysis of the L-BWT and Crocodile River re-use project.

A PPP alternative to existing institutional arrangements has been proposed for the L-BWT and the desalination and re-use projects.

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ACIP	Accelerated Community Infrastructure Programme
AfDB	African Development Bank
AGRP	Average Groundwater Resource Potential
AMD	Acid Mine Drainage
AMCOW	African Ministerial Conference on Water
B/C ratio	Benefit Cost Ratio
BAS	Best Attainable State
BOT	Build, Operate, Transfer
CSIR	Council for Scientific and Industrial Research
DBOM	Design, Build, Operate and Transfer
DBSA	Development Bank of Southern Africa
DFIs	Development Finance Institutions
DWA	Department of Water Affairs (RSA)
DWAF	Department of Water Affairs and Forestry (RSA)
DWS	Department Water and Sanitation (RSA)
EAIF	Emerging Africa Infrastructure
EC	Electrical Conductivity
EFR	Ecological Flow Requirements
EHI	Estuarine Health Index
EIRR	Economic Internal Rate of Return
ENPV	Economic Net Present Value
EWR	Ecological Water Requirement
GDP	Gross Domestic Product
GEF	Global Environmental Facility
GEP	Groundwater Exploitation Potential
GESI	Global Environmental Sanitation Initiative
GRA II	Groundwater Resources Assessment Phase II
GoL	Government of Lesotho
GRP	Groundwater Resource Potential
GTAC	Government Technical Advisory Centre

HIV/AIDS	Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome
IAPP	International Association for Public Participation
ICT	Information and Communications Technology
IDF	International Development Fund
IFC	International Finance Corporation
IFIs	International Funding Institutions
IGRAC	International Groundwater Resources Assessment Centre
IPCC	International Panel for Climate Change
IRR	Internal Rate of Return
IVRS	Integrated Vaal River System
IWRM	Integrated Water Resources Management
JIA	Joint Irrigation Authority
JPTC	Joint Permanent Technical Committee
JPWC	Joint Permanent Water Commission
KFW	German Federal Government Development Bank
Kl	Kilo liter
L-BWTS	Lesotho-Botswana Water Transfer Scheme
LHDA	Lesotho Highlands Development Authority
LHWP	Lesotho Highlands Water Project
LOR	Lower Orange River
l/s	Litre per second
MAFS	Ministry of Agriculture and Food Security (Lesotho)
MAP	Mean Annual Precipitation
MAR	Mean Annual Runoff
MAWF	Ministry of Agriculture, Water and Forestry (Namibia)
MCA	Multi-Criteria Analysis
MC	Management Centre (Botswana)
MDB	Multilateral Development Bank
MEWR	Minerals, Energy and Water Resources (Botswana)
Ml/d	Mega liter per day
mm/a	Millimeters per annum
m^3/s	Cubic Meters per second

m^3/a	Cubic Meters per annum
MW	Megawatts
MWh	Megawatt hours
AUDA-NEPAD	African Union Development Agency - New Partnership for Africa's Development
NSDP	National Strategic Development Plan
NWA	National Water Act
NAP	National Action Programme
NGO	Non-governmental Organisation
NPV	Net Present Value
NRW	Non-Revenue Water: This is the difference between the volume of water supplied into the system and the billed authorised consumption.
OECD	Organisation for Economic Co-operation and Development
ORASECOM	Orange-Senqu River Commission
ORP	Orange River Project (Gariep and Vanderkloof dams and supply area)
OVTS	Orange Vaal Transfer Scheme
PES	Present Ecological State
PIDG	Private Infrastructure Development Group
PF	Potability Factor
PGEP	Potable Groundwater Exploitation Potential
PPP	Public Private Partnership
PSC	Public Sector Comparator
PV	Present Value
PWC	Permanent Water Commission
RO	Reverse Osmosis
RQO	Resource Quality Objectives
RSA	Republic of South Africa
SADC	Southern African Development Community
SADC-GIO	Southern African Development Community Groundwater Information Portal
SAP	Strategic Action Programme
SIV	System Input Volume

SOEs	State Owned Entities
STI	Short-term Intervention
TCTA	Trans Caledon Tunnel Authority
TDA	Transboundary Diagnostic Analysis
TDS	Total dissolved solids
TTT	Technical Task Team
ToR	Terms of Reference
UGEP	Utilisable Groundwater Exploitation Potential
UN	United Nations
UNDP	United Nations Development Programme
URV	Unit Reference Value
USD	USA Dollar
VRS	Vaal River System
WARMS	Water Authorisation and Registration Management System
WASCO	Water and Sanitation Company
WC	Water Conservation
WDM	Water Demand Management
WIDP	Water Infrastructure Development Programme
WMA	Water Management Area
WQ	Water Quality
WRYM	Water Resources Yield Model
WRPM	Water Resources Planning Model
WTW	Water Treatment Works
WUC	Water Utilities Corporation
ZAR	South African Rand

1 INTRODUCTION

1.1 Background to the Study Area

The Orange-Senqu River Basin is one of the largest river basins south of the Zambezi with a catchment area of approximately 1 million km^2. It encompasses all of Lesotho, a significant portion of South Africa, Botswana and Namibia. In terms of spatial coverage, about 64.2% of the basin lies in South Africa, 24.5% in Namibia, 7.9% in Botswana and 3.4% in Lesotho.

The Orange-Senqu River originates in the Highlands of Lesotho and flows in a westerly direction, approximately 2,300 km to the west coast of South Africa and Namibia, where the river discharges into the Atlantic Ocean. See **Figure 1-1.**

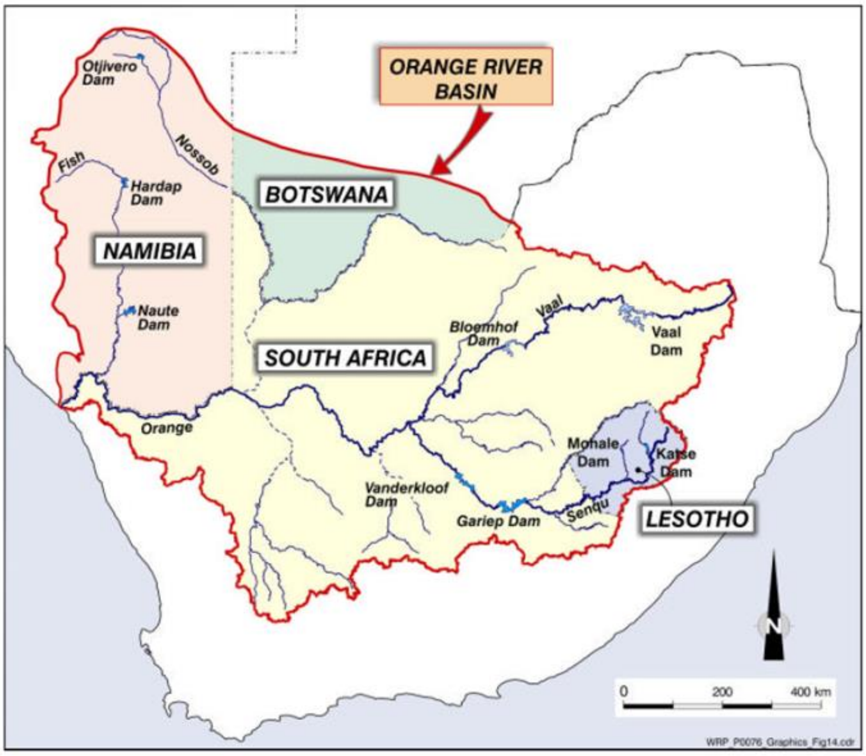

Figure 1-1: Orange-Senqu River Basin

On the part of Lesotho, there are three distinct hydrologically homogenous river basins, where each river basin has its clear source where it originates. These river basins, namely: Senqu, Mohokare and Makhaleng River Basins all flow in the westerly direction and join together outside the border of Lesotho with the Orange River to form one large basin known as the Orange-Senqu River Basin.

It has been estimated that the natural runoff of the Orange-Senqu River Basin is in the order of 11,300 million m^3/a; of which approximately 4,000 million m^3/a originates in the Senqu River Basin in the highlands of Lesotho; 6,500 million m^3/a from the Vaal and Upper Orange River; with approximately 800 million m^3/a from the Lower Orange and Fish River in Namibia of which about 480 million m^3/a is from the Fish River. The Basin also includes a portion in Botswana and Namibia (north of Fish River) feeding the Nossob and Molopo Rivers.

Southern Africa has fifteen (15) transboundary watercourse systems of which thirteen (13) exclusively stretch over the Southern African Development Community (SADC) Member States. The Orange–Senqu is one of these thirteen (13) transboundary watercourse systems. SADC member states embrace the ideals of utilizing the water resources of these transboundary watercourses for the regional economic integration and for the mutual benefit of the riparian states. The region has demonstrated a great deal of goodwill and commitment towards collaboration on water issues. Thus, SADC in the revised Protocol on Shared Watercourses of August 2000 and ORASECOM in the Revised Agreement on the Establishment of the Orange-Senqu Water Course Commission of December 2018 has adopted the principle of basin-wide management of the water resources for sustainable and integrated water resources development.

To enhance the objectives of integrated water resources development and management in the region, the Orange–Senqu River Commission (ORASECOM) was established in November 2000.

ORASECOM was established in terms of an agreement between the Governments of four States, namely, Botswana, Lesotho, Namibia and South Africa, (the Agreement on the Establishment of the Orange-Senqu River Commission – established by agreement in 2000 and agreement revised in 2018) for managing the transboundary water resources of the Orange-Senqu River Basin and promoting its beneficial development for the socio-economic wellbeing and safeguarding of the basin environment. ORASECOM is guided by the Revised Protocol on shared Water Courses in the Southern African Development Community of August 2000.

This led to the development of a basin level Integrated Water Resources Management (IWRM) Plan adopted in February 2015 by the ORASECOM Member States. The IWRM Plan provides a strategic transboundary water resources management framework and action areas and serves as a guiding and planning tool for achieving the long-term development goals in the basin. A key aspect of the transformative approach for strengthening cooperation has been identified as the need for joint projects and implementation that provides a mutually inclusive transboundary benefit based on equitable sharing of the water resources.

The IWRM Plan recommends strategies and measures for promoting sustainable management of the water resources of the basin. It also defines strategic actions that will ensure and enhance water security, considering the long term socio-economic and environmental demands on the water resources of the basin. The Lesotho to Botswana Water Transfer Scheme, a major component under this study, was not included in the 2015 IWRM Plan as one of the strategic actions but has lately been identified as a priority project.

The Orange-Senqu River Basin is a highly complex and integrated water resource system, characterized by a high degree of regulation and major inter-basin transfers (both into and out of this basin) to manage the resource availability between the location of relatively abundant precipitation and the location of greatest water requirements. The infrastructure involves water storage and transmission infrastructure, transmitting water to demand centres that are in some cases located outside of the basin through intra and inter-basin transfers. Most of the existing infrastructure are those under the Lesotho Highlands Water Project (LHWP) which transfers water to South Africa and those for inter-basin transfer to the Vaal Basin, which is part of the Orange-Senqu Basin. The following are the main existing schemes transferring water into the Basin from other neighbouring catchments:

- Thukela-Vaal Transfer Scheme
- The Heyshope to Grootdraai Transfer Scheme
- The Zaaihoek Transfer Scheme
- The Inkomati Transfer system
- The Usutu transfer system

Figure 1.2 provides approximate values of the natural run-off in the Orange-Senqu River Basin. These figures highlight the variable and uneven distribution of runoff from east to west in the Basin. The figures refer to the natural runoff which would have occurred had there been no developments or impoundments in the catchment. The actual runoff reaching the river mouth is considerably less than the natural values and are estimated to be in the order of half the natural values. The difference is due mainly to the extensive water utilization in the Vaal River Basin, most of which is for domestic and industrial purposes.

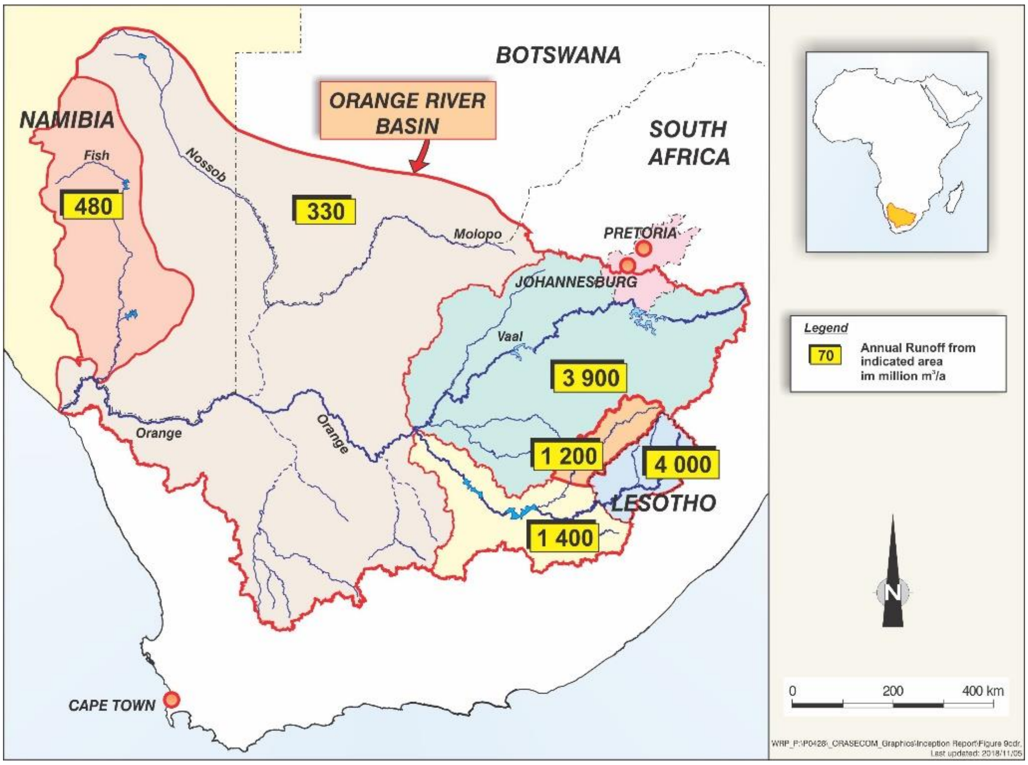

Figure 1-2: Approximate Natural Run-off in the Basin

Several major transfer systems are used to bring water into the Upper Vaal River catchment to support the high-water requirements, in particular, those within the Gauteng area as well as for several Power Stations.

Large volumes of water are also used to support extensive irrigation and some mining demands along the Orange River downstream of the Orange-Vaal rivers' confluence, as well as significant irrigation developments in the Eastern Cape Province in South Africa, supplied through the Orange-Fish Tunnel. In addition to the water demands, evaporation losses from the Orange River and the associated riparian vegetation that depend on the river account for 500 to 1,000 Million m^3/a.

As already indicated, there are locations of relatively abundant precipitation and water availability, and locations of greater water requirements. Water scarcity in locations of greatest need is the main challenge in the Basin. This requires a coordinated joint development, management and conservation of the water resources system. The climate in the Basin varies from relatively temperate in the eastern source areas, to hyper-arid in the western areas. As shown in **Figure 1.3**, average annual precipitation decreases from more than 1,000 mm/a in the source areas of the Basin to less than 50 mm/a at the river mouth.

This varies considerably from year to year. Much of the rainfall occurs as intense storms, which can be highly localized. The temporal and spatial distribution of precipitation within any particular year can be considerable.

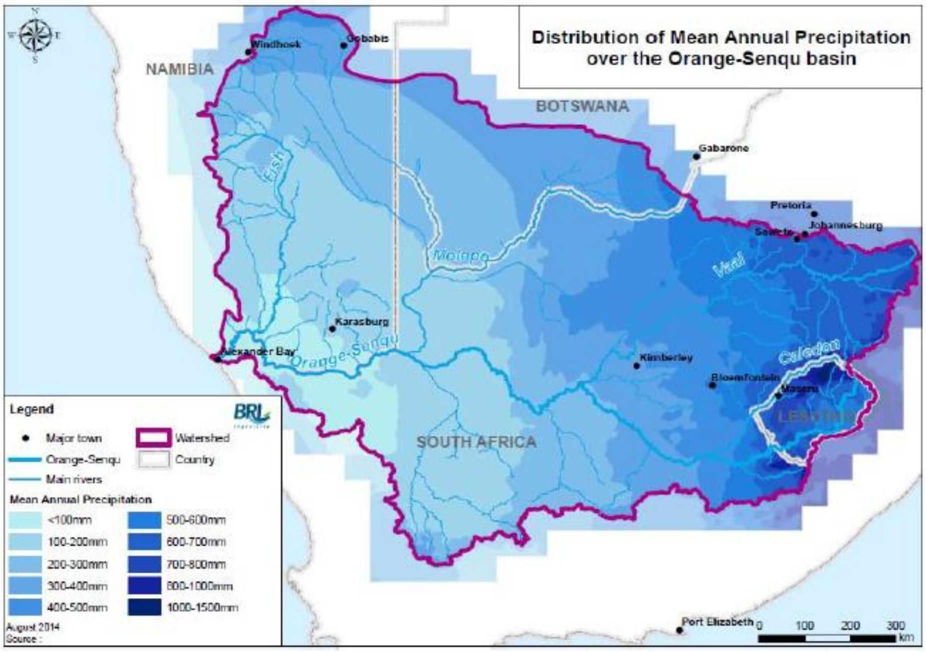

Figure 1-3: Distribution of Mean Annual Precipitation

In **Figure 1.4,** it is evident that evaporation increases from south-east to north-west reaching a maximum of more than 1,650 mm/a in the west. Even in the cooler and wetter parts of the Basin, evaporation in most cases exceeds precipitation. Temperature and evaporation follow a similar distribution with the coolest temperatures in the Lesotho Highlands and the hottest in the western Kalahari.

It is generally considered that Southern Africa will be highly impacted by climate change. Specifically, there are concerns that precipitation in most areas may decrease and that temperatures may increase over time. This study, therefore, aims to enhance investment in transboundary water security and to build resilience to climate change into the implementation of the strategic projects and actions described in the IWRM Plan.

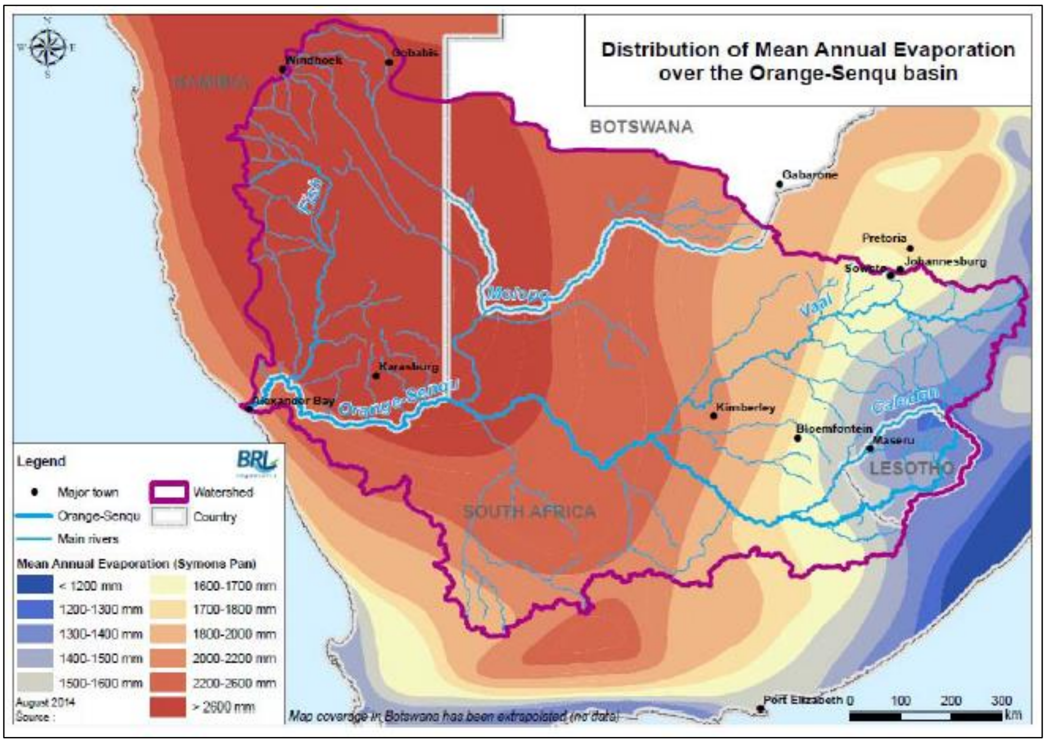

Figure 1-4: Distribution of Mean Annual Evaporation

1.2 Objective of the Assignment

The objective of the study was to assist ORASECOM and its member States in operationalizing the updated IWRM Plan. The objective was therefore met through three outputs:

- A Climate Resilient Investment Plan for the Orange-Senqu River Basin based on the updated Core Scenario (Report 003/2019);
- Operationalization Plan (Report 012/2019) for ten (10) priority actions selected from the updated IWRM Plan; and
- Pre-feasibility level report (Report 015/2019) for the L-BWT Project, and the feasibility level report (Report 017/2019) for a new dam, on Makhaleng River in Lesotho.

The study was divided into two distinct parts:

- Preparation of a Climate Resilient Investment Plan, based on the updated Water Resources Yield and Planning Model and the updated Core Scenario defined in the IWRM Plan of 2015, as Components I & II of the study; and
- The pre-feasibility and feasibility study of Lesotho-Botswana Water Transfer Project, as Components III & IV of the study.

The four components of the study referred to above are:

- Component I: Climate Resilient Water Resources Investment Plan;
- Component II: Operationalisation of the Integrated Water Resources Management Plan;
- Component III: Pre-feasibility study of the Lesotho to Botswana Water Transfer Project;
- Component IV: Feasibility Study of the dam on Makhaleng River in Lesotho.

1.2.1 Climate Resilient Investment Plan (Components I and II)

The high level of variability in precipitation due to climate variability and change defined the need to optimize and implement efficient water resources development and management in the Basin. The development of new infrastructure to meet increasing water demands, even if technically and environmentally feasible, would be both expensive and complex. Economic considerations of water use had been identified as a key part in the planning and optimal use of what would become an increasingly scarce and expensive resource. Projections of future water demand and associated infrastructure development must be based on balanced considerations of economic, social, and environmental factors. The integration of water resources yield analysis, water resources development planning and economic optimization would ensure the development of short, medium- and long-term solutions to address basin water resources needs and development challenges.

The study included water resource assessments in Botswana, Lesotho, Namibia and South Africa. This was to include updating of inputs with more recent results from the Reconciliation Strategy Maintenance Studies in RSA as well as other recent water resource-related assessments conducted in the basin countries. The study was also to conduct comprehensive basin-wide analyses which had to be integrated with economic analyses to determine the optimized and most efficient development options, as part of setting the long-term development investment strategy and plan for the Basin.

Components I & II addressed the water resources investment plan and the operationalization of the updated IWRM Plan with the following outputs:

- Updated Core Scenario of the IWRM Plan, which included the Lesotho-Botswana Water Transfer Scheme and any other new projects identified (ORASECOM 003/2019);
- Estimate of the Climate Change Effects on the updated Core Scenario (ORASECOM 007/2019);

- Optimised IWRM Plan Core Scenario through an economic approach (ORASECOM 009/2019);
- Financial Strategy for the Core Scenario (ORASECOM 010/2019);
- Updated Basin Wide Investment Plan approved by ORASECOM, which included new projects that took into consideration climate change effects (ORASECOM 010/2019);
- A comprehensive assessment of existing policies, legal and institutional arrangements and structures (ORASECOM 008/2019);
- Selected 10 strategic actions, Terms of Reference and cost estimates for each strategic action (ORASECOM 013/2019); and
- A road map for operationalization of the ten (10) strategic actions contained in the updated Integrated Water Resource Management Plan (ORASECOM 012/2019).

1.3 Purpose and Structure of this report

The purpose of this report was to prepare an investment plan to implement the Core Scenario.

This investment plan showed the timing of each component of the Core Scenario, as well as the funding requirements to implement the components and suggested institutional arrangements to implement, own and operate the components.

This report contained only summarized information on water requirements, funding and institutional arrangements. Each of these components was supported by detailed stand-alone reports.

1.4 Notes on Costs

- All costs are estimated based on 2018 price levels unless otherwise stated.
- The costs were abstracted from reports prepared by others.
- Some of these reports were only at a pre-feasibility level of detail while others were at a feasibility level.
- These reports were of various ages and the costs quoted in these reports were escalated to the 2018 price levels, using published annual inflation figures.
- Costing was not done as a part of this assignment.

Furthermore, in future, costs and project viability would need to be verified through detailed feasibility and design level planning studies.

2 OVERVIEW OF BASIN WIDE INVESTMENTS

The Basin Wide Investment Plan comprises projects that had already been identified by the basin states, and which had been subject to various levels of planning. The Investment Plan includes several discrete investments to be made by the basin states, either individually or jointly in collaboration. All the projects have been investigated to at least a pre-feasibility level by one or more member states in that approximate costs have been determined and are considered likely to be developed.

Summarised details of the projects were included in **Table 2-1**. The projects were grouped into clusters based on the larger schemes or sub-systems of which they formed one of the key components.

Table 2-1: List of projects to form part of the basin-wide investment plan

	Project Name
Cluster 1	**Orange River Project (ORP) Scheme future improvements**
1.1	Utilise the lower-level storage in the Vanderkloof Dam
1.2	Real-Time flow modelling and monitoring in the Lower Vaal downstream of Bloemhof Dam and the Orange River downstream of Vanderkloof Dam to the Orange River mouth;
1.3	Building of the Verbeeldingskraal Dam upstream of Gariep Dam;
1.4	Formally agree on Orange EWRs and implement Reserve/EWR releases (River mouth of high importance)
1.5a	Noordoewer/Vioolsdrift Dam (used to compensate for the Polihali Dam impact on the ORP and for re-regulation of the flow for the Orange-River Mouth)
1.5b	Noordoewer/Vioolsdrift Dam (used as a resource to increase system yield,)
1.6	Development of 12 000 ha of irrigation for Resource-poor farmers (RSA) of which ±30% was completed
1.7	Polihali Dam (Lesotho Highlands Water Project (LHWP) Phase ll and connecting tunnel to Katse Dam; using revised operating rule, still to be agreed for both phases of LHWP
Cluster 2	**L-BWT Scheme**
2.1	Makhaleng Dam and possible irrigation developments in Lesotho
2.2	L-BWT Pipeline, transfer pipeline to Gaborone/Lobatse
Cluster 3	**Lesotho Lowlands Water Project**
3.1	Hlotse Dam: Urban/rural demands plus irrigation developments
3.2	Ngojane Dam: Urban/rural demands plus irrigation developments
Cluster 4	**Integrated-Vaal River System (IVRS) intervention options**
4.1	Thukela-Vaal transfer further phase
4.2	Desalination and re-use of mine water effluent in RSA
4.3	Utilise Crocodile Return Flows in Tshwane to reduce the demand supplied from Rand Water via Vaal
Cluster 5	**Caledon to Greater Bloemfontein transfer**
5.1	Tienfontein pump station capacity increase to 7m^3/s;

5.2	Increase Tienfontein pumping capacity to 3.87 m^3/s Novo Transfer scheme capacity to 2.2 m^3/s; to Rusfontein Dam
Cluster 6	**Greater Bloemfontein internal resource improvements**
6.1	Raise Mockes Dam to increase storage capacity
6.2	Increase Maselspoort WTW capacity to 130 Ml/d
6.3	Planned indirect re-use from Bloem Spruit WWTW (±16 million m^3/a)
6.4	Planned direct re-use from Bloem Spruit WWTW (±11 million m^3/a)
Cluster 7	**Gariep to Greater Bloemfontein Transfer**
7.1	Pump station and pipeline from Gariep Dam to Bloemfontein Phase 1
7.2	Pump station and pipeline from Gariep Dam to Bloemfontein Phase 2
Cluster 8	**Neckartal Dam Scheme (Dam has been completed)**
8.1	Neckartal irrigation scheme development and water requirement
8.2	Neckartal Dam hydro-power generation and related releases
Cluster 9	**Integrated Water management actions**
9.1	Removal of unlawful irrigation
9.2	WC/WDM Irrigation
9.3	WC/WDM Urban and Industrial
9.4	Increase permit licence coverage
9.5	Improve assessments of aquifers (storage capacities, recharge rates, sustainable yields and other characteristics)
9.6	Manage Salinity
9.7	Manage eutrophication
9.8	Manage and control of alien and invasive species and problem pests
9.9	Set water quality objectives/standards
9.10	Identify priority water needs to support economic development at basin level
9.11	Set out guidelines and procedures to improve equitable utilisation and benefit-sharing at the basin level
9.12	Harmonize policy, legal and institutional frameworks

Each cluster is discussed in more detail under sections 3 to 11. Please take note that this study started in August 2018. The water resource planning analysis carried out shortly thereafter used the applicable implementation dates and sequence of the intervention options as available at the time. Some of these dates have since changed. It is important that the dates used in planning scenarios agree with those used in the economic analysis. For that reason, the updated dates were not used in the economic analysis. Greater detail of each scheme is contained in individual planning reports which are referenced at the end of this report (RASECOM, 2019a, 2019b, 2019c, 2019d, 2020a).

3 CLUSTER 1: ORANGE RIVER PROJECT (ORP) SCHEME FUTURE IMPROVEMENTS

This cluster mainly comprises intervention options to improve the ORP water balance as well as the Polihali-Vaal Water Transfer, which was used to support the IVRS, but significantly reduced the yield available from the ORP. These intervention options or projects included the following:

- Utilize the lower-level storage in Vanderkloof Dam;
- Real-Time flow modelling and monitoring in the Lower Vaal River catchment, downstream of the Bloemhof Dam and in the Orange River catchment downstream of the Vanderkloof Dam to the Orange River Mouth;
- Building of the Verbeeldingskraal Dam upstream of Gariep Dam;
- A study to formally agree on the Orange River EWRs (Reserve) and implement the related releases (River mouth of high importance);
- Noordoewer/Vioolsdrift Dam;
- Polihali Dam (Lesotho Highland Water project (LHWP) Phase ll and connecting tunnel to Katse Dam, possibly using the revised operating rule, which is still to be agreed.

3.1 Utilize the lower-level storage in Vanderkloof Dam

Vanderkloof Dam is an existing dam with its current minimum operating level (m.o.l.) at about 40 m above the riverbed level, which equates to a dead storage capacity of 1 015 million m^3. This high m.o.l. was fixed by the outlet into the Vanderkloof main canal for irrigation supply purposes as well as the outlets used for hydro-power generation by Eskom. This m.o.l. could be lowered to reduce the dead storage capacity to 165 million m^3. The impact of sedimentation on the reduced dead storage capacity in Vanderkloof Dam is minimal as most of the sediment is captured in Gariep Dam. The estimated reduction in storage in Vanderkloof Dam by 2040 due to sedimentation is only 40 million m^3(ORASECOM,2014). That would increase the live storage from the current 2 173 million m^3 to 3 023 million m^3, with the gross storage of the dam being 3 188 million m^3. The location of the Vanderkloof Dam is shown in **Figure 4-1**.

By utilizing that additional live storage, the historic firm yield from Vanderkloof Dam could be increased by 137 million m^3/a. For that option, it would be required to install a pumping system with 15 m^3/s capacity, in order to lift the water from the dam into the Vanderkloof Main Canal. The capital cost of such a modification is estimated at R180 million and the cost of operating the dam is estimated to increase by about R10 million per annum based on 2018 prices.

This intervention would also result in a loss of power generated specifically during severe drought periods when the water level in Vanderkloof Dam drops below the current m.o.l. The quantification of the loss of generated power was complex and depended on the volume of water released to supply downstream water requirements, as well as the water level in the dam. The water level in the dam is further highly dependent on the operating rule used.

Based on the analysis and related results carried out in the Orange River Reconciliation Strategy Study (DWS, 2015) it was stated that the economic benefits or disbenefits on the effect of hydro-power generation for the option were considered too uncertain to be estimated as part of the Reconciliation Strategy Study, but it was not expected to be significant. The Reconciliation Strategy Study, therefore, recommended that during the pre-feasibility study of this component, Eskom should be part of the evaluation and recommendations relating to this component. Eskom is fully aware of this option and participated in the Orange Reconciliation Strategy Study. A section in the final Reconciliation Strategy was also added by Eskom, addressing this option.

This is a quick win project in that construction can commence almost immediately (2020). For the purpose of this study 2018 was taken as the implementation date for this option. In reality, this option will most probably only be implemented once a severe drought is experienced with expected low water levels in Vanderkloof Dam. It is thus foreseen that this option will only be put in place after the construction of Vioolsdrift or Verbeeldingskraal dams, which will also influence the operating rules to be used.

Users supplied with water via the Vanderkloof Main canal mainly include irrigation along the Orange-Riet and Ramah canals, as well as the supply to some small towns such as Koffiefontein, Richie and Jacobsdal via the Orange Riet Canal. A total of about 260 million m^3/a is transferred through the Orange Riet canal of which 5.5 million m^3/a is for urban use at the 2018 development level. The irrigation requirement from the Ramah canal is given as almost 56 million m^3/a at the 2018 development level.

Releases directly into the river from the Vanderkloof Dam via the hydro-power turbines or via sluicegates (mainly when the water level in the dam is very low) amount to approximately 2 209 million m^3/a at the 2018 development level. This water is mainly used for irrigation purposes but also supplies water to towns and mines (about 100 million m^3/a) along the Orange River from Vanderkloof Dam to the River mouth, as well as for the environmental water requirements along the river and at the River mouth.

3.2 Real-Time flow modelling and monitoring in the Lower Vaal River downstream of Bloemhof Dam and in the Orange River downstream of Vanderkloof Dam to the Orange River mouth

Real-time modelling and monitoring are a management tool, that combined with operations rules, will provide data for better and more timeous decision-making regarding the management of the releases from the Gariep Dam and especially from the Vanderkloof Dam, to determine when, and to what extent releases need to be made to supply all the users downstream of the Vanderkloof Dam to the river mouth, over a distance of approximately 1300 km, also taking into account possible spills from the Vaal River.

The initiation of real-time modelling will require a capital expenditure of approximately R6 million and an annual operation cost of approximately R1 million.

It is estimated that real-time modelling together with appropriate operating rules could increase the availability of water by approximately 80 million m^3/a. Real-time modelling could commence almost immediately (2020/21). This option is already behind schedule based on the recommendations from the Orange Reconciliation Strategy study (DWS, 2015) that proposed 2016 as the year to activate this option. The area to be controlled by real-time modelling and monitoring is shown in **Figure 4-1**.

3.3 Building of the Verbeeldingskraal Dam upstream of the Gariep Dam

The Verbeeldingskraal Dam is a proposed new dam to be built upstream of the Gariep Dam in the Orange River, located wholly in South Africa as recommended by the Orange Reconciliation Strategy study (DWS, 2015). There is however the possibility, if agreed with Lesotho, that the dam can be built higher which will then inundate some area in Lesotho. This will have the advantage of a larger storage capacity and increased yield available from the dam.

The dam is located in the Orange River just upstream of the Aliwal North Town, as indicated in **Figure 4-1.**

As recommended in the Orange Reconciliation Strategy study (if not inundating part of Lesotho) the dam will have a maximum wall height of 67 m at full supply level and storage of 1 363 million m^3. The dam will increase the net yield of the system by 200 million m^3/a. The purpose of this dam is to augment the ORP to be able to supply the final agreed EWR or ecological Reserve, increasing urban and mining demands, as well as to restore the ORP water balance impacted by some of the negative yield impacts on the ORP at the time when the Polihali Dam and its transfer system to support the IVRS, is in place. The water will be held back as long as possible before it is released to the Gariep Dam so that the high evaporation losses from the Gariep Dam can be reduced.

The construction cost of the dam is estimated at R4.0 billion and the annual operating cost at R12 million at 2018 prices.

Construction is scheduled to commence in 2027 and be completed in 2031.

3.4 Orange River Agreed EWR's (Ecological RESERVE)

The most recent and current EWRs from an environmental point of view were already determined in various previous studies as follows:

- Determination of Ecological Water Requirements for surface water (river, estuaries and wetlands) and groundwater in the Lower Orange WMA. (Client: DWS). 2015 – 2017
- Orange-Senqu Strategic Action Programme. Research project on environmental flow requirements of the fish river and the Orange-Senqu River mouth: Study manager and EFR specialist. (Client: ORASECOM). 2011 - 2013
- Support to Phase 2 of the ORASECOM Basin Wide Integrated Water Resources Management Plan: EFR study leader and specialist. (Client: ORASECOM). 2009 – 2011

These studies were undertaken by the same specialists and culminated in the EWR study finalised during 2017 which resulted in the EWRs being signed off (July 2018) as the Preliminary Reserve for the Lower Orange River. Operating scenarios which included the present-day situation and future options (for the Orange System as a whole) were evaluated to determine the impact on the yield and to attempt to optimize the yield and minimize ecological damage. The recommended operating scenario included revised operating rules in conjunction with non-flow related interventions and formed the basis of the legally binding Preliminary Reserve. Once the National Water Resources Classification System has been undertaken for the Orange Reserve, this Preliminary Reserve will be refined (if necessary) and then signed off as the Reserve. A stakeholder engagement study (not required by the law) formed part of the Preliminary Reserve assessment for the Lower Orange. During the future Classification study, extensive stakeholder engagement and public participation are required. The focus during the classification study will be to find a balance between achieving the desired ecological state (as the Target Ecological Category) and the impact on the economy of the region.

A Preliminary Reserve study for the Upper Orange System has currently (2021) been initiated. The main focus of this study will be to address the EWRs in some of the tributaries not previously assessed and on groundwater issues amongst others as the main river options are limited and have been included in the Preliminary Reserve for the Lower Orange. Any scenarios to manage the most ecological important sections of the river (river downstream of Upington and the estuary, a Ramsar Site) involve the operation of the system as a whole.

The old & outdated estuary environmental water requirements determined as part of the Orange River Replanning Study (DWAF, 1996) are currently still released (287.5 million m^3/a) from Vanderkloof Dam. It must be noted that this release is not achieving the environmental objectives, mostly as it includes water that is released un-seasonally for irrigation and other purposes as well as increasing flows to the estuary and river in certain months where there is currently too much flow (in terms of ecological water requirements) in the river. It is also uncertain whether any of the non-flow related interventions have been implemented as some of those would be the responsibility of other departments such as the Department of Environmental Affairs

The Preliminary Reserve does not impact negatively on the current ORP system yield. The Preliminary Reserve represents an average of ±533 million m^3/a compared to the historical EWR which represent an average of ± 942 million m^3/a and significantly reduced the yield available from the resources (Gariep and Vanderkloof dams).

The Reserve (agreed on during a future Classification study) could significantly impact on the selection of future dam sizes and combinations of dams to be built such as Noordoewer /Vioolsdrift Dam, Verbeeldingskraal Dam and to a lesser extent (as these dams affect only a small portion of the total runoff), also the dams to be built in Lesotho such as the Makhaleng Dam and the other Lesotho Lowlands dams.

The cost of a National Water Resources Classification and Resource Quality Objectives study as well the current Preliminary Reserve study for the Upper Orange System combined can be in the order of R16 to 20 million. This estimate considers that a comprehensive assessment of the Preliminary Reserve will have been undertaken. However, the implications of the international sharing of the river on the study costs are unknown as no Classification study has to date been undertaken that considered the international implications.

3.5 Noordoewer/Vioolsdrift Dam (NVD)

The Noordoewer/Vioolsdrift Dam is a proposed new dam that will be built in the Lower Orange River across the border of South Africa and Namibia. This dam will be a combined Namibia/RSA project to increase the ORP yield, reduce the current high system operating requirements, and control EWR releases, mainly for the Orange River mouth.

The location of the dam is shown in **Figure 4-1.** The final dam size is still to be determined. Indications from the recently completed Noordoewer/Vioolsdrift study are that it will most probably be a medium size dam (capacity anywhere between 470 million m^3 and 2 800 million m^3), since a large dam may result in unmanageable negative impacts on the downstream environment. For this study, a wall height of 41 m at full supply level and a storage of 650 million m^3 was selected for analysis purposes.

The dam will re-regulate water to the Orange River mouth and provide water for the EWRs, irrigators, mining and urban users downstream of the dam. This will reduce the load on the Gariep and the Vanderkloof dams. The dam is estimated to provide a net yield of 280 million m^3/a. The Noordoewer/Vioolsdrift Dam can be used to restore the ORP water balance due to a reduction in the ORP yield of 284 million m^3/a, as a result of the Polihali Dam (see **Section 3.**5). In reality, however, it is expected that the Vioolsdrift Dam yield will also be used to supply water to new additional irrigation developments in Namibia downstream of the dam, although it might still contribute to part of the ORP yield loss replacement. Two options for the NVD were thus considered.

- One where the NVD is purely used as a yield replacement dam to restore the water balance, due to the negative impact of the Polihali Dam on the ORP yield.
- Secondly when NVD is used as a new resource, using its net yield mainly to support existing and new users.

The capital cost of the dam is estimated at R4.4 billion and the annual operating cost at R13 million.

Construction is scheduled to commence in 2025, with an estimated completion date of 2028.

3.6 Development of 12 000 ha for resource-poor farmers in the RSA from the ORP

Based on results from the Orange River Replanning Study (DWAF, 1996), it was decided by DWAF RSA that the surplus yield from the ORP available at the time, will be allocated to the future development of resource-poor farmers. This process already started about 10 years or more ago and is still ongoing. These developments will be supplied from existing infrastructure. The 12 000 ha proposed development was split between the Free State, Northern Cape and Eastern Cape (see **Figure 3-1**), as summarized below:

- Free State = 3 000 ha of which 837.6 ha has already been developed;
- Northern Cape = 4 000 ha of which 1671 ha has been developed; and
- Eastern Cape = 5 000 ha of which 2460 ha have been developed.

As this development is already in process for several years, it was not included in the investment plan as part of the economic evaluations but was included only for modelling purposes.

3.7 Polihali Dam (Lesotho Highlands Water Project (LHWP) Phase II and connecting tunnel to Katse Dam; using new operating rule

The Polihali Dam is to be constructed as the main component of Phase II of the Lesotho Highlands Water Project. The location of the Polihali Dam is shown in **Figure 4-1.**

The dam will have a wall height of 150 m at full supply level and storage of 2 322 million m^3, making it the largest storage dam of the three LHWP dams, with Katse at 1 950 million m^3 and Mohale Dam at 947 million m^3.

The primary purpose of the Polihali Dam is to augment the Vaal River System and to generate additional hydroelectricity for Lesotho, mainly through the Muela turbines.

The gross yield from the Polihali Dam was determined as 391 million m^3/a, with the net yield contribution to the Orange /Senqu River system estimated at 107 million m^3/a. The Polihali Dam has a severe impact on the downstream ORP and is reducing the ORP yield by about 284 million m^3/a.

The capital cost of the Polihali Dam and the transfer tunnel is estimated at R31,137million and the annual operating cost at R96 million.

Construction is scheduled to commence in 2020 with an estimated completion date of 2025.

4 CLUSTER 2: L-BWT SCHEME

The proposed Lesotho-Botswana Water Transfer Scheme comprises the Makhaleng Dam and the L-BWT transfer pipeline supplying areas in Lesotho, South Africa and Gaborone/Lobatse, in Botswana. In Lesotho water will also be released directly from the Makhaleng Dam for new irrigation developments, as well as for local urban/domestic water supply through a separate pipeline.

The location of the Makhaleng Dam and the route of the transfer pipeline is shown in **Figure 4-1.**

Key information based on the results from the L-BWT Scheme Pre-feasibility Phase II for this transfer Scheme includes the following:

- The dam will have a wall height of about 126 m at full supply level and storage of 1 133 million m^3 (3 MAR dam).
- The gross yield from a 3 MAR Makhaleng Dam at the N1A site was determined as 334 million m^3/a. Utilizing this gross yield in full for the Lesotho-Botswana transfer system would result in a decrease in the downstream system yield by approximately 200 million m^3/a which would need to be compensated for. It was recommended that a separate Reconcilliation Strategy type of study must be initiated to look at the inballance in the Upper Orange and Senqu catchments due to all the future developmenst such as Makhaleng, Polihali, Lesotho Lowland dams etc. It was assumed that the gross yield from Makhaleng Dam will be available for the L-BWT Scheme including developments within Lesotho and also possible other developments within the RSA.
- The capital cost of the dam is estimated at R4.1 billion and the annual operating cost at R20 million for the Arch dam option.
- The capital cost of the pipeline is estimated at R48 billion and the annual operating and pumping cost at the full supply capacity of the transfer system at R838 million/a.
- Construction is scheduled to commence in 2025 with a completion date of the dam estimated to be 2030, and the pipeline commencing at around the same time but possibly completing about three years later i.e. in 2033.

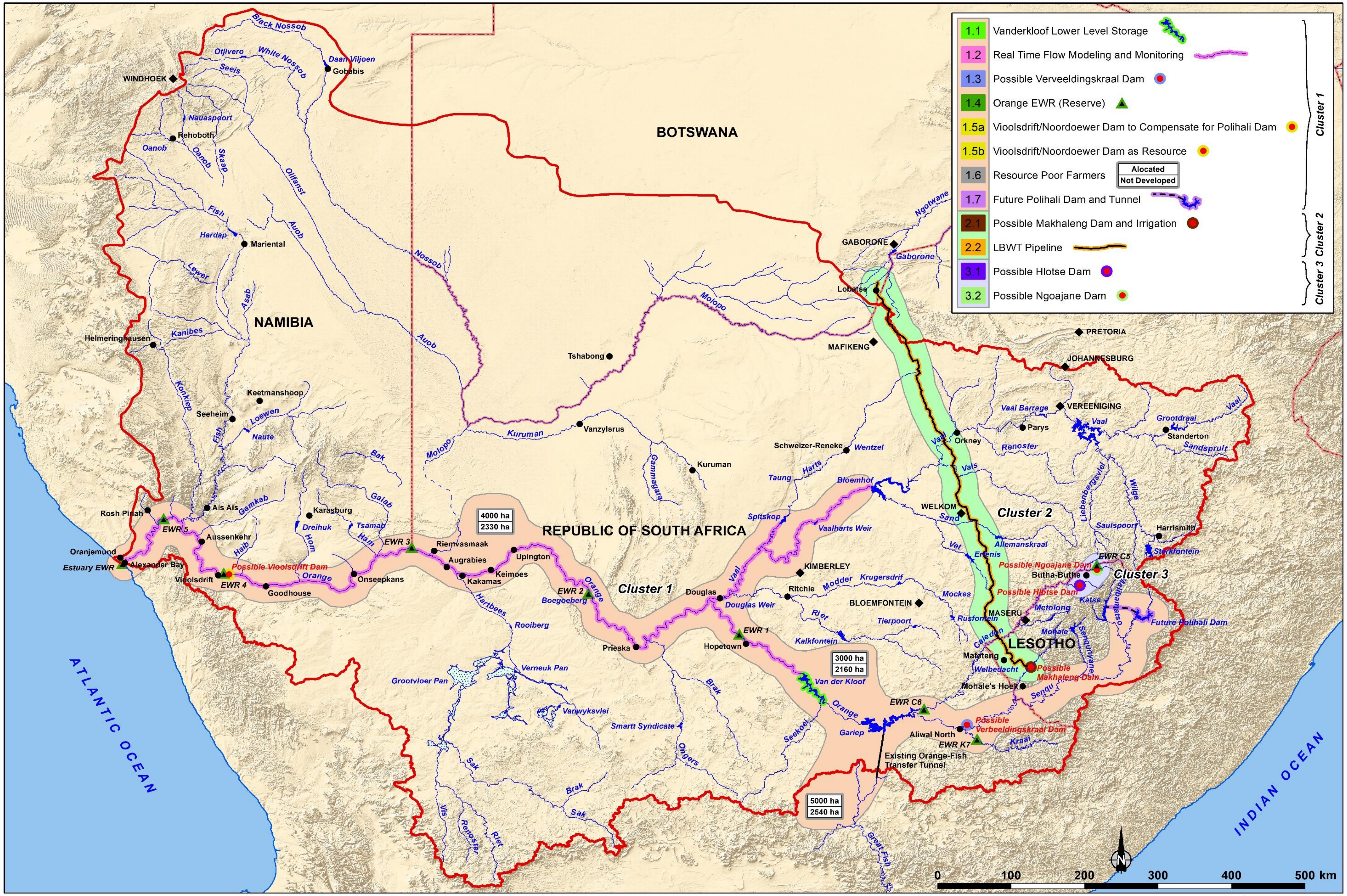

Figure 4-1: Future Development Clusters 1, 2 and 3

While dependent on the final agreed water allocations, it is currently foreseen that the dam and the pipeline will supply users in the different countries as follows:

- Directly from dam:

  Lesotho for irrigation purposes - 0 to 78 million m^3/a, still depending on the final agreed water allocations and can be higher for specific options.

- Dam via main transfer Pipeline:
  - Lesotho urban ±22 million m^3/a;
  - RSA urban ±20 million m^3/a; and
  - Botswana urban 156 million m^3/a.

5 CLUSTER 3: LESOTHO LOWLANDS

The Lesotho Lowlands Cluster comprises two proposed dams, supplying urban/rural demands and irrigation developments within Lesotho, namely:

- Hlotse Dam; and
- Ngoajane Dam.

The location of the dams is shown in **Figure 4-1.**

5.1 Hlotse Dam

The Hlotse Dam is located in the Hlotse River, a tributary of the Mohokare/Caledon River with an expected total demand of 66.3 million m^3/a to be imposed on the dam by 2050. This demand includes the urban/rural (about 30%) and irrigation developments (about 70%). The Hlotse Dam has a gross storage of 105 million m^3 and a wall height of about 51 m at full supply level with an estimated net yield of 54 million m^3/a (gross yield 85 million m^3/a). The large difference between the net and gross yield is due to the significant reduction in supply to existing downstream users when the Hlotse Dam is introduced. This means that some of the yield generated by the dam needs to be released to mitigate the loss of the existing system yield for the existing downstream users.

The construction cost is estimated at R884 million and the operating annual cost at R3 million at 2018 development level costs.

Construction of the dam is estimated to commence in 2026, and it is expected to be completed by 2030.

5.2 Ngoajane Dam

The Ngoajane Dam is located just north of Hlotse Dam in the Hololo River a tributary of the larger Mohokare/Caledon River. The dam will be used to mainly supply urban/rural water requirements (80%) and some irrigation with a total combined water requirement estimated at 29 million m^3/a, by 2050. The gross storage of the dam is 36 million m^3/a with a wall height of 47.5 m at the full supply level. The net yield of the system is estimated as 10.6 million m^3/a, with a gross yield of 30.8 million m^3/a. As in the case of the Hlotse Dam, the large difference in the gross and net yield is a result of the significant reduction of existing system yield for existing downstream users.

The construction cost is estimated at R497 million and the annual operating cost at R3 million/a.

Construction of Ngoajane Dam is estimated to commence in 2030 and is estimated to be completed in 2034.

6 CLUSTER 4: IVRS INTERVENTION OPTIONS

The Vaal River System Intervention Options comprises:

- Further phases of the transfer from the Thukela River;
- Utilising the Crocodile River Return Flows in Tshwane (Pretoria) to reduce the demand from the Vaal River via the Rand Water Board supply system; and
- Desalination and re-use of mine water effluent.

6.1 Further Phases of Thukela River Water Transfer

The proposed further phases of the Thukela River Water Transfer comprise two new dams at Jana on the main stem of the Thukela River and the Mielietuin Dam on the Bushmans River (a tributary of the Thukela River) with new pipelines and pump stations linking these dams to the existing Thukela Water Transfer Scheme.

The proposed further phases will increase the yield of the Vaal River system, by approximately 522 million m^3/a. This represents the net yield from the two dams after provisions were made for required yield loss mitigation releases for existing downstream users.

The location of the dam and the transfer pipeline is shown in **Figure 6-2.**

Key information on this water transfer scheme includes:

- The Jana Dam with the net yield of 396 million m^3/a and the Mielietuin Dam with the net yield of 126 million m^3/a;
- The Jana Dam with a gross storage of 2 652 million m^3 and the Mielietuin Dam with a gross storage of 467 million m^3;
- The dam wall height at full supply level for the Jana Dam is 186 m and for the Mielietuin Dam is 95 m;
- The total pumping head is high at about 580 m, requiring substantial electrical energy;
- The construction cost for the total scheme is estimated at R22 492million and the annual operations cost at R172 million/a, at the 2018 development level; and
- Construction of the further phases is scheduled to commence in 2032 and it is estimated to be completed by 2036.

6.2 Crocodile River Return Flows

The Vaal River System Reconciliation Strategy (DWAF, 2009) identified the re-use of return flows in the Upper Crocodile (West) River as one of the important intervention options for the

IVRS. These return flows are generated from the Vaal River water, transferred over the water shed from the Vaal River Catchment into the Upper Crocodile River Catchment by Rand Water, to supply water to urban and industrial areas within the Northern Gauteng Province. By re-using these return flows, the demand of the Northern Gauteng area, of which most is supplied from the IVRS, will be reduced.

This strategy was further taken up in the City of Tshwane Water Resource Masterplan (Tshwane, 2014). The City of Tshwane Metropolitan Municipality (MM) is planning a re-use plant at Rietvlei Dam with a capacity of 100 Mℓ/d. Water transferred from the Olifants WWTW will also be treated at the Rietvlei Plant. The second re-use plant of 50 Mℓ/d is planned at the Roodeplaat Dam, utilizing water from the Zeekoegat WWTW extension, which is flowing into the Roodeplaat Dam. These two treatment plants will further treat the Tshwane return flows to a potable standard to re-use that water in the Tshwane Municipality. The locations of these treatment plants are shown in **Figure 6-2**. Key information on the re-use schemes includes the following:

- The potential savings in Tshwane's demand supplied from the Vaal River System is estimated to be in the order of 56 million m^3/a, as a result of the re-use;
- The capital cost to implement this further treatment capacity is estimated at R1 474 million, at the 2018 price level;
- The annual operation costs are estimated to be R127 million/a (2018); and
- This intervention option is expected to be in place by 2025.

6.3 Desalination and re-use of mine water effluent

The desalination and re-use of acid mine drainage (AMD) were listed as one of the most important intervention options from the Vaal River System Reconciliation Strategy (DWAF, 2009) as it significantly improves both water quality and water quantity. The implementation of this intervention option is forming part of the continuation of the IVRS Reconciliation Strategy Phase 2 (DWS, 2018).

In the IVRS, the desalination of AMD will ensure a reduction in the release of water from the Vaal Dam for dilution purposes; it will also reduce demand through reclamation and direct re-use, as well as improve the salinity levels in the Vaal River system, and the Orange-Senqu River Basin, by eliminating or substantially reducing the discharge of saline AMD.

The AMD mainly occurs in the Middle Vaal catchment downstream of the Vaal Dam (see **Figures 6-2 and 6-1).** The Short-Term Intervention (STI) of the project is currently maintained.

The STI consists of pumping and treatment infrastructure which reduces the concentration of metals and neutralizes the acidity before releasing the water into the natural water courses.

The pumping and treatment processes introduced through the immediate and short-term solution only neutralize AMD's high acidity and address the metals (notably iron) carried in the water. In the medium, to long term, the option of neutralizing will not be sustainable, as it could result in excessive salt loads in the surface water of the receiving catchments. For the long-term, the desalination and selling the pumped mine water to users should be investigated. During 2014/15 the proposed long-term solution for AMD was put on hold due to further requested investigations. In April 2019 a detailed dilution assessment was undertaken as part of the investigation for the pre-feasibility study on the long-term solutions for the AMD problem. The results from the investigation recommended a full recalibration of the Vaal Barrage catchment hydrology and water quality modules before proceeding with the implementation of the Long-term Solution. The water quality recalibration study has not yet been initiated and details on what the Long-term solution would entail is thus not yet available.

The long-term solution work was estimated to start in 2021 with full implementation by 2025. These dates will change depending on the findings from the proposed recalibration study.

Figure 6-1: AMD regions (TCTA, 2017)

Initial estimations indicated a positive quantity contribution to the IVRS of 500 million m^3/a. Current indications are that this might be less. RSA DWS is in the process to carry out further detailed studies in this regard, and a final updated quantity contribution is thus not yet available.

The design capacity for the present short-term solution and recent performance of the plants (TCTA, 2018) are shown in **Table 6-1**.

Table 6-1: Performance of the AMD treatment plants in 2017/2018

Description	Western Basin	Central Basin	Eastern Basin
Design Capacity	40 Ml/day	84 Ml/day	110 Ml/day
Average Treated Volume	34.06 Ml/day	58.15 Ml/day	70.85 Ml/day

This is an expensive intervention option with total capital expenditure at 2018 price levels estimated at R8,8 billion and operational costs at R1.3 billion/a.

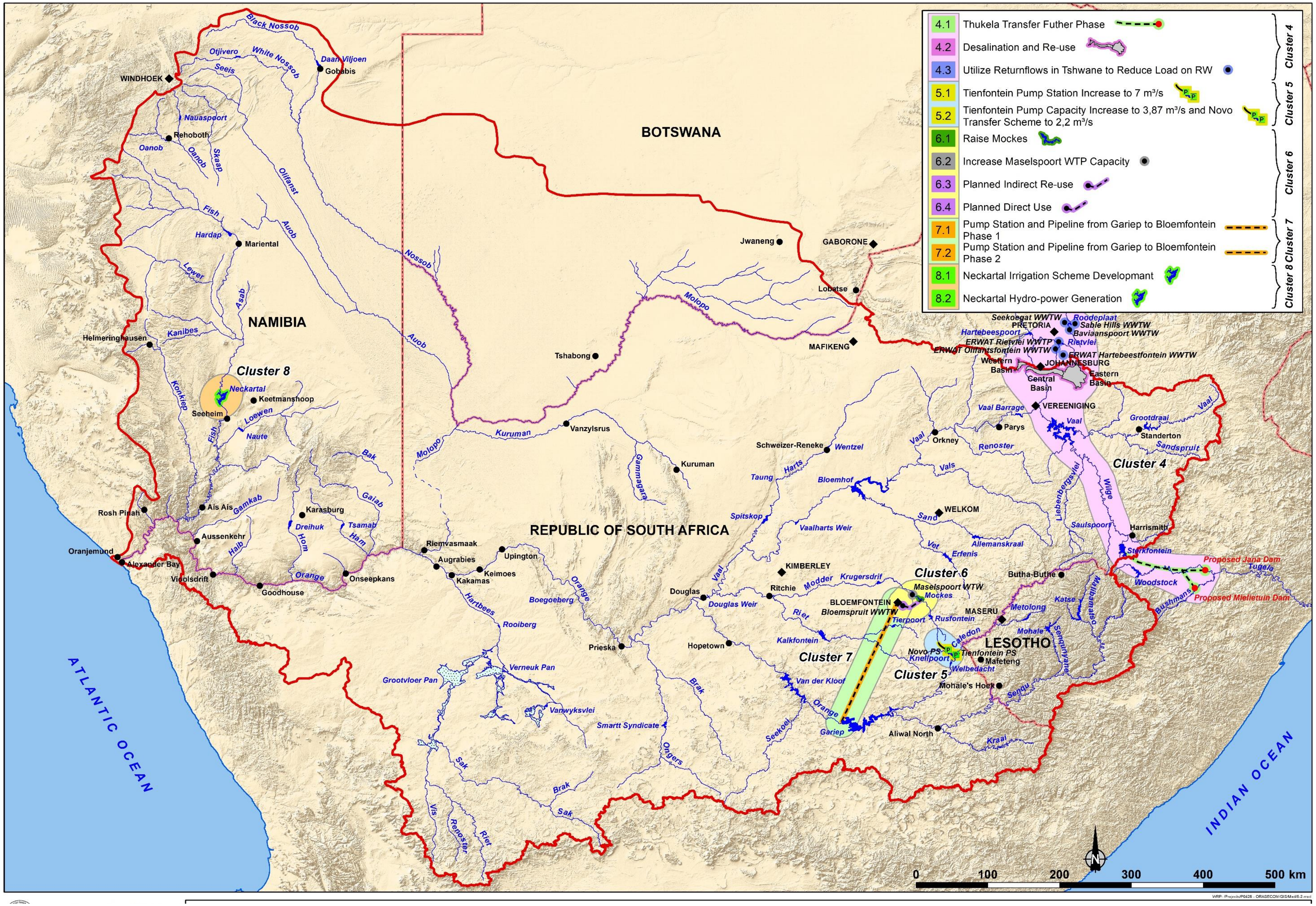

Figure 6-2: Future development Clusters 4, 5, 6, 7 and 8

7 CLUSTER 5: CALEDON TO GREATER BLOEMFONTEIN TRANSFER

The Greater Bloemfontein Water Supply system is currently supplied from the following two main resources.

- The Caledon River: Two abstraction points are utilized in the Caledon/Mohokare River, the upstream one at Tienfontein pump station, where water is pumped directly from the Caledon River into the Knellpoort Dam, an off-channel storage dam. The second abstraction point is from Welbedacht Dam in the Caledon River, downstream of Tienfontein pump station. Water is then treated at the Welbedacht WTP and from there pumped to Bloemfontein and other small towns.
- The Modder River: Water is supplied from three storage dams, Groothoek Dam, Mockes Dam and Rustfontein Dam. The Rustfontein Dam is by far the largest storage dam in the Modder River part of the water supply system, and also receives support from the Knellpoort Dam in the Caledon River Catchment.

One of the main augmentation options for the Greater Bloemfontein Water Supply system (DWS, 2012) is to transfer water from the Gariep Dam to Bloemfontein, via a pipeline and pump stations.

Cluster 5 considers the future intervention options from the Caledon/Mohokare River. **Cluster 6** focuses on the internal water supply system and resources located in the Modder River catchment, with **Cluster 7** addressing the future transfer from the Gariep Dam to the Geater Bloemfontein water supply scheme.

The location of the overall scheme is shown in **Figure 6-2** with detail given in **Figure 7-1.**

The intervention options (Cluster 5) to increase the water supply from the Caledon/Mohokare River include the following:

- Increase the total pump capacity at the Tienfontein Pump Station to 3.87 m^3/s. Simultaneously increase the Novo transfer capacity to 2.2 m^3/s. The Tienfontein pump station mainly abstracts water during the summer months, because the flow rate in the river is in general too low in the winter months to pump. The Novo transfer system is used to transfer water from the Knellpoort Dam to the Rustfontein Dam. These capacity increases are expected to be in full operation in 2019/20.
- Increase the total pump capacity at Tienfontein pump station to 7 m^3/s by 2040.

The first intervention option is in place with the pump capacities at both pump stations already increased to the required capacities. The upgrading of the Eskom power line has recently been completed. From 2021 onwards both pump stations will be able to utilize the full increased pump capacities simultaneously as sufficient power supply is now available from the Eskom grid.

Other key information on the Caledon transfer schemes include:

- Increasing the Tienfontein pump station capacity to 3.87 m^3/s and the Novo transfer capacity to 2.2 m^3/s.
    - This option has already been constructed.
    - This option is expected to increase the system yield by 4.4 million m^3/a;
- Increasing the Tienfontein pump station capacity to 7 m^3/s;
    - This option is expected to increase the system yield by 13.7 million m^3/a;
    - The capital cost for this option is estimated at R180 million (2018);
    - The operational cost is estimated at R7 million/a (2018)

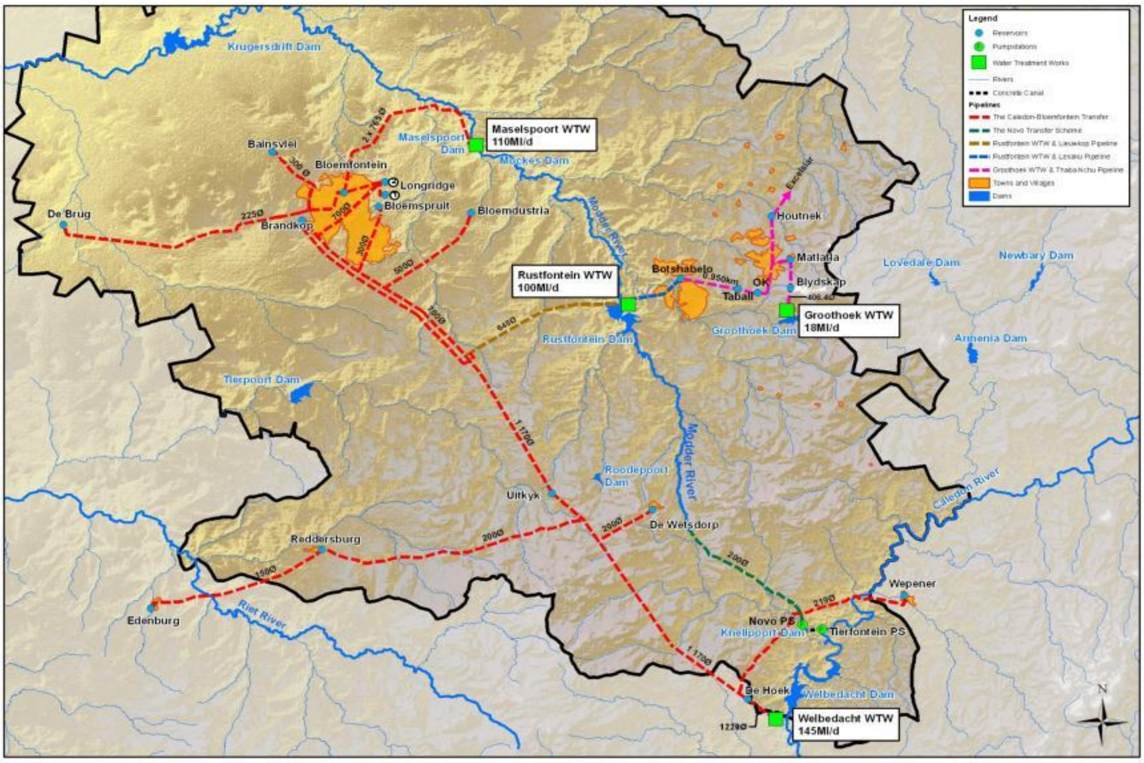

Figure 7-1: Greater Bloemfontein current water supply system

8 CLUSTER 6: GREATER BLOEMFONTEIN INTERNAL RESOURCE IMPROVEMENTS

As described under Cluster 5, **Section 7**, Cluster 6 will focus on the internal system and resources located in the Modder River Catchment (see **Figures 6-2 & 7-1**). Most of these options were recommendations from the Mangaung Gariep Augmentation Project (Mangaung, 2018), although there is a lot of similarities with those recommended from the Greater Bloemfontein Reconciliation Strategy (DWS, 2012). Several components form part of Cluster 6 and include the following:

- Raise Mockes Dam – This component is included mainly to capture and store return flows for indirect re-use purposes, and to minimise spills from the dam. The yield benefit from the raising of the Mockes Dam on its own is very small.
- Increase the Maselspoort WTW capacity to 130 Mℓ/d to be able to accommodate the increased volumes due to indirect re-use. This will include the upgrading of the plant to treat the lower water quality from the re-use return flows, to potable standards.
- Indirect re-use of 16 million m^3/a from the Bloemspruit WWTW to be captured in Mockes Dam.
- Direct re-use of 11 million m^3/a to be fed directly into the water supply system at the Maselspoort WTW downstream of the Mockes Dam.

Other key information on the internal resource improvements include:

- The total system yield is increased by 30 million m^3/a due to the combination of all improvements;
- The total capital cost for all components combined is R 1 638 million;
- The combined operational cost for all components was estimated at R 174 million/a;
- The different components within Cluster 6 are activated at different times as indicated below;
    - Raising of the Mockes Dam – Start 2021 and completed in 2023;
    - Increase the Maselspoort WTW capacity – Start in 2019 and complete in 2021;
    - Indirect re-use of 16 million m^3/a – Start in 2019 and complete in 2021;
    - Direct re-use of 11 million m^3/a – Start in 2028 and complete in 2030.

9 CLUSTER 7: GARIEP TO GREATER BLOEMFONTEIN TRANSFER

As described under Cluster 5, **Section 7**, Cluster 7 will focus on the future transfer from the existing Gariep Dam to the Greater Bloemfontein Water Supply system. This option was recommended from both studies, the Greater Bloemfontein Reconciliation Strategy (DWS, 2012) and the Mangaung Gariep Augmentation Project (Mangaung, 2018). However, DWS has advised that that the best option from a national perspective must still be confirmed through an independent study that is soon to be commissioned by DWS.

There are several possible route options for the transfer pipeline from Gariep Dam. For the purpose of this report, only one of the pipeline route options was selected, namely the clear water pipeline from Gariep Dam to a point near Bloemfontein. Based on the latter study, the transfer scheme will be constructed in two phases:

- Phase 1: Transfer capacity of 32 million m^3/a by means of a pump station and pipeline;
- Phase 2: Inclusion of a booster pump station increasing the transfer capacity by another 11 million m^3/a, to a total transfer capacity of 43 million m^3/a.

The location of the proposed transfer scheme is shown in **Figure 6-2.**

Additional key information on the transfer scheme includes:

- Phase 1 is scheduled to commence construction in 2020 with completion in 2023;
- Phase 2 is scheduled to commence in 2032 with completion in 2034;
- Phase 1 capital cost estimated at R 3 800 million
- Phase 1 operational cost estimated at R 171 million/a
- Phase 2 capital cost estimated at R 500 million
- Phase 2 operational expenditure estimated at R 59 million/a

10 CLUSTER 8: NECKARTAL SCHEME

It is important to note that the construction of the Neckartal Dam located in the lower Fish River in Namibia was recently completed and the dam started to store water already in 2018. For this reason, the cost for this dam was not taken into account in the economic and financial assessments. The location of the dam is shown in **Figure 6-2.**

The main purpose of this dam is to supply water to a new irrigation development. Water will be released from the dam directly into the river and abstracted downstream from a diversion weir into a canal system, used to distribute the water to the irrigators. The releases from the dam into the river will take place via hydro-power turbines, which were already installed.

The planning of the irrigation scheme is currently well behind schedule, and it is expected that irrigation will only start taking place by 2028/2029. The total irrigation requirement was estimated at 90 million m^3/a. Based on the installed turbine capacities the volume that can be released through the turbines was determined as 100 million m^3/a. The difference of 10 million m^3/a will most probably be used to support the EWR downstream of the diversion weir.

In the meantime, water is expected to be released for power generation purposes from Neckartal Dam. Depending on the amount of losses between the dam and the Orange River mouth (expected to be high) it can be considered to utilize these flows to supply the river mouth environmental requirements or part thereof and thereby reducing the demand on Gariep and Vanderkloof dams. The saved water in the ORP system can then be utilized for other purposes such as the increasing water requirements on the Lower Orange River for Namibia and the RSA. This is an option that should be further investigated.

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Key information relating to the Neckartal Scheme includes the following:

- Gross storage for Neckartal Dam is 823 million m^3;
- The full supply level of the dam above river level is 64.4 m;
- The yield from the dam at 98% assurance is estimated at 108 million m^3/a.
- Installed capacity of the hydro-power turbines is 2.7 MW;
- The average expected energy generation is 796 MWh;
- The planned irrigation scheme to cover approximately 5 000 ha;
- The capital cost for the irrigation scheme was estimated at R500 million;
- The operational costs for the irrigation scheme were estimated at R15 million/a;
- Neckartal hydro-power releases and generation is expected to start in 2021; and
- The Neckartal irrigation scheme construction is estimated to start in 2025 to be completed by around 2028.

11 CLUSTER 9: INTEGRATED WATER MANAGEMENT OPTIONS

The integrated water management options comprise several components which include the following:

- Removal of unlawful irrigation;
- WC/WDM within irrigation schemes;
- WC/WDM in the urban and industrial sectors;
- Increasing the area of water use permit/licence coverage;
- Improve assessments of aquifers (storage capacities, recharge rates, sustainable yields, and other characteristics);
- Manage salinity;
- Manage eutrophication;
- Management and control of alien and invasive species and problem pests;
- Set water quality objectives/standards;
- Consolidation of climate data and extreme event data at basin level;
- Identify priority water needs to support economic development at basin level;
- Set out guidelines and procedures to improve equitable utilisation and benefit-sharing at the basin level; and
- Harmonize policy, legal and institutional frameworks.

The primary integrated water management options are Water Conservation and Water Demand Management (WC/WDM) in the irrigation sector and WC/WDM in the urban and industrial sectors. The reconciliation strategies prepared for the IVRS (DWAF, 2009), the Orange System (DWS, 2015) and the Greater Mangaung (DWA, 2012) Water Supply systems, regarded WC/WDM as a high priority action to significantly reduce water use in these systems and to maintain a positive water balance in future years. In the IVRS Reconciliation Strategy, it was stated that savings from WC/WDM in the irrigation sector will not be available for other water users or water use sectors, but that the savings will be utilized by the existing farmers to extend their irrigation area or to improve their assurance of supply. This is regarded as the benefit and main motivation for irrigators to improve or change their irrigation systems to achieve higher irrigation efficiencies and free up water for further use and increased income. Therefore, this saving will not necessarily result in a reduction in water demand.

The Orange Reconciliation Strategy followed more or less the same approach regarding WC/WDM in the irrigation sector, with the main difference, that some of the savings can in future be used for purposes other than irrigation. The main reason for this is that along the

Orange River fertile soil for irrigation is in some places limited, so that an increase of irrigation will not necessarily take place when more water is made available through WC/WDM. In such cases, the irrigators might be willing to sell some of the water to other users to obtain some benefit for their WC/WDM efforts. For the Orange system, it was estimated that approximately 5% of the current irrigation use can be saved to be utilized by other users. The remainder of the WC/WDM saving in the irrigation sector is expected to be utilized by the existing irrigators to increase their irrigation area. The 5% savings through WC/WDM in the irrigation sector in the Orange system was estimated at 73 million m^3/a. Note however that savings in the irrigation sector can be significantly higher, but only the 5% is regarded to be the volume available for other use or to reduce the total water demand.

The capital expenditure to achieve a 5% saving on the Orange System irrigation demand was estimated at R199 million with the operational expenditure at about R 2 million/a

It is expected that the largest savings from WC/WDM that will lead to a reduced overall water demand will be from the urban and industrial sectors.

Initial combined savings in the urban and industrial sectors due to WC/WDM were estimated at 240 million m^3/a from the different reconciliation strategies. WC/WDM strategies were already implemented in most of these identified areas and it is estimated that by 2018 total savings of approximately 85 million m^3/a were already achieved. Consequently, a further potential saving of 155 million m^3/a can be saved. With more effort, even additional savings can be achieved.

To be able to save the 155 million m^3/a in the urban/industrial sectors through WC/WDM, the expected capital expenditure was estimated at R6 115 million with the operational expenditure at R 1 274 million/a.

12 URV AND COST BENEFIT ANALYSIS OF OPTIONS

A unit reference value (URV) calculation and a Cost-Benefit Analysis of the above investment projects using a discount rate of 8% per annum has been undertaken.

The first economic analysis undertaken is of the Unit Reference Value (URV) of each identified cluster. Unit reference value (URV) is a common measure that provides a ratio of the investment cost of a water intervention relative to the quantity of water supplied. The URV is a widely used criterion for the economic evaluation of water resource development options, especially when competitive options differ in terms of infrastructure composition and operations costs.

This analysis provides insight into the cost per unit of the effectiveness of each cluster in the Core Scenario whereby the effectiveness is the resultant impact of each project intervention on the Basin's water balance. URVs represent the economic cost-effectiveness between water projects and their objective is to provide a unit of comparison across the different schemes in the Updated Core Scenario.

URV calculations are generally used to rank water resource development options that are comparable in that the options serve the same purpose or supply the same area.

It is acknowledged that the different clusters are not comparable and serve different water demand areas, although the projects within a cluster are generally comparable. However, the URV as a single indicator does give the relative cost of each cluster in that it shows that the cluster might be extraordinarily expensive or cheap. The URV can also be used by each basin state as a benchmark against which other internal options that are not considered in the investment plan can be rated.

Sensitivity analyses were also carried out and the results of these are available in the Optimized IWRMP Core Scenario economic approach Report Component I (report No. ORASECOM 009/2019).

The URV calculation encompasses the cumulative present values (PVs) of the capital and operational costs over an estimated period, relative to the cumulative PVs of the quantity of water assured. The following formula was used to determine the URV.

$$URV \frac{PV(capital\ costs)\ +\ PV(operational\ costs)}{PV\ (quantity\ of\ water\ incrementally\ assured)}$$

The assumed review period varies by project type, and the applicable social discount rate used is 8%[2]. The PV of costs is the discounted value of the costs over the project life. The investment cost is the estimated cost of the project at current rates.

The results of the URV analyses are provided in **Table 12.1** below:

Table 12-1: URV Analyses (in economic prices, ZAR 2018) Cluster 1 URV Results

	Discount Rates 8%			Investment Cost	Yield
	URV	PV Costs	PV Water		
Project Name	**R/m³**	**R millions**	**Million m³**	**R millions**	**Million m³**
Cluster 1 Orange River Project Scheme future improvements *	**6.52**	35,869	5,501	39,808	724
Utilise the lower-level storage in Vanderkloof Dam	**0.18**	308	1,676	180	137
Noordoewer/Vioolsdrift Dam used as an individual resource. Medium size dam, 36m dam wall height to spill level and gross storage of 650 million m3	**3.43**	4,217	1,230	4,397	280
Polihali Dam (Lesotho Highland Water project (LHWP) Phase ll and connecting tunnel to Katse Dam; using new operating rule (net yield). Dam wall height to spill level is 150m with gross storage of 2 322 million m³	**28.81**	27,717	962	31,137	107
Gross_Polihali Dam (Lesotho Highland Water project (LHWP) Phase ll and connecting tunnel to Katse Dam; using new operating rule (Based on the gross yield)	**11.31**	27,717	2,452	31,137	391

Note: * - Include Polihali Dam and related net yield.

Table 12-2: Cluster 2 URV Results

	Discount Rates 8%			Investment Cost	Yield
	URV	PV Costs	PV Water		
Project Name	**R/m³**	**R millions**	**Million m³**	**R millions**	**Million m³**
Cluster 2 L-BWT Scheme	**53.17**	54,775	1,030	54,257	162/334
Makhaleng Dam	**3.55**	4,566	1,286	6,006	334
L-BWTS pipeline, transfer pipe to Gaberone/Lobatse	**49.62**	50,210	1,012	48,252	162

[2] Conningarth Economists (2014) A Manual for Cost Benefit Analysis in South Africa with Specific Reference to Water Resource Development. Water Research Commission.

Table 12-3: Cluster 3 URV Results

	Discount Rates			Investment Cost	Yield
	8%				
	URV	PV Costs	PV Water		
Project Name	**R/m³**	**R millions**	**Million m³**	**R millions**	**Million m³**
Cluster 3 Lesotho Lowlands	**1.60**	1,290	806	1,381	65
Hlotse Dam, dam wall height to spill level 51m and gross storage of 105 million m3: Urban/rural demands plus irrigation developments	**1.44**	818	570	884	54
Ngoajane Dam, dam wall height to spill level 47.5m and gross storage of 36 million m3: Urban/rural demands plus irrigation developments	**2.00**	472	236	497	11

Table 12-4: Cluster 4 URV Results

	Discount Rates			Investment Cost	Yield
	8%				
	URV	PV Costs	PV Water		
Project Name	**R/m³**	**R millions**	**Million m³**	**R millions**	**Million m³**
Cluster 4 IVRS intervention options	**6.55**	44,476	6,792	32,739	578
Desalination and re-use of mine water effluent;	**4.97**	20,717	4,172	8,773	500
Utilise Croc Return Flows in Tshwane to reduce the load from Rand Water via Vaal	**4.76**	2,586	544	1,474	56
Thukela transfer further phase	**10.20**	21,172	2,076	22,492	522

Table 12-5: Cluster 5 URV Results

	Discount Rates			Investment Cost	Yield
	8%				
	URV	PV Costs	PV Water		
Project Name	**R/ m³**	**R millions**	**Million m³**	**R millions**	**Million m³**
Cluster 5 Caledon to Greater Bloemfontein transfer	**4.08**	253	62	180	6
Tienfontein pump station capacity increase to 7m³/s;	**4.08**	253	62	180	6

Table 12-6: Cluster 6 URV Results

	Discount Rates			Investment Cost	Yield
	8%				
	URV	PV Costs	PV Water		
Project Name	**R/ m³**	**R millions**	**Million m³**	**R millions**	**Million m³**
Cluster 6 Greater Bloemfontein internal resource improvements	**10.79**	3,592	333	1,638	30

Table 12-7: Cluster 7 URV Results

	Discount Rates 8%			Investment Cost	Yield
	URV	PV Costs	PV Water		
Project Name	**R/ m^3**	**R millions**	**Million m^3**	**R millions**	**Million m^3**
Cluster 7 Gariep to Greater Bloemfontein Transfer	**14.71**	6,582	448	4,300	43
Pump station and pipeline from Gariep Dam to Bloemfontein Phase 1	**16.77**	5,145	323	3,800	32
Pump station and pipeline from Gariep Dam to Bloemfontein Phase 2	**9.36**	1,167	125	500	11

Table 12-8: Cluster 9 URV Results

	Discount Rates 8%			Investment Cost	Yield
	URV	PV Costs	PV Water		
Project Name	**R/ m^3**	**R millions**	**Million m^3**	**R millions**	**Million m^3**
Cluster 9 Integrated Water management options	**9.74**	22,422	2,303	6,314	228
WCDM Irrigation	**0.31**	239	768	199	73
WCDM Urban and Industrial	**14.46**	22,183	1,535	6,115	155

While the URVs have only been determined for WCDM irrigation and WCDM Urban and Industrial, several other Integrated Water Management (IWRM) options have been costed and included in the investment plan (see Cluster 9 in Table 2 of the Executive Summary).

While IWRM options are economically relatively competitive compared to other more traditional options and have reasonable to low URVs they are not always as easy to implement as the traditional water resource development options. This is because IWRM options generally require political will and cooperation from the community, irrigators and the industrial and mining sectors.

IWRM options, such as treating Acid Mine Drainage at source have additional benefits such as limiting the pollution of rivers, which in turn leads to less expensive treatment of water at WTWs and reduced environmental damage.

Although the URV figures vary significantly, it is observed that the interventions which involve large transfer schemes and pipelines – clusters 2 and 7 have the highest URV values, with the L-BWT Scheme being the most expensive.

As noted at the beginning of this section, the URV calculation aims to assess the cost-effectiveness of a particular intervention, by overlaying an intervention's water yield with its associated costs.

Table 12-9: Summary of Clustered Scheme URVs

	Discount Rates			Investment Cost	Yield
	8%				
	URV	PV Costs	PV Water		
Cluster Name	R/m³	R millions	Million m³	R millions	Million m³/a
Cluster 1 Orange River Project Scheme**	6.52	35,869	5,501	39,808	724
Cluster 2 L-BWT Scheme	53.17	54,775	1,030	54,257	162/334
Cluster 3 Lesotho Lowlands	1.60	1,290	806	1,381	65
Cluster 4 IVRS intervention options	6.55	44,476	6,792	32,739	578
Cluster 5 Caledon to Greater Bloemfontein transfer	4.08	253	62	180	6
Cluster 6 Greater Bloemfontein internal resource improvements	10.79	3,592	333	1,638	30
Cluster 7 Gariep to Greater Bloemfontein Transfer	14.71	6,582	448	4,300	43
Cluster 9 Integrated Water management options *	9.74	22,422	2,302	6,314	228

Note: *: Cluster 9 calculations only included the WC/WDM intervention options.

** Cluster 1 Include Polihali Dam and related net yield.

The above URV results provide a broad range of outputs, driven by a number of project-specific design features, which impact on an interventions cost profile and water yield – the two key variables in the URV analysis. The implication of this is that a linear comparison of the URVs across the clusters is quite difficult to establish. In a situation where the assessment is of a similar intervention category (e.g. dams), the URV can serve as a basis for comparison of the relative efficiencies of different interventions.

Cost-Benefit Analysis

A CBA is used to determine the feasibility of a project intervention from a socio-economic perspective, as it is presently designed. It is a framework used to provide an evidence base for the social rationale of the project. A CBA weighs up the overall economic impacts of implementing the various project interventions in the Core Scenario and will therefore provide an indication of whether the project will result in a net cost or benefit to society i.e. whether the project is economically viable. The economic appraisal is conducted from the perspective of the economy to assess whether the clustered schemes would have a net positive socio-economic impact.

The criteria used in the evaluation of the economic model include the following indicators[3]:

Economic Net Present Value (ENPV): is the present value of the project's benefits minus the present value of the project's costs. A positive ENPV indicates a net benefit associated with

[3] Details on the full methodology can be found in the Optimized IWRMP Core Scenario economic approach Report Component I (state report No.).

the project intervention and therefore economic viability and rationale for implementing the intervention.

The formula is shown below:

$$NPV = CF_0 + \frac{CF_1}{(1+r)^1} + \frac{CF_2}{(1+r)^2} + \cdots + \frac{CF_n}{(1+r)^n}$$

Where:

CF_0 – initial investment

CF_1 - CF_n – cash flows over the project period

r – social discount rate

n – number of periods

Benefit/Cost Ratio (BCR): This indicator is the ratio between benefits and costs of the Project. The present value of the project's benefits is divided by the present value of the project's costs. A project is interpreted as economically viable and worth implementing if the BCR is greater than 1; that is, the discounted benefits are greater than the discounted costs.

Economic Internal Rate of Return (EIRR): Relates to the ENPV but it is expressed as a percentage. The EIRR is an indication of a project intervention's rate of return at which the NPV will be zero. For a project to be acceptable, the ERR should be greater than the discount rate.

The key measure in the CBA is the BCR. The interpretation of CBA results is therefore outlined as follows:

- A BCR below 1 implies the project is not economically viable and may require a further assessment of the project's structure/design and/or outputs to enhance its economic benefits;
- A BCR above 1 implies that while the project is deemed to be economically viable.

The Results of the Cost-Benefit Analysis are provided in Table 12.10 below.

Table 12-10: Summary of Cost/Benefit Analysis

Discount rate 8%

	Cluster 1: Orange River Project Scheme future improvements	Cluster 2: L-BWT Scheme	Cluster 3: Lesotho Lowlands	Cluster 4: IVRS intervention options	Cluster 5: Caledon to Greater Bloemfontein transfer	Cluster 6: Greater Bloemfontein internal resource improvements	Cluster 7: Gariep to Greater Bloemfontein Transfer
E-NPV	6,469	-22,994	200	119,783	2,093	6,723	-1,006
E-IRR	10.7%	0.8%	5.0%	13.6%	38.7%	22.6%	1.9%
BCR	2.63	0.46	1.20	3.43	10.92	3.72	0.80
NPV (R millions)							
Total Economic Costs	3,969	42,248	1,008	49,342	211	2,468	5,001
Capital Cost	3,743	37,840	966	37,606	149	1,105	3,312
Operational Cost	227	4,408	42	11,736	62	1,363	1,689
Total Economic Benefits	10,439	19,254	1,208	169,125	2,304	9,191	3,995
Increase in economic activity	5,000	18,483	660	161,889	25	725	747

Urban & Industrial	3,290	5,992	89	161,889	25	725	747
Irrigation	1,089	226	571	-	-	-	-
Mining	620	12,264	-	-	-	-	-
Health benefit	5,439	771	548	7,236	2,279	8,466	3,247

Note: Polihali Dam (Lesotho Highland Water project (LHWP) Phase ll and connecting tunnel to Katse Dam intervention are clustered under the ORP scheme, however, its economic impact is realizable under the IVRS scheme. Therefore, the economic costs and benefits are accounted for under the IVRS scheme

13 INVESTMENT TIMELINE

The proposed investment timeline of the investment plan is summarised in **Figure 13.1** below:

Year	Orange RSA	IVRS RSA	Greater Bloemf RSA	Lesotho	Botswana	Namibia	All Countries
2018	Construction start - vanderkloof Lower Level storage utilisation						
	WCDM Urban and Industrial	WCDM Urban and Industrial	WCDM Urban and Industrial				WCDM Urban and Industrial
2019	Utilise the lower level storage in Vanderkloof Dam		Increase Tienfontein pumping capacity to 3.87 m^3/s Novo Transfer scheme capacity to 2.2 m^3/s; to Rusfontein Dam				
							Control alien invasives
			Start with indirect re-use construction				Increase permit/license coverage
	Preparation work Real time modelling/monotoring		Start with Increase Maselport WTW Capacity to 130 Ml/d				
2020	Real time modelling/monotoring						Harmonise policy,legal, and institutinal frameworks
	WCDM Irrigation	Removal of unlawfull irrigation					Manage salinity
	Construction Gariep Bloemfontein pipeline start - phase 1	Polihali Dam (Lesotho Highland Water project (LHWP) Phase II construction start	Construction Gariep Bloemfontein pipeline start - phase 1	Polihali Dam (Lesotho Highland Water project (LHWP) Phase II construction start			
2021		Desalination and re-use of mine water effluent construction start	Contruction start - Raise Mockes Dam to increase storage capacity			Neckartal Dam hydropower releases	Set out guidelines and procedures to improve equitable utilization and benefit sharing basin level
							Consolidsation of climate data and extreme event data at basin level
			Complete Increase Maselport WTW Capacity to 130 Ml/d				Manage eutrophication
			Planned indirect reuse from the Bloem Spruit WWTW (± 16 million m^3/a); Maselspoort				Improve assessments of aquifers
2022							Identify priority water needs to support economic development at basin level
							Set water quality objective standards
2023			Raise Mockes Dam completed				
	Pump station and pipeline from Gariep Dam to Bloemfontein Phase 1		Pump station and pipeline from Gariep Dam to Bloemfontein Phase 1				
2024							
2025	Noordoewer/Vioolsdrift Dam construction start RSA & Namibia	Utilise Croc Return Flows in Tshwane to reduce load from Rand Water via Vaal		Makhaleng Dam and pipeline costruction start		Neckartal Dam irrigation development start	Formaly agree on environmental requirements and releases to river mouth
		Desalination and re-use of mine water effluent fully implemented				Noordoewer/Vioolsdrift Dam construction start RSA & Namibia	
		Polihali Dam (Lesotho Highland Water project (LHWP) Phase II and connecting tunnel to Katse Dam; using new operating rule		Polihali Dam (Lesotho Highland Water project (LHWP) Phase II and connecting tunnel to Katse Dam; using new operating rule			
2026				Hlotse Dam construction start			
2027	Construction Verbeeldingskraal start						
						Noordoewer/Vioolsdrift Dam start deliver RSA & Namibia	
2028	Noordoewer/Vioolsdrift Dam start deliver RSA & Namibia		Construction start - direct reuse from the Bloem Spruit WWTW (± 11 million m3/a); Maselspoort			Neckartal Dam irrigation demands (large schemes)	
2029							
2030				Hlotse Dam to deliver			
			Planned direct reuse from the Bloem Spruit WWTW (± 11 million m3/a); Maselspoort	Makhaleng Dam to deliver			
				Ngoajane Dam construction start			
2031							
2032	Completed Verbeeldingskraal Dam upstream of Gariep Dam;	Thukela transfer further phase construction start					
	Start Phase 2 gariep Bloemfontein pipeline contruction		Start Phase 2 gariep Bloemfontein pipeline contruction				
2033				Lesotho to Botswana pipeline complete			
2034	Pump station and pipeline from Gariep Dam to Bloemfontein Phase 2		Pump station and pipeline from Gariep Dam to Bloemfontein Phase 2	Ngoajane Dam to Deliver			
2035							
2036							
2037		Thukela transfer further phase Delivery start					
2038							
2039							
2040			Tienfontein pump station capacity increase to 7m^3/s;				

Figure 13-1: Proposed investment timeline

14 L-BWT SCHEME - PROPOSED INSTITUTIONAL AND FUNDING ARRANGEMENTS

- Makhaleng Dam and possible irrigation developments
- L-BWT pipeline, transfer pipe to Gaborone/Lobatse

The recommendations on the institutional and funding arrangements for the L-BWT made in this study are preliminary.

A separate institutional and funding study was funded by SIWI and CRIDF. Although that study was completed after this team had compiled this report, the recommendations of those studies are briefly discussed at the end of this section for completeness.

The final institutional and funding recommendation for the L-BWT will be agreed upon before finalising the Road Map in Phase 2 of this Study, and the recommendations made in this report will be revisited and aligned with the vision of the Road Map at that time.

The following is noted:

- **The Lesotho Highlands Development Authority (LHDA)** is already funding, planning, implementing, maintaining and operating large dams and transfers (tunnels) in Lesotho, as a parastatal organisation (SOE) wholly owned by the Lesotho Government.
- **The Trans Caledon Tunnel Authority (TCTA)** is already funding planning, implementing, operating and maintaining large dams and pipelines in South Africa and supplying the Rand Water Board and others with water, as a parastatal organisation (SOE) wholly owned by the South African Government.
- **The Botswana Water Utilities Corporation (WUC)** is already funding, planning, implementing, operating, maintaining, and distributing water resources in the country's urban centres and other areas mandated by the Botswana Government, as well as the supply of bulk water to the Department of Water Affairs and the various Local Authorities for distribution to villages and other small settlements in the country, as a parastatal organisation (SOE) wholly owned by the Botswana Government.

The most pragmatic, cost-effective and "fastest start time" way of proceeding would be to utilise the above institutions to develop the various components of the proposed L-BWT Project, being dam and pipelines/tunnels in Lesotho, bulk transfer pipelines in South Africa, and bulk and distribution pipelines in Botswana.

Work done with TCTA shows that the more planning, construction and operating work that is delegated to TCTA, the more efficiently TCTA can apply its overheads.

In other words, a substantial portion of TCTA's overheads are relatively fixed and the more construction that TCTA does, the lower the overheads per ZAR million of construction that it undertakes.

Similarly, the more water that TCTA stores and supplies, the cheaper the cost of the overheads per kl.

Another way of viewing this is that the additional costs to TCTA of supervising the South African portion of the L-BWT Project will be relatively low as most of the project management and fund-raising capacity and methodology is already established in-house.

The same benefits of scale, saving of establishment costs, and "quick start-up" would apply to using LHDA for the Lesotho component of the L-BWT Project and the WUC for the Botswana component, as opposed to duplicating structures.

A new Commission, similar to the LHWP Joint Commission, would be required to coordinate the activities of these three institutions.

Taking into consideration that water transferred through the transfer pipeline to Botswana would impact directly on yield of the South African Orange River Schemes of Vanderkloof and Gariep if compensation releases are not made from Makhaleng Dam, it is recommended that strong consideration be given to "tying" the respective planning of the LHWP Commission and the Lesotho-South Africa-Botswana Transfer Commission closely together.

Whether this means that that Commission is an expanded LHWP Commission, with Botswana as an additional member, or whether it means that the Lesotho-RSA-Botswana Commission (L-BWT Project Commission) is a new parallel Commission with a few key members shared with the LHWP, would need to be agreed by the Parties.

Figure 14-1 below shows such an institutional arrangement:

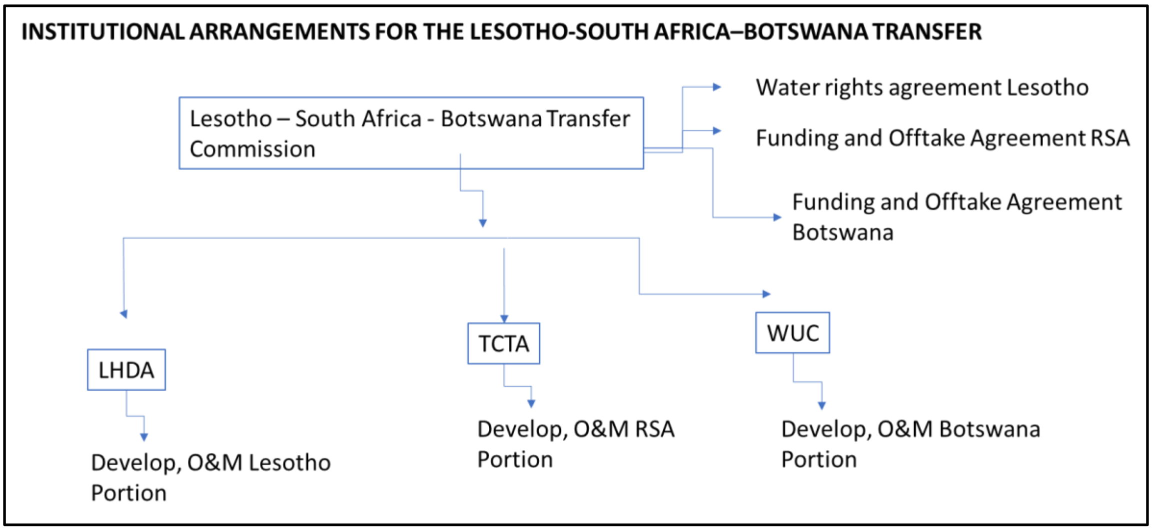


Figure 14-1: Institutional arrangements for Lesotho - Botswana Transfer (L-BWT Project).

14.1 Single corporation alternative

As an alternative to mandating LHDA, TCTA, and WUC to build and operate the L-BWT, there could be benefits in rather appointing a single corporation in their stead.

This corporation could be an existing corporation such as Rand Water, or alternatively a special purpose vehicle or corporation established by the States specifically for that task.

The disadvantage of establishing a new institution, compared to using an existing corporation, is that all of its overheads would accrue to the project and that it takes time to establish a new corporation and to boot up through procurement of board, staff, systems, offices etc.

14.2 THE PPP ALTERNATIVE TO FUNDING THE L-BWT PROJECT

Multi-lateral funding agencies generally have the express or implied objective of promoting private sector participation in projects. These funding agencies generally argue that nearly any project that a government agency can deliver, can be delivered more effectively and efficiently by the private sector because of the competitive procurement process and because the market ejects private sector participants who do not perform competitively. They argue that in comparison to a competitive private sector process, the government are monopolies with little competition incentive to perform effectively. For this reason, multi-lateral funding agencies are generally proponents of PPP (Public-Private Partnership) or BOT (Build Operate Transfer) projects.

Governments on the other hand are generally hesitant in reaching financial closure on such projects. There are many examples in Southern Africa, where a BOT project was developed to a relatively advanced conceptual stage by Government, and then at the last minute the decision was reversed, and the project was given to an SOE to implement.

It is consequently important that all governments concerned fully commit to such an approach in writing (bind themselves contractually) before the large investment of management time and disbursement of consulting resources is embarked on in developing such an approach. It is in no country's interest to walk the PPP line for five years or so and then at the very end to write off that investment in time and resources because the political appetite is not there.

A PPP or BOT project would generally comprise the following participants:

- Project Sponsor – perhaps the L-BWT Project Commission
- Funders – generally commercial banks, but perhaps Mezzanine funding from the New Development Bank to reduce the cost of commercial interest.
- Special purpose BOT vehicle – generally a private consortium/concessionaire appointed through pre-qualified competitive tender.
- Off-takers – perhaps the Dept. of Water Affairs, TCTA or a Water Board in South Africa, and perhaps the Government of Botswana or WUC Botswana.

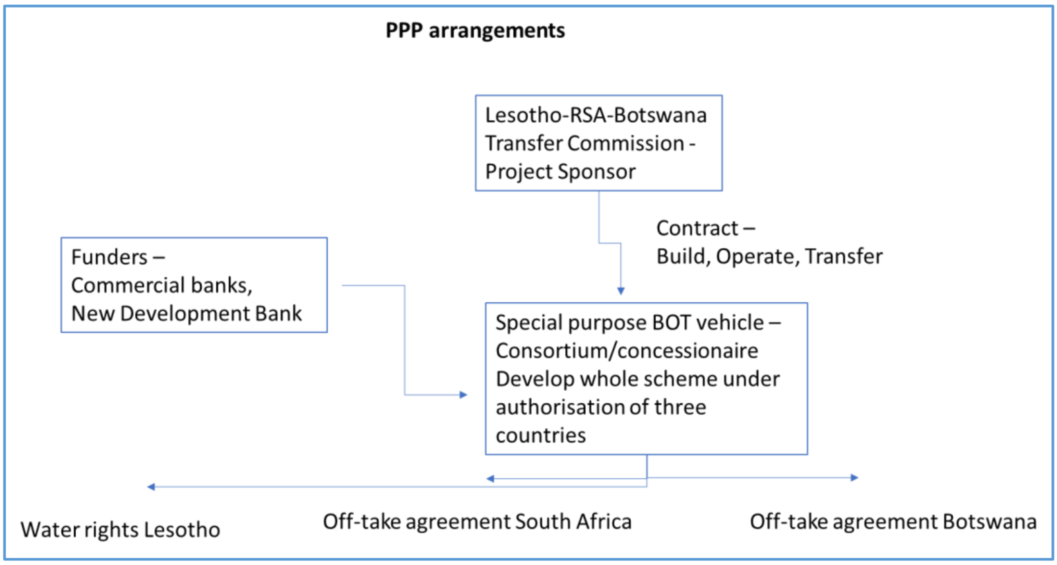


Figure 14-2: PPP arrangements.

14.3 SIWI AND CRIDF FUNDED INSTITUTIONAL ANALYSIS FOR THE LESOTHO-BOTSWANA WATER TRANSFER SCHEME (L-BWT)

The above institutional and funding arrangement options for the L-BWT was shared with the teams appointed by CRIDF and SIWI to do the institutional and funding analysis for the L-BWT.

The CRIDF analysis was completed after this report was submitted to ORASECOM for review.

An analysis of the CRIDF conclusions show that they are closely aligned with those of this report on the "coordination and alignment" of the L-BWT: The CRIDF analysis concludes that the project could be enabled by a Tri-partite Agreement or Treaty setting out the roles and responsibilities of the countries, as well as the joint financial and institutional arrangements for the implementation of the project by the three countries. Planning and oversight of the project development and implementation in accordance with this agreement would require a Commission or Committee with representation by the three countries. This could be established as a new international body or as a sub-committee of ORASECOM but would have overall responsibility for representing the interests of the parties and achievement of the terms of the agreement.

Regarding the Financing and Development of the L-BWTS, the CRIDF report considers that the "financing and development" of the L-BWTS could be done by an unincorporated JV, a bilateral JV SPV between two countries or a tri-partite JV SPV.

In the unincorporated JV model, each country finances its portion of the project and this may be managed as an EPC contract under an implementing agent within each country. The critical aspect would be that each country is liable for its own financing and repayment of its debt on the asset (even where this is deemed an intangible asset located in another country), linked to the off-take agreements and funding between the countries.

A bilateral SPV between Botswana and South Africa would require its own agreement about the joint liability for the debt and sovereign guarantees underpinning the raising of that debt. This would only be relevant in a situation where South Africa has a significant portion of the off-take and is, therefore, willing to take on significant obligation for the underlying project debt.

The incorporated JV option would have significant institutional hurdles that are not likely to be outweighed by any potential benefits, given the highly uneven fiscal conditions within the three countries.

The CRIDF analysis considers that the "operation and maintenance" of the project may reflect the institutional arrangements for the financing and development, but this is not necessary. Once the project has been constructed, the coordination and alignment would be overseen by the Committee/Commission through existing national entities as implementing agents, either the National Departments of Water Infrastructure Divisions or National Infrastructure Agencies (e.g. LHDA, TCTA and WUC). These entities would be contracted or delegated responsibility for operation and maintenance in accordance with the agreement, including any collection of tariffs for water sold in their jurisdictions.

A key finding of the CRIDF studies was that "*At the scale of the L-BWT Project, the financial obligations will extend beyond the capacity of any one of the host countries. Accordingly, multiple pools of funding will be required to be accessed in order to finance the envisaged capital expenditure. Bankability of the L-BWT Project will be the key financial driver to achieve successful financing.*"

In addition, the CRIDF study suggested key considerations for accessing the bankability of the project include "*the commitments of the host governments to underpin the debt financing obligations of the borrower; and the ability of the host countries' fisci to assume additional debt obligations.*"

This means that even with a PPP option the governments would need to underwrite the project.

14.4 URGENT NEED TO REACH AGREEMENT ON THE FUNDING AND INSTITUTIONAL ARRANGEMENTS FOR THE LESOTHO-BOTSWANA WATER TRANSFER SCHEME (L-BWTS)

During Phase II of this study, the member countries will urgently need to confirm whether water from the L-BWTS is indeed affordable to the recipient States and whether they agree to continue with its implementation.

If the Parties do give their consent to continue with the Project then it is recommended that TCTA be mandated to test the appetite of private sector partners to fund this project either with or without direct government guarantees.

We are however in agreement with the CRIDF findings that an incorporated SPV is unlikely to manage the expropriation and other regulatory hurdles required to implement a project traversing three countries and private land in South Africa.

Consequently, we are in favour of using existing State-Owned Entities such as LHDA, TCTA and Rand Water to implement components of the scheme in the different countries.

15 PROPOSED INSTITUTIONAL AND FUNDING ARRANGEMENTS FOR THE OTHER CORE SCENARIOS

15.1 Cluster 1: Orange River Project Scheme future improvements (proposed institutional and funding arrangements)

- Utilise the lower-level storage in Vanderkloof Dam
- Real-Time flow modelling and monitoring in the Lower Vaal downstream of Bloemhof Dam and the Orange River downstream of Vanderkloof Dam to the Orange River mouth
- Building of the Verbeeldingskraal Dam upstream of Gariep Dam
- Noordoewer/Vioolsdrift Dam (combined w/ Polihali Dam)
- Noordoewer/Vioolsdrift Dam
- Polihali Dam (Lesotho Highland Water project (LHWP) Phase II and connecting tunnel to Katse Dam; using a revised operating rule for both phases of the LHWP.

15.1.1 Utilise the lower-level storage in the Vanderkloof Dam

Vanderkloof and Gariep dams are currently owned by DWS-RSA.

In accordance with the Constitution and the National Water Act, the national government (DWS) is responsible for water resource management.

Consequently, until such time as a National Water Infrastructure Agency is established, these schemes and their improvements will remain with DWS-RSA and possibly be funded and implemented by TCTA.

15.1.2 Real-Time flow modelling and monitoring in the Lower Vaal downstream of Bloemhof Dam and the Orange River downstream of the Vanderkloof Dam to the Orange River mouth

DWS-RSA currently owns and operates a stochastic hydrology model of the Vaal River and Orange River Systems.

This system would be required to be linked in real-time to gauging stations and dam monitoring stations owned and operated by all four of the basin states.

ORASECOM would need to coordinate the further development and utilisation of these models.

15.1.3 Building of the Verbeeldingskraal Dam upstream of Gariep Dam

Vanderkloof and Gariep dams are currently owned by DWS-RSA.

Consequently, the building of the Verbeeldingskraal Dam within South Africa will remain with DWS-RSA.

The funding of the dam may however be delegated to TCTA.

15.1.4 Polihali to be used in combination with Noordoewer/Vioolsdrift or Verbeeldingskraal or a lower off-take Vanderkloof Dam to maintain a positive water balance in the ORP

Noordoewer/Vioolsdrift Dam will span the border between Namibia and South Africa and will serve to off-set some of the storage and abstraction of water upstream and to preserve the estuary.

Although the institutional arrangements will only be finalised during the implementation phase, various institutional options were considered in the "Noordoewer/Vioolsdrift Dam Feasibility Study Main Report of 31 March 2020, Report no. PWC/JFS/1-2014/17, undertaken on behalf of the Permanent Water Commission of The Republic of Namibia and The Republic of South Africa.

Ownership and control will be vested in the Governments of Namibia and the Republic of South Africa, and a joined Management Authority is recommended for the implementation and the operation of the NVD. The establishment of an International Operating Area (IOA) would best facilitate the implementation of the NVD project.

The basic premise for sharing the cost of a project is that it should relate to the benefit that each State will receive from the project and that it should be reasonable, fair and just, having due regard for the relevant circumstances to reflect an equitable balance between the interests of the states. The sharing of the cost of a project should be assessed, negotiated and taken up in a treaty between the states involved.

Project financing must still be considered.

A draft treaty was compiled as part of this Study for the project to give effect to the institutional arrangement for the project, the sharing of water from the project, the funding and recovering of the cost of the project and managing the cross-border issues, based on the outcomes of the deliverables of the tasks of the Feasibility Study for the NVD Project.

15.1.5 Polihali Dam (LHWP Phase 2)

Polihali Dams will form part of the LHWP, together with Katse and Mohale Dams and the Matsoku Diversion.

Governance responsibility rests with the RSA-Government of Lesotho (GoL) LHWC, and implementation responsibility with LHDA, and funding responsibility with TCTA or LHDA.

15.2 Cluster 3: Lesotho Lowlands (proposed institutional and funding arrangements)

- Hlotse Dam: Urban/rural demands plus irrigation developments
- Ngojane Dam: Urban/rural demands plus irrigation developments

LHDA, a GoL owned Entity, already operates Katse and Mohale dams and the Matsoku Diversion in the Lesotho Highlands Water Project on behalf of the GoL.

As such LHDA already has the capacity and expertise to operate large dams.

It is suggested that LHDA also operates the Lesotho Lowlands dams. This will be more efficient than establishing a parallel authority/entity with similar scarce capacities.

This approach would then be similar to RSA/DWS using TCTA to implement projects outside of the scope of the LHWP.

15.3 Cluster 4: IVRS intervention options (proposed institutional and funding arrangements)

- Thukela transfer further phase
- AMD
- Utilise Crocodile Return Flows in Tshwane to reduce the load from Rand Water via Vaal

15.3.1 Thukela Transfers

The augmentation of the transfers from the Thukela River to the Vaal will be governed and operated by RSA-DWS who operates the current transfers from the Thukela.

RSA-DWS will probably contract with TCTA to fund and implement the scheme, but not to operate it, as DWS already operates the current transfer.

15.3.2 AMD

The responsibility for the governance of Acid Mine Drainage resides with RSA-DWS.

The following alternative procurement models for implementation have been identified and analysed at a feasibility level of detail:

a) a ‘traditional’ Government-funded and a traditionally procured Employer Design, Procure, Construct and Operate solution, which is the Public Sector Comparator model (PSC);

b) a Design, Build, Operate and Maintain (DBOM) scenario funded by an Implementing Agent, using Private Sector or Government funding, which is also a Public Sector Comparator model (PSC); and

c) a private sector-funded Public-Private Partnership (PPP).

A final decision will be made by DWS after consultation.

15.3.3 Utilise Crocodile Return Flows in Tshwane to reduce the load from Rand Water via Vaal

The WWTW is currently owned by the City of Tshwane and they will own the re-use works.

The use of RO (Reverse Osmosis) technology lends itself to PPP projects.

There are specialist firms that design, construct and implement such projects for municipalities, industrial users and mines. One such South Africa firm is successfully operating 6 multi-stage RO plants on a 24/7 basis.

Such PPP contractors could be appointed separately by each municipality or could be appointed by a Water Board for all/some municipalities in a region.

Johannesburg Water and the Cities of Tshwane and Mangaung are probably all capacity-and-skills-wise capable of procuring and managing such a contractor, but it is proposed that it would be prudent to use a water board as project sponsor – client when it comes to a PPP serving smaller less capacitated towns.

15.4 Cluster 5: Caledon to Greater Bloemfontein transfer (proposed institutional and funding arrangements)

- Tienfontein pump station capacity increase to 7 m^3/s;
- Increase Tienfontein pumping capacity to 3.87 m^3/s Novo Transfer scheme capacity to 2.2 m^3/s; to Rusfontein Dam (already constructed).

This phased project is primarily a regional project augmenting the water supply to the City of Mangaung (Bloemfontein) but may have on-route offtakes.

However, DWS owns the dams except for the Mockes Dam that belongs to Mangaung.

The Tienfontein infrastructure belongs to DWS.

Consequently, DWS will continue to operate its own infrastructure and Mangaung will continue to operate its own.

[In the future consideration could be given to transferring bulk pump stations and bulk pipelines from DWS to Bloemwater, a South African water board, which operates other bulk pump stations and pipelines.]

15.5 Cluster 6: Greater Bloemfontein internal resource improvements (proposed institutional and funding arrangements)

This project would be within the domain of the City of Mangaung with possible components falling within the bulk system owned and operated by Bloemwater.

15.6 Cluster 7: Gariep to Greater Bloemfontein Transfer (proposed institutional and funding arrangements)

- Pump station and pipeline from Gariep Dam to Bloemfontein Phase 1
- Pump station and pipeline from Gariep Dam to Bloemfontein Phase 2

This phased project is primarily a regional project augmenting the water supply to the City of Mangaung (Bloemfontein) but may have on-route offtakes.

The Gariep Dam is owned by RSA DWS and will continue to be operated by RSA DWS.

It is proposed that Bloemwater, a South African water board, operate the bulk pump stations and pipelines and that there be an agreed measured transfer point between Bloemwater and the City of Mangaung. Such point probably being the discharge into a bulk reservoir owned by Mangaung.

[Alternatively, Mangaung or DWS could operate the bulk pump stations and pipelines.]

15.7 Cluster 8: Neckartal Scheme (proposed institutional and funding arrangements)

Neckartal Dam will primarily supply water to irrigation within Namibia.

As such it is proposed that the dam and pipeline/canal be operated by DWA-Namibia in cooperation with Namibia-Department of Agriculture, Planning, Extension & Engineering Services.

15.8 Cluster 9: integrated water management options (proposed institutional and funding arrangements)

The integrated water management options comprise several components which include the following:

- Removal of unlawful irrigation;
- WC/WDM within irrigation schemes;
- WC/WDM in the urban and industrial sectors;
- Increasing the area of water use permit/licence coverage;
- Improve assessments of aquifers (storage capacities, recharge rates, sustainable yields, and other characteristics);
- Manage salinity;
- Manage eutrophication;
- Management and control of alien and invasive species and problem pests;
- Set water quality objectives/standards;
- Consolidation of climate data and extreme event data at basin level;
- Identify priority water needs to support economic development at basin level;
- Set out guidelines and procedures to improve equitable utilisation and benefit-sharing at the basin level;
- Harmonize policy, legal and institutional frameworks.

15.8.1 Integrated Water management options (Urban - Industrial)

It is proposed that ORASECOM should have an oversight responsibility in formulating agreements between the Basin States on WC/WDM, Water Quality discharge and environmental targets.

However, the implementation would need to be done at a local level by municipalities under the regulation of the respective national government departments and other regulating authorities.

15.8.2 Integrated Water management options (Agriculture)

It is proposed that ORASECOM should have an oversight responsibility in formulating an agreement between the Basin States on WC/WDM, Water Quality discharge, and environmental targets.

However, the implementation would need to be done at a local level by the respective national agricultural departments.

In South Africa, the Water User Associations would also be involved.

15.8.3 International Water management options (general)

As above, it is proposed that ORASECOM should have an oversight responsibility in formulating agreements between the Basin States.

The projects to be coordinated by ORASECOM will be highlighted in the Road Map.

16 SOURCES AND AVAILABILITY OF FUNDING

16.1 Assessing public financing availability

Many Governments are taking steps to mitigate the adverse effects of climate change on water resources by allocating a significant portion of annual budgetary provisions to replace old and install new water infrastructure to serve multiple purposes (such as water storage, power, irrigation, water supply and tourism). It is well known that many government's fiscal allocations are inadequate to deliver the substantial water infrastructure needed, as there are also other competing demands from other sectors of the economy. The figure below illustrates the trend of infrastructure development financing from the Basin Member States national budgets.

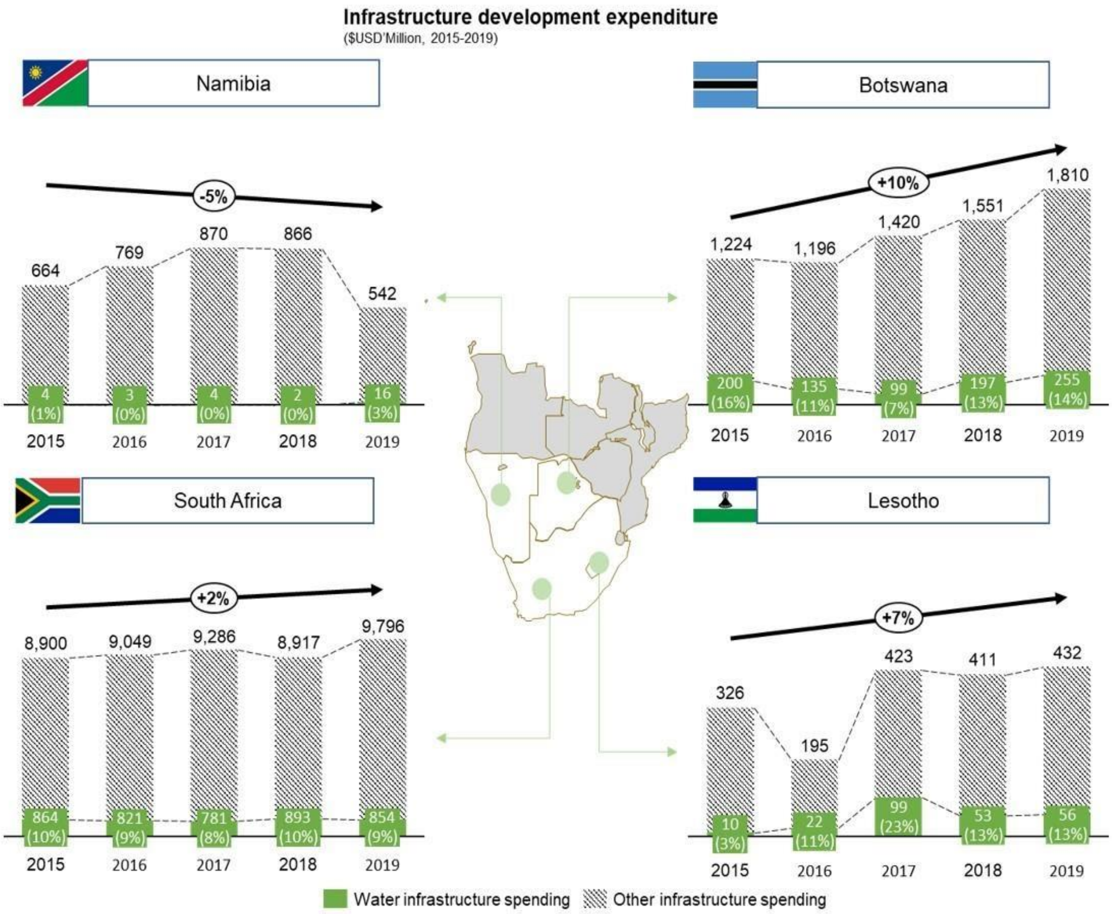


Figure 16-1: Infrastructure development expenditure of Orange-Senqu River Basin Countries

Source: *Annual budgets of countries (2015-2019); Botswana Medium-term Expenditure Framework (MTEF), 2019; Genesis Analytics team, 2019.*

Between 8% - 10% of the Orange-Senqu River basin countries' annual infrastructural development fund is allocated to water, except Namibia with less than a 5% allocation. To further elucidate the availability of the public finances of the Basin countries to support the core scenario, a brief overview of the macroeconomic and public finances of each country is presented below.

16.1.1 Botswana

The figure below presents a snapshot of the key macroeconomic indicators of Botswana's economy.

Key Economic Characteristics (2017)						
Population (Million)	GDP Current (Million USD$)	GDP per capita (PPP USD $)	Agriculture share of GDP	Mining & Quarry share of GDP	Manufacturing share of GDP	Utilities services share of GDP
2.534	13,253.7	10,499	2.0%	17.4%	5.1%	1.0%

Classification of end-users in the water accounts							
Irrigation system	Livestock	Mining	Manufacturing	Services	Households	Transfer to other river basin	In-stream and ecological requirements
Crop irrigation	✓	Diamond Quarry	4 manufacturing industries	• Utilities • Construction • 5 service industries	• Urban • Rural	✓	✗

Figure 16-2: Snapshot of Botswana's economy and classification of water end-users

Source: World Bank database, 2018; Botswana GDP report 2017; Lange and Hassan, The Economics of Water Management in Southern Africa: An Environmental Accounting Approach, 2006.

Considering the role played by water in the performance of the mining sector, ensuring a stable supply of water is a key government programme. In this regard, the government has increased fiscal allocation to the development of strategic water infrastructure to improve water supply across the country. In 2015, USD 200 million (16% of the total infrastructure development fund (IDF)) was allocated to water-focused infrastructure, this however declined to USD 99 million in 2017 - 7% of total IDF (see **Figure 16-3**). This resulted in negative sectoral growth for both the water and mining sectors (-19.5% and -11.2% respectively) and a slower growth rate of 2.5% for the whole economy (Botswana Budget Strategy Paper, 2019).

Noting this, the government doubled infrastructure allocation to the water sector in 2018 – USD 197 million (13% of total IDF) was hallmarked for water infrastructure investment. More funds are being allocated to water infrastructure in 2019 to sustain the economic recovery plan of the government.

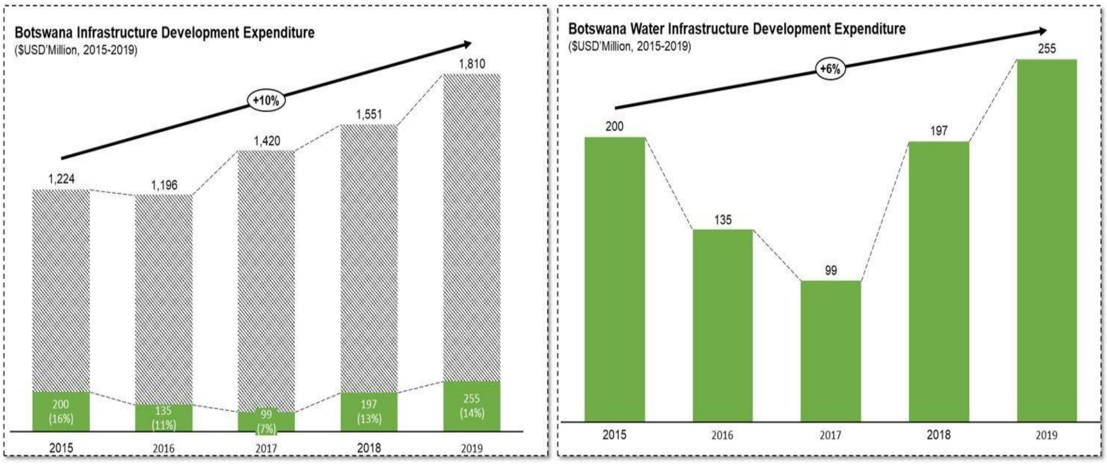


Figure 16-3: Botswana Total and water infrastructure development expenditure (2015 - 2019)

Source: *Annual budgets of Botswana (2015-2019)*

USD 255 million (14% of total IDF) was budgeted to implement key water infrastructure projects such as the construction of strategic reservoirs; bulk water transfer pipelines; groundwater resource development and water supply distribution networks including treatment facilities (Botswana 2019 Budget Speech). Some projects such as Gaborone Waste Water Treatment and Chobe-Zambezi Water Transfer Scheme are listed for a Public-Private Partnership funding arrangement (Botswana budget brief 2019).

Based on the National Development Plan 11 (2017 -2023), water remains a strategic sector to drive economic growth in Botswana. There is a plan for massive infrastructural development in the sector and a high allocation of funds towards achieving this goal.

16.1.2 Lesotho

Figure 16.4 presents a snapshot of the key macroeconomic indicators of Lesotho's economy.

It was anticipated that advance infrastructure development associated with the second phase of the Lesotho Highlands and the growth of both the mining and construction sectors would sustain the economy from 2019 onwards by boosting government revenue. Following this, government budgetary operations are expected to return their 2017 position and maintain the upward trend to 2020. This projection is supported by strong growth from the mining, construction, exports earnings from diamonds and recovery of the South African economy. An expansive infrastructure development programme will also be embarked upon to support economic activities, especially critical water infrastructure.

Key Economic Characteristics (2017)						
Population (Million)	GDP Current (Million USD$)	GDP per capita (PPP USD $)	Agriculture share of GDP	Mining & Quarry share of GDP	Manufacturing share of GDP	Utilities services share of GDP
2.233	2,578.3	2,926	6.1%	8.3%	13.7%	5.4%

Classification of end-users in the water accounts							
Irrigation system	Livestock	Mining	Manufacturing	Services	Households	Transfer to other river basin	In-stream and ecological requirements
Crop irrigation Fishing	✓	Diamond Quarry	3 manufacturing industries	• Utilities • Construction • 3 service industries	• Urban • Rural	✓	✗

Figure 16-4: Overview of Lesotho's macro-economy

Source: World Bank database, 2018; Lesotho GDP report 2017; Lange and Hassan, The Economics of Water Management in Southern Africa: An Environmental Accounting Approach, 2006.

Government's stand to continue fiscal expansion to support the National Strategic Development Plan (NSDP) enablers will see more budgetary allocation to building more water infrastructure. Two of the key strategic actions in the NSDP (facilitating the development of water harvesting, irrigation and climate-smart (greenhouses and hydro-phonics) agricultural infrastructure, and developing multi-purpose dams to provide water for irrigation, clean electricity generation, potential export opportunities and sport) clearly establishes a nexus between water infrastructure, economic growth, employment and export.

Water royalties received from South Africa is also an important non-tax revenue of the Lesotho government. This component accounts for about 10% of annual government revenue (Lesotho Annual Budget, 2018/2019). Considering the economic growth and government revenue importance of water infrastructure in Lesotho, many lowland water projects have been initiated by the government and these projects are financed through funds (loans, grants among others) from development financial institutions such as Arab Bank for Economic Development, European Investment Bank, World Bank, Republic of South Africa, ADFU- Abu Dhabi and African Development Fund.

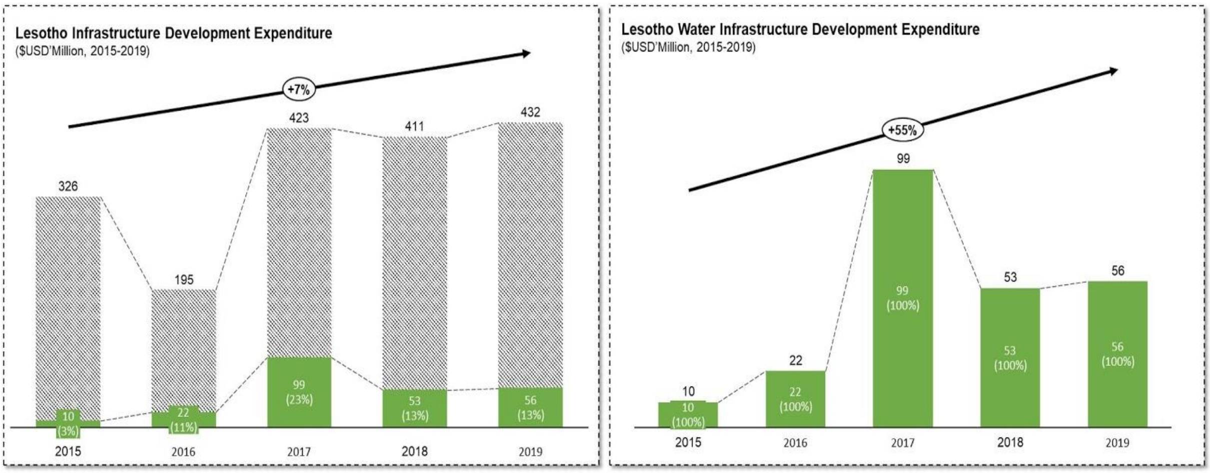


Figure 16-5: Lesotho Total and water infrastructure development expenditure (2015 - 2019)

Source: *Annual budgets of Lesotho (2015-2019)*

16.1.3 Namibia

Figure 16.6 presents a snapshot of the key macroeconomic indicators of Namibia's economy.

Key Economic Characteristics (2017)						
Population (Million)	GDP Current (Million USD$)	GDP per capita (PPP USD $)	Agriculture share of GDP	Mining & Quarry share of GDP	Manufacturing share of GDP	Utilities services share of GDP
2.534	13,253.7	10,499	6.5%	9.0%	10.0%	2.0%

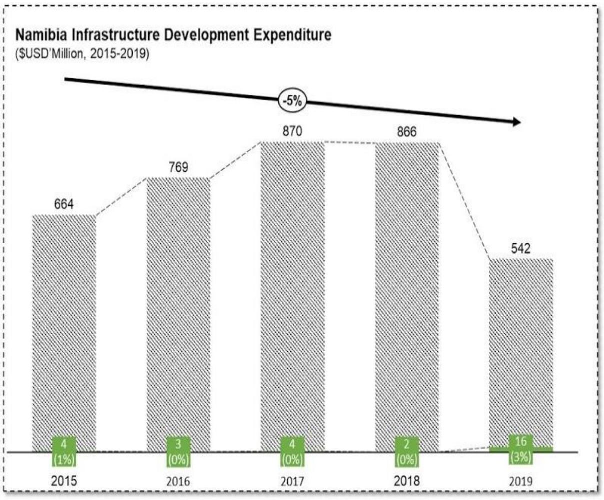
Classification of end-users in the water accounts							
Irrigation system	Livestock	Mining	Manufacturing	Services	Households	Transfer to other river basin	In-stream and ecological requirements
Crop irrigation Fishing	✓	Diamond Quarry	7 manufacturing industries	• Utilities • Construction • 7 service industries	• Urban • Rural	✗	✗

Figure 16-6: Snapshot of Namibia economy and classification of water end-users

Source: World Bank database, 2018; Namibia GDP report 2017; Lange and Hassan, The Economics of Water Management in Southern Africa: An Environmental Accounting Approach, 2006.

The Namibian economy, like other Orange-Senqu River basin countries, relies heavily on the primary sector - agriculture, fishing and mining. These primary sectors contribute 14.5% cumulatively to the Namibian economy (agriculture - 3.9%, fishing - 2.6% and mining - 9.0%). Aside from the importance of water to the output level of these sectors, the Vision 2030 and the third National Development Plan of Namibia identified inadequate water supplies as the "most important limiting factor for development" in the country.

The Namibian government adopted a posture to ensure sufficient water reserves for human consumption, industrialisation, land servicing for agriculture and housing development. In addition, there is a 2020 goal of increasing human consumption of water from 50% to 100% (Namibian Medium-Term Expenditure Framework, 2018/2019). Both postures led to an increase in water infrastructure spending in 2019, despite a reduction in total allocation to infrastructure development. This increase is 650% of the 2018 figure and this increase is expected to continue going further as the country pushes to meet the 2020 water supply goal.



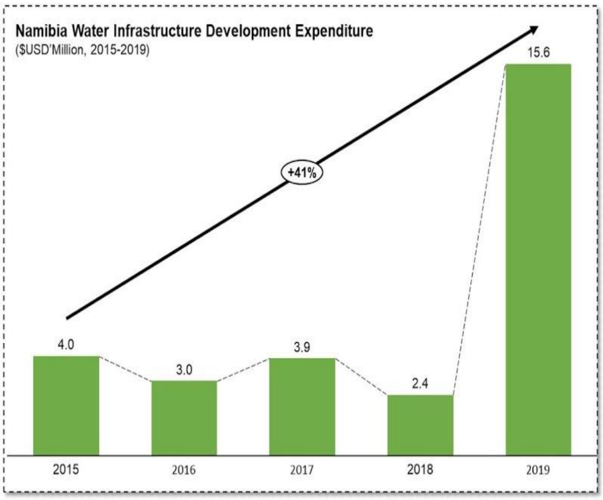


Figure 16-7: Namibia Total and water infrastructure development expenditure (2015 - 2019)

Source: *Annual budgets of Namibia (2015-2019)*

The expansive water infrastructure spending is expected to be financed using the combination of domestic funds, grants, PPP arrangement and debts from external development financing institutions.

NamWater - the only agency in charge of supply bulk water in Namibia, current posture shows the continuation of planned new and rolled-over water projects which will require more fund allocation from the annual budgetary provision of government.

16.1.4 South Africa

South Africa is an upper-income country with an estimated per capita income of USD 13,498 as of 2017. The economy is largely primary sector dependent like other Orange-Senqu River Basin countries. Economic growth is significantly affected by the performance of both the agriculture and mining sectors, and about 70% of the country's gross domestic product (GDP) is supported by the water sector (SA water sector, 2012). This shows strong nexus with water and the overall economic performance of South Africa.

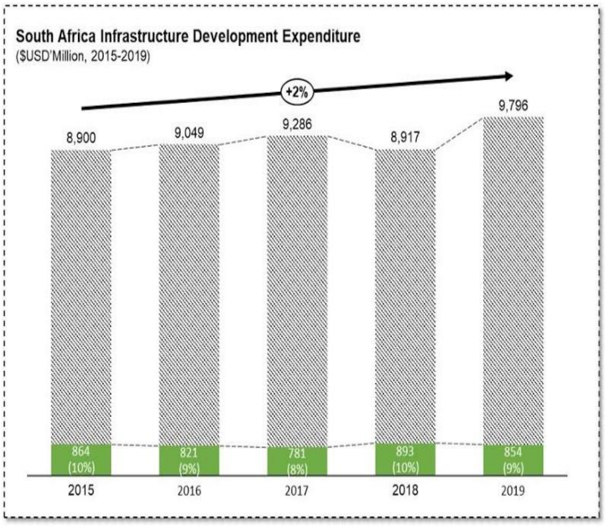
Key Economic Characteristics (2017)						
Population (Million)	GDP Current (Million USD$)	GDP per capita (PPP USD $)	Agriculture share of GDP	Mining & Quarry share of GDP	Manufacturing share of GDP	Utilities services share of GDP
56.717	348,871.6	13,498	2.4%	7.5%	12.3%	2.1%

Classification of end-users in the water accounts							
Irrigation system	Livestock	Mining	Manufacturing	Services	Households	Transfer to other river basin	In-stream and ecological requirements
Irrigation Fishing	✓	Gold Quarry	2 manufacturing industries	• Utilities • Construction • 2 service industries	• Urban • Rural	✓	✓

Figure 16-8: Snapshot of South Africa's economy

However, the state of South Africa's water infrastructure shows the need for replacement and upgrade. Over the medium-term (until 2021), the allocation of infrastructure development funding to water is planned to increase at an annual rate of 3.7% till 2020/2021. This is expected to sustain the water infrastructure development programme (WIDP) of the country (SA national budget estimates & expenditure, 2018/19).

81.7% of all budgetary allocations to the Water Department was hallmarked for the WIDP till 2020/21. Spending in this programme focused on the provision of regional bulk water infrastructure, water services infrastructure grants, accelerated community infrastructure programme (ACIP) sub-programmes and transfers to the water trading entity (SA national budget estimates & expenditure, 2018/19). The government also approved an increase in allocations to WIDP from USD 866 million in 2017/18 to USD 947 million in 2020/21.



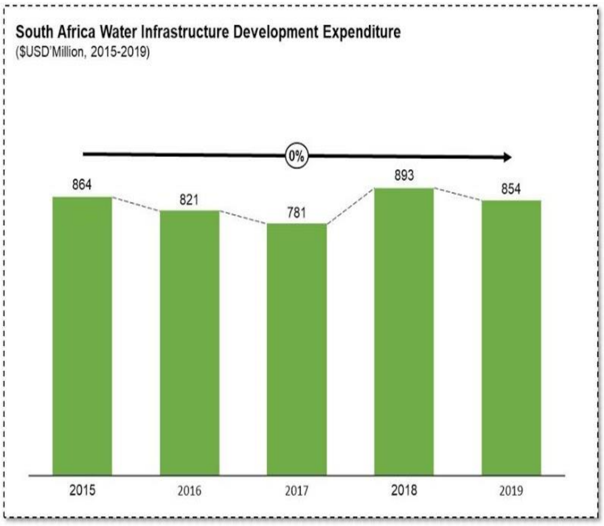


Figure 16-9: South Africa Total and water infrastructure development expenditure (2015 - 2019)

Budgetary allocations to other South African water infrastructure development programmes such as ACIP, water services infrastructure grants, transfers to water trading entity and the regional bulk water programmes, are also expected to increase between 3% and 4% within the same period.

16.1.5 Summary

The table presents a summary of the potential funds available for the core scenario intervention, based on the narrative above relating to each country's water sector budgets.

Table 16-1: Summary of Basin countries' water budgets, 2019

Country	Water sector budget (USD millions)
Botswana	255
Lesotho	56
Namibia	15
South Africa	854
Total	**1 180**

The total water sector annual budget in 2019 across the four countries is estimated to be in the region of USD 1.18 billion. Given that the estimated capital budget for the Core Scenario is R123 billion (USD 9 billion), it is clear that even if the water sector budgets of the four countries were totally allocated to the Core Scenario, there will still be a significant shortfall in the funding requirements for the Core Scenario.

The Basin Member States demonstrate a dedication to their respective water sectors by developing water programmes to fund and/or source funding for water infrastructure. Water is shown to be a critical driver of growth for key sectors. Given the scarcity in financing water infrastructure from the private sector, there is a need for alternative sources of financing to reduce the financial burden on the national fiscus.

16.2 Assessing PPP conduciveness

The large core scenario projects (dams, pipelines, waste-water schemes) are likely to require significant private sector capital. The chapter of this report briefly unpacks this potential for private sector investment, through a PPP approach.

PPP arrangements can take various forms depending on the level and type of risk assumed by the private sector. The PPP arrangement is determined by the unique characteristics of the specific sector and project. The points below are important to keep in mind when determining an optimal PPP arrangement:

- Service, design-build, management and lease contracts are most suited to projects whereby the state wishes to retain significant risk and responsibility over the service because: a) their duration tends to be short in length and b) only a moderate level of risk is transferred to the private sector.
- The various concession forms (Build-Transfer-Operate, Build-Operate-Transfer, Build-Finance-Operate-Transfer, Build-Own-Operate-Transfer) are more applicable to project types with large capital requirements and long duration, such as roads, water and sanitation, waste, hospital facilities or power plants, as the preparation costs as well as financing costs for such projects are relatively high.
- The more constrained the government is in terms of its budget, the more risk it would be willing to transfer to its private partner.
- The less commercially viable the sector, the less willing the private sector would be to take on substantial financial risk.

It must be noted that not all projects are suitable to be structured as PPPs. Projects being considered for PPP arrangements must be carefully assessed to ensure that the potential for private sector participation is clearly demonstrated, particularly when countries are in their infancy of developing and implementing successful PPP projects. In addition to the aforementioned, it is critical for a project to demonstrate a willingness to pay for the infrastructure (e.g. a water tariff), and a clear line of sight to the revenue (revenue can clearly be ring-fenced); or alternatively, there is an express commitment from the Government for continual payments for the infrastructure (through an annual subsidy).

PPP Conduciveness Assessment of Basin Member States

A high-level assessment of the four Basin Member States PPP legislative/regulatory and institutional framework has been undertaken. The table below provides a summary of the four Basin Member States PPP conduciveness.

Table 16-2: PPP Conduciveness of the Basin Member States

Criteria	Botswana	Lesotho	Namibia	South Africa
Is there is a suitable legislative/regulatory framework to oversee the project?	**Yes.** While there is no PPP Act, the PPP Policy clearly outlines the process of developing a project as a PPP. Botswana is also a regulatory framework for PPP procurement.	**Yes.** Lesotho has established a PPP Policy and Public Procurement Policy, however, they are relatively new.	**Yes.** Namibia has a PPP Act	**Yes.** South Africa has a well-established PPP framework.
Is there a suitable institutional framework, including a dedicated unit, or a public authority with the legal competence to award projects.	**Yes.** There are three key institutional players, including a dedicated unit mandated to provide technical assistance.	**Yes.** There are four key institutional players including a PPP Unit and Public Procurement Authority.	**Yes.** Namibia has a dedicated PPP Unit and PPP Committee.	**Yes.** The GTACs PPP Unit provides specialised transaction advisory services with regard to PPPs.
Have there been any PPP projects that reach financial closure?	**No.** There are no demonstrable projects that have been undertaken and reached financial closure.	**No.** There are no demonstrable projects that have been undertaken and reached financial closure.	**No.** There has not been a project undertaken under the PPP process that has reached financial closure.	**Yes.** South Africa has taken 22 PPPs to financial close. The largest PPP project being the Gautrain Rapid Rail Link project.

Overall, all countries have some level of a PPP framework established, although some countries' PPP frameworks are relatively recent (for instance Lesotho). Each country demonstrated the establishment of a dedicated unit and procurement authority to develop projects and finally procure them as PPPs. Notwithstanding the aforementioned, there does not seem to be an extensive pipeline of projects taken through the PPP process, except for South Africa. This might be an indication of a need to strengthen the identification of suitable projects.

16.3 Proposed financing mechanisms

The required funding for the projects/programmes contained in the IWRMP core scenario could take a number of forms and be obtained from a number of different sources. While, public sector and OECD donor financiers have traditionally constituted the largest proportion of infrastructure financing in Africa, the contributions from the non-traditional private sector (e.g. institutional investors) and other innovative sources is growing albeit slowly.

Projects/programmes of this scale and complexity as those included in the IWRMP core scenario will need to be structured to minimise the cost of capital, based on several key measures - affordability, risk structure and commercial viability - to reflect the intent of the investor. The main broad categories of funding are developmental capital, the commercial capital and blended financing - see **Figure 16-10**.

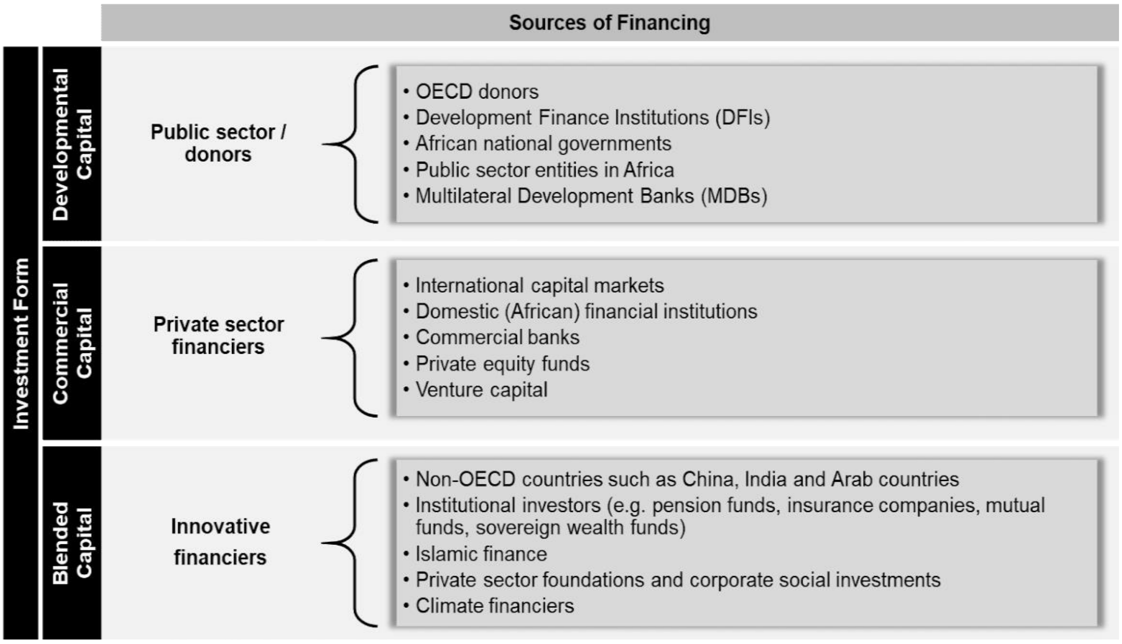


Figure 16-10: Investment forms and sources of finance

Developmental capital (predominantly from the public sector and donor funding) is financing that is provided at sub-market interest rates or as a grant. Such funding is provided by institutions whose focus is on the social value of the project that they are investing in, rather than primarily generating a financial return. The institutions that typically provide developmental capital are the fiscus, public/donor agencies and Development Finance Institutions (DFIs).

Commercial capital (e.g. private sector investment) is driven by the investor's need to secure an appropriate financial return on investment. Commercial capital will only invest in projects that clearly demonstrate financial viability, where the risks associated with the project have been identified and minimized, and where mitigation strategies have been put in place. The main forms of commercial capital are commercial debt and equity.

Blended Finance refers to non-traditional sources of funding and funding instruments for sustainable development. The financiers may seek some level of financial return, however, there is usually a focus on the social value of a project. The Organisation for Economic Co-operation and Development (OECD) provides a formal definition as follows: "*the strategic use of development finance for the mobilization of additional finance (commercial) towards sustainable development in developing countries*."

16.3.1 Donor Funding Options for the IWRMP core scenario

Given the limited domestic resources, donor funding has been an important source of funding for infrastructure projects in Africa. Multilateral banks such as the World Bank Group and the African Development Bank (AfDB), and bilateral banks such as the Development Bank of Southern Africa (DBSA) offer various financing mechanisms for developing countries infrastructure needs.

Several donor agencies have set up infrastructure funds that provide capital to private sector water projects in Sub-Saharan Africa. Public infrastructure funds are dedicated vehicles targeting infrastructure development that source capital from governments, international aid agencies or bilateral and multilateral development banks. These funds target a rate of financial return slightly below rates typical to commercial investors and also require demonstration of some level of targeted impact by the initiative. Three examples that are able to provide funds for private water infrastructure development are described below:

- PIDG Emerging Africa Infrastructure Fund (EAIF): another initiative of the PIDG, EAIF uses public funds from donor governments to raise capital from the private sector. It then on-lends these funds to infrastructure projects in Africa. The EAIF extends project and corporate loans of between USD 10 million and USD 50 million with loan periods of up to 20 years.
- IFC Global Infrastructure Fund: a USD 1.2 billion equity sector fund managed by the IFC's Asset Management Company that invests in projects in various sectors, including water, of global emerging markets. It is funded by a variety of

institutional investors, including sovereign funds, pension funds, and development finance institutions.

- AfDB Africa 50 Fund: an infrastructure investment platform established in late 2015 currently funded governments and development finance institutions that intends to raise funds from institutional investors. The platform offers two investment vehicles: the largest is a debt investment vehicle focused on bankable, readily prepared and easily developed infrastructure projects. No projects have yet been funded. The platform intends to focus on high-impact national and regional projects mostly in the water, transport, ICT and energy sectors.

In the updated core scenario, the projects with larger capital costs could seek financing from the aforementioned funds or any other relevant infrastructure fund through a special purpose vehicle.

16.3.2 Financing the IWRMP through commercial capital

The updated core scenario financing strategy would require some degree of commercial capital raised from the private sector for the project. The main forms of commercial capital are commercial debt and equity. Early-stage project preparation is essential to attract private sector investment, and also to plan appropriately for the right project structure provided there is sufficient commerciality demonstrated by the project's features (e.g. revenue generation).

One avenue by which private sector investment may be structured is through Public-Private Partnerships (PPPs). This discussion on the potential for private sector investment in the IWRM core scenario, therefore, uses PPP transactions as a lens by which the potential for investment is assessed. PPPs are a procurement mechanism in which the public and private sector share the risks of project implementation, including financing of the project. In PPPs, risks are allocated to the party best able to manage them, to realise efficiencies. The private partner is required to meet certain service standards, whilst the public authority regulates to ensure adequate performance. To this end, PPPs tend to be performance-orientated with returns conditional on service delivery. Moreover, state involvement allows for a social objective to be built into the contract.

It is also important to note that the sources of private investment are increasingly sourced within the African continent. The African private equity market is estimated to be worth USD 30 billion. Domestic African markets are an underutilized but highly important source of financing. Africa can finance its development through domestic markets using viable financing instruments such as remittances, pension funds, and private equity funds. Regional DFIs, MDBs and infrastructure funds can support the mobilization of locally sourced capital.

16.3.3 Financing instruments

Irrespective of the source of funding (that is, public or private), the main instruments for funding large infrastructure projects include subsidies/grants, debt, equity and guarantees/risk mitigation instruments. **Figure 16-11** shows the main instruments and different categories within each instrument.

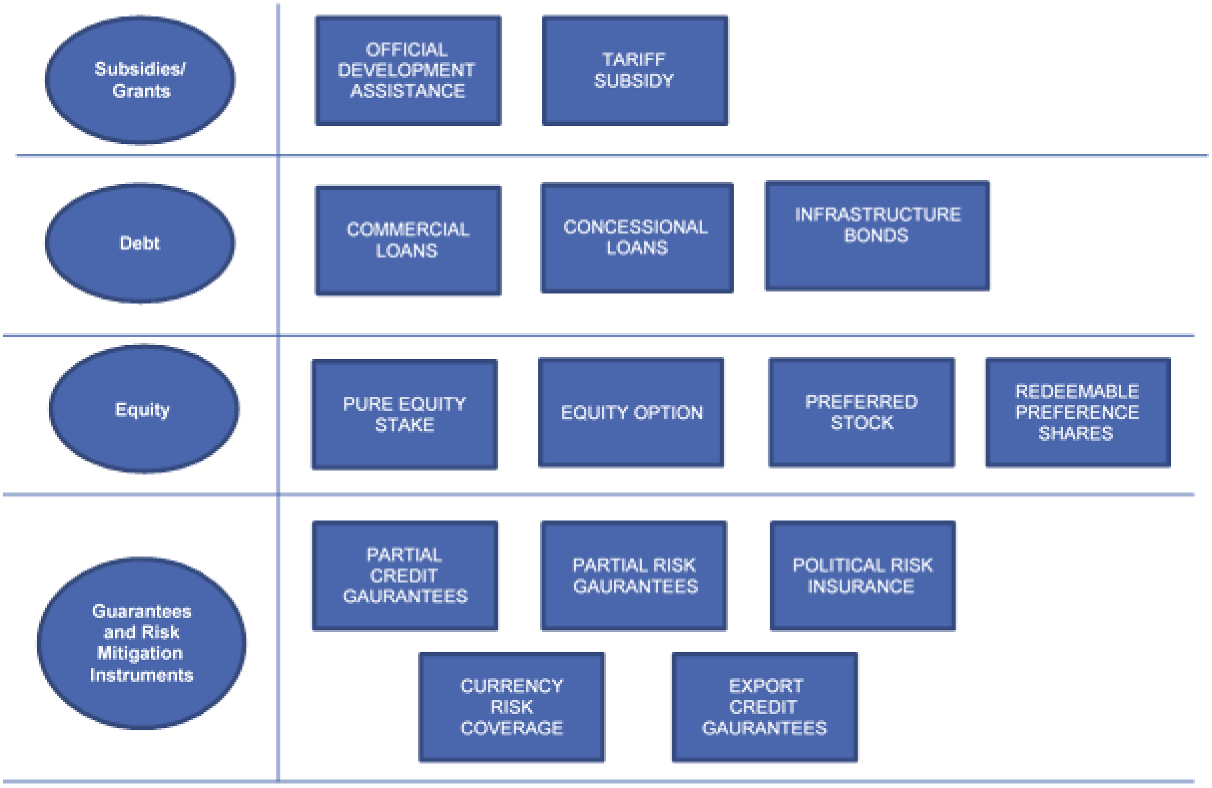


Figure 16-11: Financing Instruments and categories

Source: Infrastructure Consortium for Africa (2012)

Subsidies/Grants: Grant funding can mostly be accessed from traditional sources including OECD countries and private sector foundations although countries in the Middle East and the Far East also provide grants for infrastructure financing. The constraint on grant funding is that it must be justified clearly in terms of; a clearly demonstrated economic and social value for the project, and a rationale for why other forms of funding cannot be obtained. Subsidies are often provided by local governments where the project requires a certain price or tariff level to be commercially viable, but which is unaffordable to the end-users. In the case of the core scenario interventions, the governments of the basin countries may consider providing a tariff subsidy for a specific project if this is required to crowd in commercial investors.

Debt: There is a range of loans that can be used for infrastructure development. Debt typically can be split into commercial and concessional loans. The difference between the two forms of debt is the terms at which the debt is provided. In most cases, commercial debt is provided at market-related interest rates. Concessional debt, on the other hand, has much lower rates and is seen as more developmental finance aimed at financing projects where a significant commercial return is not anticipated. Concessional debt is also often used to leverage commercial debt by lowering the amount of financing required. Further, several innovative bond instruments are emerging, such as infrastructure bonds and diaspora bonds.

- **Equity**: This is the long-term investment undertaken in a project and represents ownership. National governments, development Banks and DFIs as well as private sector financiers are important sources of equity financing.

- **Guarantees and risk mitigation instruments**: DFIs, IFIs and MDBs offer guarantees and risk mitigation instruments with the aim of assisting in leveraging private sector financing. Since guarantees cover commercial and political risks throughout the project development cycle, they improve the risk-return profile of the infrastructure investment, thereby making the investment more attractive for private sector financiers. Guarantees directly assist in mitigating non-repayment and political risks and have been very effective tools for leveraging finance. Private sector financiers perceive the provision of risk-insurance products, first-loss positions in projects, and other risk mitigation instruments by MDBs and DFIs to be even more important than their grantmaking functions.

16.3.4 Conclusion

In summary, the sources of capital for projects is a critical component once the project reaches an advanced stage of development, where the financing component becomes critical to achieving financial close. Most standalone infrastructure investments (in the water sector) require a combination of developmental and commercial capital injection. While the Basin Member States may be able to fully fund components of the core scenario by issuing a bond, it is more likely that the IWRMP core scenario package of interventions will require a combination of funding sources.

As such, the projects must meet the requirements of both developmental and commercial capital financiers in order to attract such investors. Furthermore, developmental capital and commercial capital are not seen as being mutually exclusive. Even for development capital, governments and donors need to be convinced that the project will be able to recover the investment or become sustainable once the initial funding has been provided. On the other hand, commercial capital is increasingly taking into account the economic and social impacts of projects. This is particularly the case for infrastructure investments in Africa and other developing regions.

16.4 Commercial viability

At the heart of the commercial viability assessment is the determination of the optimal funding structure that draws in a number of financing sources. While it is acknowledged that substantial private sector financing will be required, the extent of this, and the possibility of including some concession financing, are important considerations.

Private sector investment is usually formulated through public-private partnerships (PPPs). PPPs are an alternative mechanism of financing, procuring and managing infrastructure projects that are traditionally provided by the public sector. PPPs provide an opportunity to leverage private sector resources to develop the public infrastructure the country needs. In most PPPs, there is a financial contribution in some form from both the private and public sector parties. The private sector usually bears the upfront capital costs or ongoing operation and maintenance costs; the government may pay for the service provided, provide the land required or contribute to the provision of further assets required to support the core infrastructure at the centre of the project.

The following two sections detail the inputs and results of the two high-level financial models for the L-BWT and utilising Crocodile River Return Flows project interventions.

17 COMMERCIAL VIABILITY OF THE L-BWT- PROJECT INTERVENTION

The table below presents the project's timeline assumptions. As indicated in the table below, the base date for the capital costs is 01 January 2018, with a construction start date of 01 January 2025. The construction period is eight years, with the operations beginning 01 January 2033, and running for a period of thirty years.

The selected construction date, and the associated inflation and interest rate forecasts determine the cumulative project costs at the start of construction. The table below presents the general inflation, interest rate and tax assumptions applicable to the project.

Table 17-1: General Inputs and Assumptions

Indicator	Input
Capital Cost Base Date	01 January 2018
Construction Start Date	01 January 2025
Construction Period	8 Years
Operations Start Date	01 January 2033
Operations Period	30 Years
CPIX (inflation)	4.7%
Tax rate	22%
WACC[4]	13.6%

17.1 Project costs

The project costs are split into three categories, construction costs, operational costs, lifecycle replacement costs. They are discussed in further detail below.

17.2 Construction cost

The total construction costs for the project is R65.6 billion (2018 prices). This is mainly dominated by the pipeline costs, shown in **Table 17-2**.

The dam costs are included in the costs as the dam is needed to supply water to the pipeline.

[4] Weighted Cost of Capital

Table 17-2: L-BWT PROJECT Construction Cost

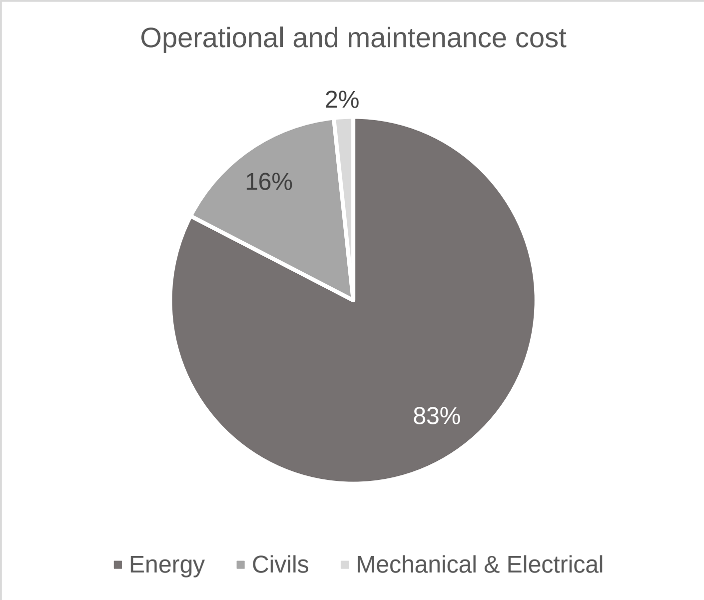
Item	Amount (R Billions)	Percentage split
Pipeline cost	60.9	93%
Dam cost	4.6	7%
Total construction costs	**65.6**	

Operational and maintenance costs

The ongoing operational costs are the annual recurrent costs associated with the daily operation and regular maintenance of the pipeline. The operational costs are made up out of the following:

- Energy and demand charges
- Civils maintenance cost
- Mechanical and electrical maintenance cost

The split is shown in the figure on the right.



The total energy, civils, mechanical and electrical costs are R852 million. This amount is split into the operational cost categories as follows - energy costs (83%), civils maintenance (16%), mechanical and electrical (2%). The total operational and maintenance cost over the operational review period of thirty years amounts to R25.6 billion.

Lifecycle costs

These are costs associated with the periodic major maintenance and replacement of certain fixed assets over the life of the project. The table below presents the recapitalisation schedule.

Table17-3: Recapitalisation schedule

Recapitalisation	Period / Amount
Recapitalisation period – Civils	30 years (i.e. once in the project design life)
Recapitalisation period - Mechanical & Electrical	15 years (i.e. twice in the project design life)
Recapitalisation amount - Civils	100%
Recapitalisation amount - Mechanical & Electrical	100%
Civils as % of capital cost	98%
M&E as % of capital cost	2%

The total recapitalisation cost over the thirty-year period is R14.4 billion.

17.3 Project revenues

The revenue generation potential of the intervention is dependent on two variables – the volume of water pumped, and the tariff at which the water is sold. The intervention has two primary target markets: agricultural irrigation and urban use.

The volume of water pumped

Figure 17-3 below provides a time series of the water transfer through the pipeline over the review period.

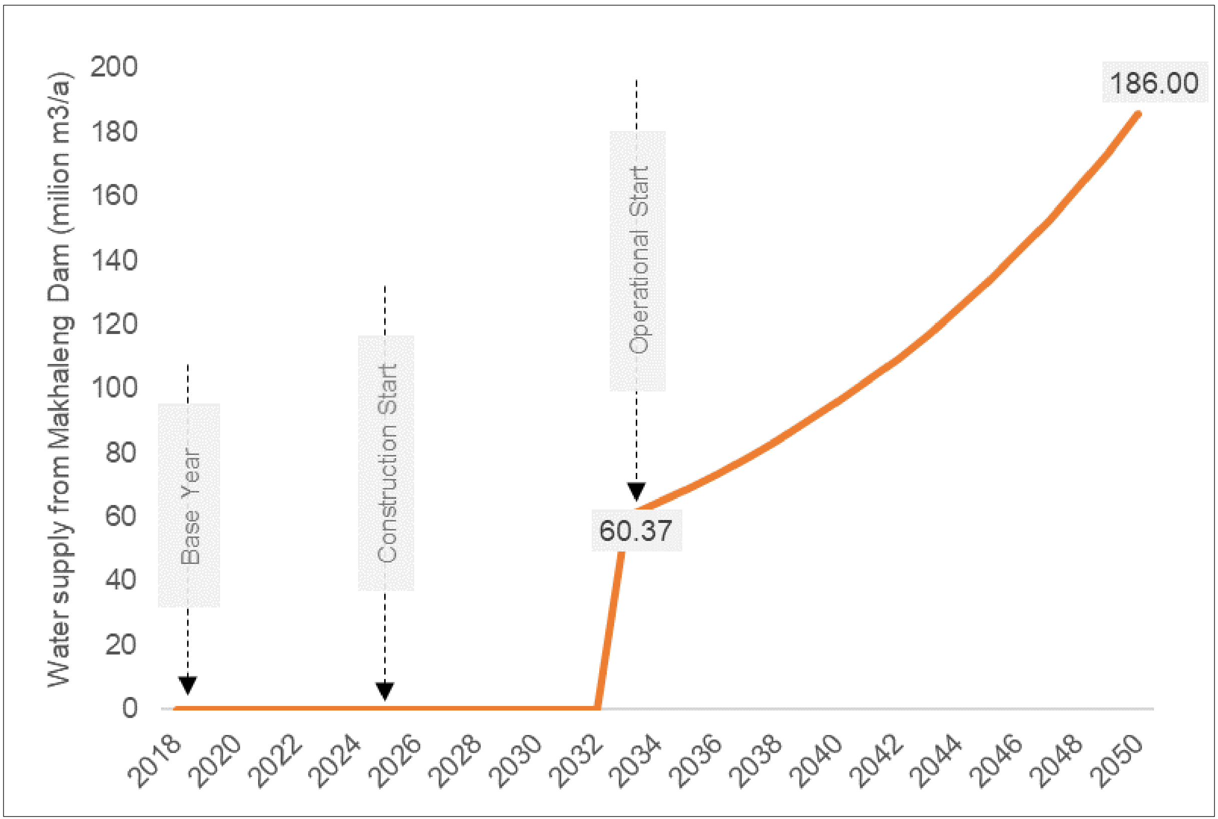


Figure 17.3: Water transfer through the pipeline over the review period

Source: Technical Team

The total amount of water pumped over the thirty years is 4 253 million m^3. The maximum supply is capped at 186 million m^3 per annum in 2050 and thereafter kept constant for the remaining twelve years.

17.4 Tariffs

It is anticipated that there will be one off-taker – the respective national water authority who would on-sell to users such as the relevant departments of agriculture, and municipalities. The tariff per cubic meter of water sold will have a direct bearing on the ability of the off-taker to meet its financial obligations to the concessionaire. Based on available published tariffs, the current tariffs at which the various customers purchase bulk raw water is shown in **Table 17-4**.

Table17-4: Current Botswana water tariffs per customer category

Customer category	Tariff BWP/KL, 2017 Botswana
Domestic customers	6.75
Industrial customers	6.75
Irrigation customers	6.75
Average Tariff	**6.75**

Source: Water Utilities Corporation, Botswana (2017)

The average of the tariffs given in **Table 17.4** is used in the model base case.

17.5 Funding structure and terms

The funding structure explored is a blended finance approach. The allocation of debt and equity for this structure is outlined in the table below.

Table17-5: Funding structure terms

<table>
<tr><th>Financing category</th><th colspan="2">Blended financing structure</th></tr>
<tr><td>Commercial debt</td><td rowspan="2">80%</td><td>60%</td></tr>
<tr><td>Concessional debt</td><td>40%</td></tr>
<tr><td>Equity</td><td>20%</td><td></td></tr>
</table>

Source: Genesis Analytics Assumptions

Commercial debt is typically provided by private sector banks/lenders and in a larger proportion for PPPs. Concessional debt is assumed to be funding provided by development finance institutions and/or the government/s under whose jurisdiction the project falls. The equity provision is assumed to be provided by private equity investors, thus targeting a commercial equity return.

Both commercial and concession debt have specific terms and rates, which are outlined in **Table 17-6**.

Table 17-6: Commercial and Concessional Department Terms

Item	Unit	Figure
Commercial Debt Terms		
Repayment period (Debt tenor)	Years	10
Moratorium period	Years	8
Upfront financing charges	Percentage	1%
Interest rate	Percentage	10%
Concessional Debt Terms		
Repayment period (Debt tenor)	Years	15
Moratorium period	Years	8
Upfront financing charges	Percentage	1%
Interest rate	Percentage	6.3%

17.6 Model output

Assessing the potential of the L-BWT project intervention to be procured through a PPP arrangement essentially involves a financial assessment of the project, built on a confirmation of the project's technical viability. The fundamental question to be answered by the financial appraisal is whether the project will be commercially attractive to private investors. The financial viability of a project is based on various parameters such as the Net Present Value (NPV) and Internal Rate of Return (IRR), which help in deciding whether a project is financially viable or not.

The project NPV gives an indication of the project's ability to self-sustain with the available revenue streams whereas the equity NPV indicates the project's ability to pay back equity providers. The project's returns in the table below clearly indicate that the project is not viable as currently structured in the base case, and would not be attractive to private sector investors. **Table 17-7** below shows the base case returns based on a tariff of R9.69 (this is the above tariff of BWP6.75, adjusted by inflation to the operation start date).

Table 17-7: LWBT Base Case Model Outputs

Parameter	Base case
Tariff (R / KL)	R9.69
Project NPV (R millions)	- R17 040
Project IRR (%)	-0.5%
Equity NPV (R millions)	- R2 767
Equity IRR (%)	0%

Investors expect a certain minimum return on their investment in a project. This is typically between 12% and 15%. In order to achieve a positive project NPV and an equity target of 15%, additional funding to support the project in the form of either a grant and/or annual tariff subsidy through annual tariff subsidy is required.

The results are presented below – the scenario analysis indicates a capital grant of 30% of capital cost and an annual tariff subsidy of 20% of the capital cost is required.

Table 17-8: Blended finance structure – the minimum required capital grant and annual tariff subsidy

	Project NPV	Annual tariff subsidy				
		0%	5%	10%	15%	20%
Capital Grant	**0%**	- 17,040	- 13,527	- 10,256	- 7,295	- 4,424
	10%	- 16,332	- 12,417	- 8,806	- 5,532	- 2,305
	20%	- 15,185	- 10,996	- 7,176	- 3,681	- 200
	30%	- 13,513	- 9,313	- 5,537	- 2,023	1,490
	40%	- 11,224	- 7,450	- 4,117	- 950	2,216

	Equity IRR	Annual tariff subsidy				
		0%	5%	10%	15%	20%
Capital Grant	**0%**	0.0%	0.0%	33.2%	44.5%	47.1%
	10%	0.0%	0.0%	36.5%	43.9%	46.6%
	20%	0.0%	0.0%	38.6%	43.3%	46.1%
	30%	0.0%	5.8%	39.2%	42.7%	45.6%
	40%	0.0%	12.8%	38.5%	42.1%	45.1%

Another approach to increase the project's viability is to increase the tariff charged to meet the required equity return rate of 15%. The results are shown in the table below - the targeted tariff is seen to be significantly higher than the base case tariff – 170% or R16.52 more expensive. It is unlikely that such a scenario will be realistic and thus does not represent the most feasible option for the project.

Table 17-9: Model output based on a targeted equity return rate

	Blended Financing
Tariff (R / KL)	R33.11
Project NPV (R millions)	-R10 111
Project IRR (%)	8.1%
Equity NPV (R millions)	R41
Equity IRR (%)	15%

Based on a targeted equity return rate of 15%, the project NPV is still found to be negative. The tables below summarise a matrix of annual tariff subsidy and capital grant combinations needed to achieve a positive project NPV and targeted equity IRR of 15% with a tariff of R33.11.

Table 17-10: Blended finance structure - required capital grant and annual tariff subsidy

	Project NPV	Annual tariff subsidy				
		0%	5%	10%	15%	20%
Capital Grant	0%	- 10,111	- 6,957	- 4,001	- 1,130	1,742
	10%	- 8,414	- 4,919	- 1,641	1,586	4,813
	20%	- 6,569	- 2,852	652	4,133	7,614
	30%	- 4,852	- 1,151	2,367	5,881	9,394
	40%	- 3,621	- 329	2,837	6,004	9,171

	Equity IRR	Annual tariff subsidy				
		0%	5%	10%	15%	20%
Capital Grant	0%	15.1%	34.2%	44.8%	47.3%	49.5%
	10%	16.9%	36.6%	44.2%	46.8%	49.1%
	20%	18.7%	38.3%	43.7%	46.3%	48.7%
	30%	20.6%	39.3%	43.1%	45.9%	48.2%
	40%	22.6%	39.1%	42.5%	45.4%	47.8%

Source: Genesis Analytics Calculations

The scenario analysis indicates that a 20% upfront capital grant or R13.1 billion and an annual tariff subsidy of 10% of the capital cost is required to achieve a project NPV of R652 million.

17.7 Conclusion

There are essentially two approaches to enhance the project’s viability, as follows:

- Increase the tariff charged from R9.69 to R33.11 to meet a minimum required equity return rate (15%) and,
- Secure upfront capital grant funding equivalent to 20% of the capital cost or R13.1 billion and a yearly annual tariff subsidy of 10% of the capital cost or R6.6 billion.

It is evident that the water from the L-BWT is expensive. During Phase II of this study, the member countries will urgently need to confirm whether water from the L-BWTS is indeed affordable to the recipient States and whether they agree to continue with its implementation. We are however in agreement with the CRIDF findings that lenders will be reluctant to lend this amount of money to a PPP without the governments of the recipient states giving explicit guarantees for the loans. It may be a good idea for ORASECOM to approach TCTA and request that it tests the willingness of its bankers to fund the project.

18 COMMERCIAL VIABILITY OF UTILISING CROCODILE RIVER RETURN FLOWS PROJECT INTERVENTION

18.1 General inputs and assumptions applied in the model

The table below presents the project's timeline assumptions. This project intervention is split into two components: Rietvlei and Roodeplaat WTW. **Table 18-1** indicates the base date for the capital costs of each component as provided by the technical team.

The selected construction date, and the associated inflation and interest rate forecasts determine the cumulative project costs at the start of construction. **Table 18-1** presents the general inflation, interest rate and tax assumptions applicable to the project.

Table 18-1: General Inputs and Assumptions

Indicator	Input	
	Rietvlei WTW	Roodeplaat WTW
Capital Cost Base Date	01 January 2018	
Construction Start Date	01 January 2021	01 January 2022
Construction Period	3 Years	
Operations Start Date	01 January 2024	01 January 2025
Operations Period	30 Years	
CPIX (inflation)	4.7%	
Tax rate	22%	
WACC	13.6%	

18.2 Project costs

The project costs are split into three categories, construction costs, operational costs, lifecycle replacement costs. They are discussed in further detail below.

18.2.1 Construction cost

The total construction cost for the project, as estimated by the Technical Team, is R1.55 billion (2018 prices). The construction cost is split into various elements for each project component as shown in **Table 18-2**.

Table 18-2: Roodeplaat and Rietvlei WTW costs

	Amount (R millions)
Rietvlei Dam	
Construction cost	**972**
Construction cost - WTW	576
Construction cost - Olifants transfer	180
Construction cost - raw pumping system	14
Roodeport Dam	
Construction cost	**576**
Construction cost - WTW	288
Construction cost - extraction work	150
Construction cost - pumping system	18
Total Capital cost	**1 548**

18.2.2 Operational and maintenance costs

The ongoing operational costs are the annual recurrent costs associated with the daily operation and regular maintenance of the pipeline. The operational costs are made up out of the following:

- Energy and demand charges
- Civils maintenance cost
- Mechanical and electrical maintenance cost

The split is shown in **Figure 18-1** on the right.

The total energy, civils, mechanical and electrical costs are based on an annual estimation of R764m, by the technical team. This amount is split into the operational cost categories as follows - energy costs (23%), civils maintenance (29%), mechanical and electrical (48%).

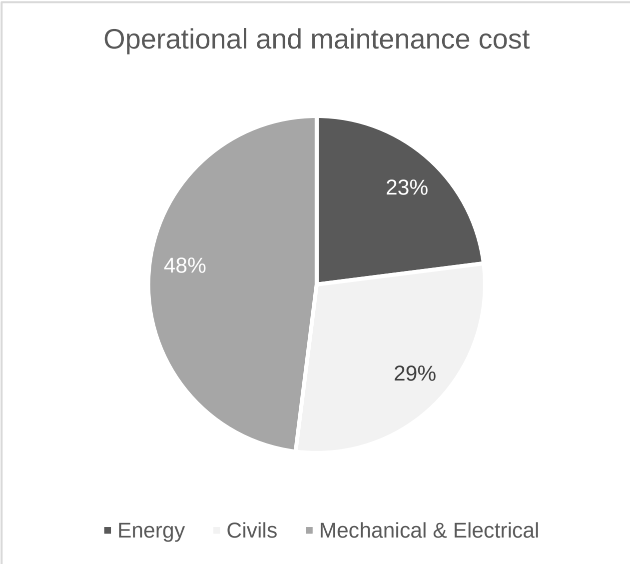


Figure 18-1: Operational and maintenance cost – Crocodile return flows

The total operational and maintenance costs over the operational review period of thirty years amount to R4.3 billion.

18.2.3 Lifecycle costs

These are costs associated with the periodic major maintenance and replacement of certain fixed assets over the life of the project. **Table 18-3** below presents the recapitalisation schedule.

Table 18-3: Recapitalisation schedule

Recapitalisation	Period / Amount
Recapitalisation period – Civils	30 years (i.e. once in the project design life)
Recapitalisation period - Mechanical & Electrical	15 years (i.e. twice in the project design life)
Recapitalisation amount - Civils	20%
Recapitalisation amount - Mechanical & Electrical	60%
Civils as % of capital cost	98%
M&E as % of capital cost	2%

The total recapitalisation cost over the thirty-year period is R228 million.

18.3 Project revenues

The revenue generation potential of the intervention is dependent on two variables – the volume of water supplied to the off-taker, and the tariff at which the water is sold. The intervention has two primary target markets: agricultural irrigation and urban use.

18.3.1 The volume of water pumped

Figure 18-3 provides a time series of the water transfer through the pipeline over the review period.

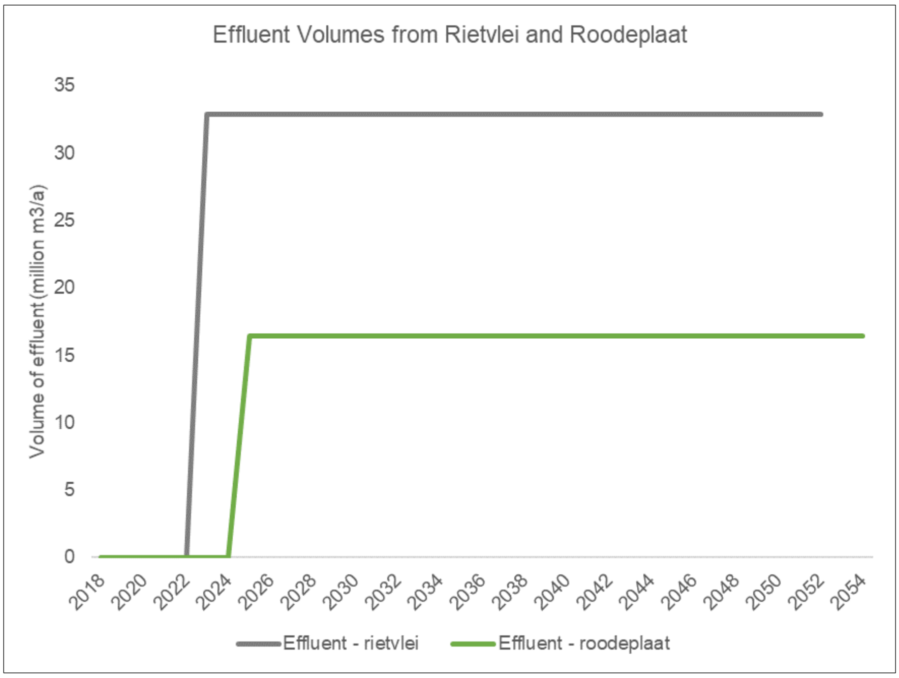


Figure 18.3: Water transfer through the pipeline over the review period

Source: Technical Team

The total amount of water pumped over the review period is 1 478 million m^3. Supply is fixed at 32.85 million m^3 per annum in 2050 and thereafter kept constant for the remaining twelve years.

18.3.2 Tariffs

It is anticipated that there will be one off-taker who would on-sell to other downstream users. The tariff per cubic meter of water sold will have a direct bearing on the ability of the off-taker to meet its financial obligations to the concessionaire. The City of Tshwane has a published 2019 tariff of R9.35[5] per KL for the supply of purified wastewater. This is the tariff that is used in the model base case.

18.4 Funding structure and terms

The funding structure explored is a blended finance approach. The allocation of debt and equity for this structure is outlined in **Table 18-4**.

Table 18-4: Funding structure terms

<table>
<tr><th>Financing category</th><th colspan="2">Blended financing structure</th></tr>
<tr><td>Commercial debt</td><td rowspan="2">80%</td><td>60%</td></tr>
<tr><td>Concessional debt</td><td>40%</td></tr>
<tr><td>Equity</td><td>20%</td><td></td></tr>
</table>

Source: Genesis Analytics Assumptions

Commercial debt is typically provided by private sector banks/lenders and in a larger proportion for PPPs. Concessional debt is assumed to be funding provided by development finance institutions and/or the government/s, under whose jurisdiction the project falls. The equity provision is assumed to be provided by private equity investors, thus targeting a commercial equity return.

Both commercial and concession debt have specific terms and rates, which are outlined in **Table 18-5**.

[5] Rand Water (2019) http://www.randwater.co.za/SalesAndCustomerServices/Tariffs/All%20Approved%20Customer%20Tariffs%202019-20/All%20customers%20approved%20tariff%202019_20.pdf

Table 18-5: Commercial and Concessional Dept Terms

Item	Unit	Figure
Commercial Debt Terms		
Repayment period (Debt tenor)	Years	10
Moratorium period	Years	8
Upfront financing charges	Percentage	1%
Interest rate	Percentage	10%
Concessional Debt Terms		
Repayment period (Debt tenor)	Years	15
Moratorium period	Years	8
Upfront financing charges	Percentage	1%
Interest rate	Percentage	6.3%

Source: Genesis Analytics Assumptions

18.5 Model Output

As stated earlier, the objective of carrying out the financial appraisal is firstly to ascertain the financial viability of the project, and secondly, to determine the possible financial returns to investors. As indicated above, the financial viability of a project is based on various parameters like the NPV and IRR which help in deciding whether a project is financially viable or not.

The project NPV gives an indication of the project's ability to self-sustain with the available revenue streams whereas the equity NPV indicates the project's ability to pay back equity providers. The project's returns in **Table 18-6** below clearly indicate that the project is not viable as currently structured in the base case and would not be attractive to private sector investors.

Table 18-6: Utilise Crocodile River Return Flows base case model outputs

Parameter	Base case
Tariff (R / KL)	R9.35
Project NPV (R millions)	- R992
Project IRR (%)	0%
Equity NPV (R millions)	- R147
Equity IRR (%)	0%

The results are presented in **Table 18-7**. Investors expect a certain minimum return on their investment in a project. This is typically between 12% and 15%. In order to achieve a positive project NPV and an equity target of 15%, additional funding to support the project in the form of either a grant and/or annual tariff subsidy through an annual tariff subsidy is required.

The scenario analysis indicates a capital grant of 10% of capital cost and an annual tariff subsidy of 9% of the capital cost is required to achieve a positive NPV.

Table 18-7: Blended finance structure – the minimum required capital grant and annual tariff subsidy

	Project NPV	Annual tariff subsidy				
		0%	5%	7%	9%	11%
Capital Grant	**0%**	- 992	- 480	- 254	- 57	141
	10%	- 956	- 386	- 163	52	267
	20%	- 904	- 300	- 73	154	380
	30%	- 825	- 223	5	233	461
	40%	- 707	- 154	58	270	482

	Equity IRR	Annual tariff subsidy				
		0%	7%	12%	17%	22%
Capital Grant	**0%**	0.0%	8.1%	15.0%	23.3%	31.6%
	10%	0.0%	8.6%	17.6%	26.6%	35.2%
	20%	0.0%	10.0%	20.8%	30.2%	38.8%
	30%	0.0%	13.3%	24.5%	33.9%	42.4%
	40%	0.0%	17.3%	28.4%	37.7%	46.0%

Another approach to increase the project's viability is to increase the tariff charged to meet the required equity return rate of 15%. The results are shown in **Table 18-8** - the targeted tariff is seen to be significantly higher than the base case tariff (R9.35) and may be unaffordable.

Table 18-8: Model output based on a targeted equity return rate

	Blended Financing
Tariff (R / KL)	R12.86
Project NPV	-R269
Equity IRR (%)	15.02%

Based on a targeted equity return rate of 15%, the project NPV is still found to be negative. The tables below summarise a matrix of annual tariff subsidy and capital grant combinations needed to achieve a positive project NPV and targeted equity IRR 15% with a tariff of R15.64. The scenario analysis indicates that a 30% upfront capital grant or R465 million is required.

Table 18-9: Blended finance structure – required capital grant and annual tariff subsidy

	Project NPV	Annual tariff subsidy				
		0%	5%	7%	9%	11%
Capital Grant	**0%**	- 269	225	423	620	818
	10%	- 185	351	566	781	995
	20%	- 102	465	691	918	1,145
	30%	- 25	546	774	1,002	1,230
	40%	37	566	778	990	1,201

	Equity IRR	Annual tariff subsidy				
		0%	5%	7%	9%	11%
Capital Grant	**0%**	15.0%	39.4%	47.3%	54.5%	61.2%
	10%	19.2%	43.0%	50.6%	57.6%	64.1%
	20%	23.7%	46.5%	53.9%	60.7%	67.0%
	30%	28.1%	50.0%	57.1%	63.7%	69.8%
	40%	32.4%	53.3%	60.2%	66.6%	72.5%

19 CONCLUSION

There are essentially two approaches to enhance the project's viability, as follows:

- Increase the base tariff of R9.35 to R12.86 to meet a required equity return rate (15%) and,
- Secure an upfront capital grant of 40% of the capital cost equivalent to R619 million.

During Phase II of this study, the member countries will urgently need to confirm they agree to continue with the implementation of the L-BWT. It may be a good idea for ORASECOM to test the willingness of its bankers to fund the project.

20 PROPOSED INVOLVEMENT OF ORASECOM IN FACILITATING AGREEMENT ON THE FUTURE ALLOCATION OF ORANGE/SENQU RIVER BASIN WATER

What is clearly shown in the hydrological/yield analysis of the basin undertaken as part of this study is just how constrained the availability of water will be once the core scenario projects listed in the investment plan are developed.

Every new upstream dam will have to make allowance through releases for downstream use, and every new downstream dam will be dependent on sufficient releases from upstream dams. In other words, any development planned in the investment plan **must not cause significant harm** to another watercourse state.

The assessment in the Institutional Report above summarises the factors and criteria that must be taken into account when agreeing on what is equitable and reasonable use. However, unless the Watercourse States actually agree on a quantified allocation of water for use amongst themselves and the environment, including the ecological Reserve, such factors and criteria will not be actionable. Further development of the basin without such allocations will likely result in disputes.

Because of the stochastic nature of the hydrology, such a quantified water allocation would necessarily be in the form of operating rules that are triggered/driven through the continual monitoring of the status of the dam levels throughout the basin, and by the water use of the different water use sectors out of those dams. In other words, it would be a dynamic allocation of water based on a maximum supply and levels of curtailment depending on the status of the dams.

A fundamental input to such operating rules is the level of assurance that each water use sector should be supplied at. Basic human needs, domestic and industrial use would generally receive water at a higher level of assurance (98%) than agriculture (80%). This means that in the case of a drought, water supply to agriculture would be reduced by a certain percentage before water supply to domestic and industrial is reduced.

Another fundamental input is the amount of new development of each of the sectors that will be supplied out of the Orange/Senqu River basin, as opposed to being supplied from other sources. And again, it will be necessary to agree on priorities between domestic/industrial and agriculture.

In order to make the future development of the Orange/Senqu River basin sustainable, and in order to avoid later conflicts, it is required that ORASECOM facilitate an agreement on the allocation of the resources of the Orange River over a specified time horizon, say the next 30 years up until 2050.

It is recommended that ORASECOM convene a Committee to enable ORASECOM to:

- Forecast the future water demand of each sector out of each current and proposed dam in the Orange River;
- Assign a level of assurance to each sector;
- Test the ability of the resource to meet such forecast demand;
- If the resource is not sufficient, then to reach an agreement on curtailing the demand in a fair and equitable way using the principles set out in the various treaties and summarised in section 5; and agree, through means of a treaty, a fair allocation of the resource between basin states and the operating rules to ensure such a fair allocation of the resource.

The Real-Time monitoring of the basin would be a necessary input to the work of this committee.

21 CONCLUSIONS

The list of projects or investments that form part of the basin-wide investment plan is listed in Table 2-1.

All of these projects have already been identified by the basin states, and have been subject to various levels of planning. No projects are included that are not already known to the Basin States.

Each project is described and the core dimensions, yields and costs as reflected in the most recent reports are included.

These assumptions are likely to change as more detailed studies and analysis is undertaken.

The purpose of the economic assessment is to provide crucial information regarding the relative economic viability of the Core Scenario to empower a sponsor and investors with an understanding of the overall impact of the project.

The economic assessment determined the economic effectiveness and efficiency of the Core Scenario. The URV analysis provided an indicative value for money of each clustered scheme and individual project intervention. While some schemes reflect low-cost effectiveness, there are identified cost efficiencies realized as indicated by the results of the CBA. The key factor to note in the URV analysis is the wide range of results, driven by the differing nature of the various interventions that make up the clusters.

The CBA provided a socio-economic rationale for the Core Scenario by weighing up the economic costs and benefits of the clustered schemes. The CBA results indicate that overall, five out of the seven schemes will result in a positive net benefit to the ultimate beneficiaries, and one is a marginally net negative outcome. The results reflect healthy BCRs and economic rates of return.

An investment timeline is proposed in table 13-1.

The investment timeline is according to the latest known information and the assumed commencement date of each investment.

For various reasons the investment timeline may slip, so this timeline should be invested as an efficient scenario.

Possible institutional arrangements for the L-BWT Scheme are proposed in Chapter 14.

The L-BWT should be coordinated by a tri-lateral institution, possibly linked to the LHWC.

The L-BWT can either be implemented and funded by existing institutions or by an SPV created specifically for the purpose.

Our preference is to maximize the use of existing institutions including LHDA, Botswana Water Corporation, TCTA and possibly Rand Water.

CRIDF funded a study on the institutional and funding arrangements of the L-BWT that was finalised after the draft of our report was submitted for comments. We made our analysis available to the CRIDF PSPs and their study came to similar conclusions.

The CRIDF study identified three types of SPVs.

Both this study and the CRIDF study agree that it could be extremely difficult for a private sector SPV to negotiate the land access and the regulatory hurdles required to build an extremely long pipeline that traverses three countries and private land. National Government Departments or State-Owned Entities would need to be involved in the implementation.

Possible institutional arrangements for the other core investment clusters are proposed in Chapter 15.

Again the emphasis has been to utilize existing institutions that are already doing the tasks as far as possible.

Sources and access to funding are discussed in Chapter 16.

The analysis includes an overview of the economy of the member states as well as an overview of the various available financial instruments.

Various water tariff scenarios based on blended finance structures (loans and grants) have been developed as an indicator of the commercial viability of the various investments.

Chapter 16, 17, 18

The sources of capital for projects is a critical component once the project reaches an advanced stage of development, where the financing component becomes critical to achieving financial close. Most standalone infrastructure investments (in the water sector) require a combination of developmental and commercial capital injection. While the Basin Member States may be able to fully fund components of the core scenario by issuing a bond, it is more likely that the IWRMP core scenario package of interventions will require a combination of funding sources.

At the heart of the commercial viability assessment is the determination of the optimal funding structure that draws in a number of financing sources. While it is acknowledged that substantial private sector financing will be required, the extent of this, and the possibility of including some concession financing, are important considerations.

During Phase II of the L-BWT study, the member countries will urgently need to confirm if they agree to continue with the implementation of the L-BWT pipeline and the Crocodile River Return Flows re-use interventions. Each will need to secure capital grant funding and a yearly annual tariff subsidy to make them attractive to investors. It may be a good idea for ORASECOM to test the willingness of its bankers to fund the project.

22 RECOMMENDATIONS

It is recommended that ORASECOM adopt the Basin Wide Investment Plan and Investment Timeline as a planning tool to facilitate the achievement and monitoring of the General Principles as set out in Article 4 of the ORASECOM Agreement and the equitable allocation of the resource.

The Investment Timeline and the water yielded by each investment should be updated from time to time and specifically when a member state gives a Notification of Planned Measures.

Preliminary funding and institutional arrangements have been recommended for each project and these will need to be confirmed by the interested parties during feasibility level studies. Where appropriate, existing institutional arrangements have been used.

The L-BWT Scheme will be a major investment relative to the GDP of the member states and this study already shows that water supplied out of it is relatively expensive and will have an impact on the current water use charges of the areas that it serves.

The members are now required to take a formal decision on whether to proceed with the L-BWT to Stage 2 of this study or not.

At the end of Stage 2 of the L-BWT study, the member States will be required to make a conclusive decision on whether the L-BWT Scheme is to continue to implementation or not.

The firm commitment of the member states to the L-BWT Scheme and the Investment Plan would greatly facilitate discussions with funding agencies and/or potential private sector partners.

Given the amount of funding that will be required, it is likely that the banks would require the recipient States to guarantee the funding of the L-BWT, whether or not a PPP approach is utilized.

23 REFERENCES

DWAF, 1996. the Orange River Replanning Study (ORRS) Refinement of the instream flow requirements for the Orange River by BKS and Ninham Shand for the Department of Water Affairs and Forestry RSA. September 1996. Report number PD 00/00/617.

DWAF, 2009. VAAL RIVER SYSTEM: LARGE BULK WATER SUPPLY RECONCILIATION STRATEGIES: WATER RESOURCE ANALYSIS (March 2009). Prepared by: DMM Development Consultants, Golder Associates Africa, SRK, WRP Consulting Engineers and Zitholele Consulting. DWAF Report Number: P RSA C000/00/4406/05.

MAWF, 2011. Integrated Water Resources Management: Orange-Fish River Basin. Presentation to MAWF.

http://www.the-eis.com/data/literature/MAWF_IWRM%20booklet%20-%20Orange%20Fish%20River%20Basin_RV2.pdf accessed on 27 November 2018

DWA,2012. Water Reconciliation Strategy Study for the Large Bulk Water Supply Systems. Greater Bloemfontein Area. Reconciliation Strategy Report June 2012. Report no. P WMA 14/C520/00/0910/05

DWS, 2015. DEVELOPMENT OF RECONCILLIATION STRATEGIES FOR LARGE BULK WATER SUPPLY SYSTEMS: Orange River – Final Reconciliation Strategy. Prepared by: WRP Consulting Engineers, Aurecon, Golder Associates Africa, and Zitholele Consulting. Authored by Authored by van Rooyen P. and Mare M DWS Report No: RDM/WMA06/00/CON/COMP/0216.

DWS, 2017. Determination of Ecological Water Requirements for Surface water (river, estuaries and wetlands) and Groundwater in the Lower Orange WMA.River EWR report. Prepared by: Rivers for Africa eFlows Consulting (Pty) Ltd. Authored by Louw D, Birkhead D, Koekemoer S, Mare M. DWS Report No: RDM/WMA06/00/CON/COMP/0317.

DWS,2018. Continuation of the Integrated Vaal River System Reconciliation Strategy Study – Phase II. Vaal River Annual Operating Analysis 2018/19. WRPM Scenario Results. Compiled by WRP Consulting Engineers for DWS

Mangaung Metro Municipality, 2018. Mangaung Gariep Water Augmentation Project. Scenario analyses Greater Bloemfontein Water Supply System. Prepared by WRP and BIGEN for Mangaung Metro

MMEWA, 2013. Botswana Integrated Water Resources Management & Water Efficiency Plan (L. Dikobe, Ed.) Gaborone, Botswana: Government of Botswana.

ORASECOM, 2014. Support to Phase 3 of the ORASECOM Basin-wide integrated Water Resources Management Plan Main Report: Compiled C Crerar and D Weston (BRL, WRP, Pegasys, Hydroc)

SMEC, 2017. Final Water Resources Assessment Report. Consulting Services for the Update Detail Designs, and Construction Supervision of the Lesotho Lowlands Water Supply Scheme. The Government of Lesotho, Lesotho Water Commission.

ORASECOM, 2019a. Lesotho-Botswana water transfer multipurpose transboundary project Component III Pre-feasibility Phase. Pre-feasibility report Phase 1 Report. Report number ORASECOM 014/2019. By WRP Consulting Engineers and Knight Piésold Consulting. ORASECOM, Pretoria, South Africa.

PWC, 2017. Permanent Water Commission Namibia RSA, 2017. Noordoewer/Vioolsdrift Dam Feasibility Study. Noordoewer/Vioolsdrift Dam Size Optimization 20170525 Final Draft (currently ongoing)

BNWMP, 2018. Botswana National Water Master Plan Update Based on Smart Water Management (February 2018)

ORASECOM, 2019b. Preparation of climate resilient water resources investment strategy & plan Component I. Climate Change. Report no. ORASECOM 007/2019. By WRP Consulting Engineers and the CSIR. ORASECOM, Pretoria, South Africa.

ORASECOM, 2019c. Preparation of climate resilient water resources investment strategy & plan Component I. Core Scenario Update Report. Report no. ORASECOM 003/2019. By WRP Consulting Engineers and the CSIR. ORASECOM, Pretoria, South Africa.

ORASECOM, 2019d. Preparation of climate resilient water resources investment strategy & plan Component I. Review and assessment of existing policies, institutional arrangements and structures. Report no. ORASECOM 008/2019. By WRP Consulting Engineers and the CSIR. ORASECOM, Pretoria, South Africa.

ORASECOM, 2020a. Preparation of climate resilient water resources investment strategy & plan Component I. Optimized IWRMP Core Scenario economic approach Report. Report no. ORASECOM 009/2020. By WRP Consulting Engineers and Genesis. ORASECOM, Pretoria, South Africa.

ORASECOM, 2020b. Preparation of climate resilient water resources investment strategy & plan Component l.