ORASECOM — Orange-Senqu River Commission — Botswana, Lesotho, Namibia, South Africa — Established 2000

The Orange-Senqu River Commission (ORASECOM)

Sharing the Water Resources of the Orange-Senqu River Basin

Botswana | Lesotho | Namibia | South Africa

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

ROADMAP FOR IWRMP OPERATIONALIZATION

Component II

August 2024

FINAL REPORT

Report number: ORASECOM 012/2019

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

COMPONENT II

ROADMAP FOR IWRMP OPERATIONALIZATION REPORT

Prepared for

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

COMPONENT II

ROADMAP FOR IWRMP OPERATIONALIZATION REPORT

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TABLE OF REPORTS

Reports submitted	ORASECOM Report No.[1]
Inception Report Components I and II	ORASECOM 010/2018
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Preparation of climate resilient water resources investment strategy & plan Component I	
Core Scenario Update Report Component I	ORASECOM 003/2019
Core Scenario Supporting Report: Water Requirements and Return flows **Component I**	ORASECOM 004/2019
Core Scenario Supporting Report: Water Conservation, Water Demand management and Re-use Report **Component I**	ORASECOM 005/2019
Core Scenario Supporting Report: Ground Water Report **Component I**	ORASECOM 006/2019
Climate Change Report **Component I**	ORASECOM 007/2019
Review and assessment of existing policies, institutional arrangements and structures Component I	ORASECOM 008/2019
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Roadmap supporting Report: Strategic actions and TORs (Appendix A to Roadmap Report)	ORASECOM 013/2019
Lesotho-Botswana water transfer multipurpose transboundary project Component III Pre-feasibility Phase	
Pre-feasibility report Phase 1 Report Component **III**	ORASECOM 014/2019
Pre-feasibility report Phase 2 Report Component **III**	ORASECOM 015/2019

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Report A Phase 2: Dam on the Makhaleng River	ORASECOM 015A/2019
Report B Phase2: Water Conveyance System	ORASECOM 015B/2019
Report C Phase 2: Environmental and Social Assessment	ORASECOM 015C/2019
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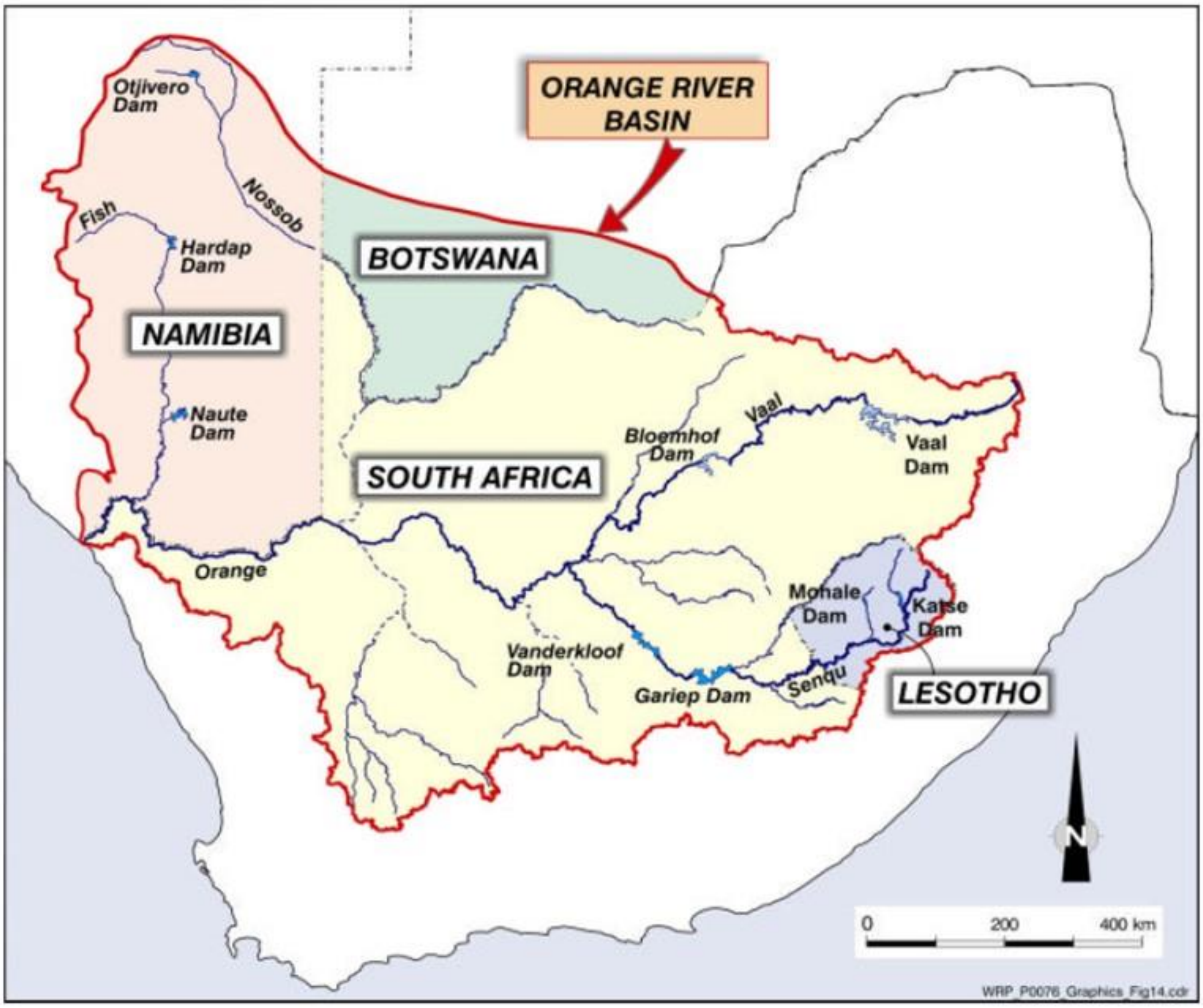
EXECUTIVE SUMMARY

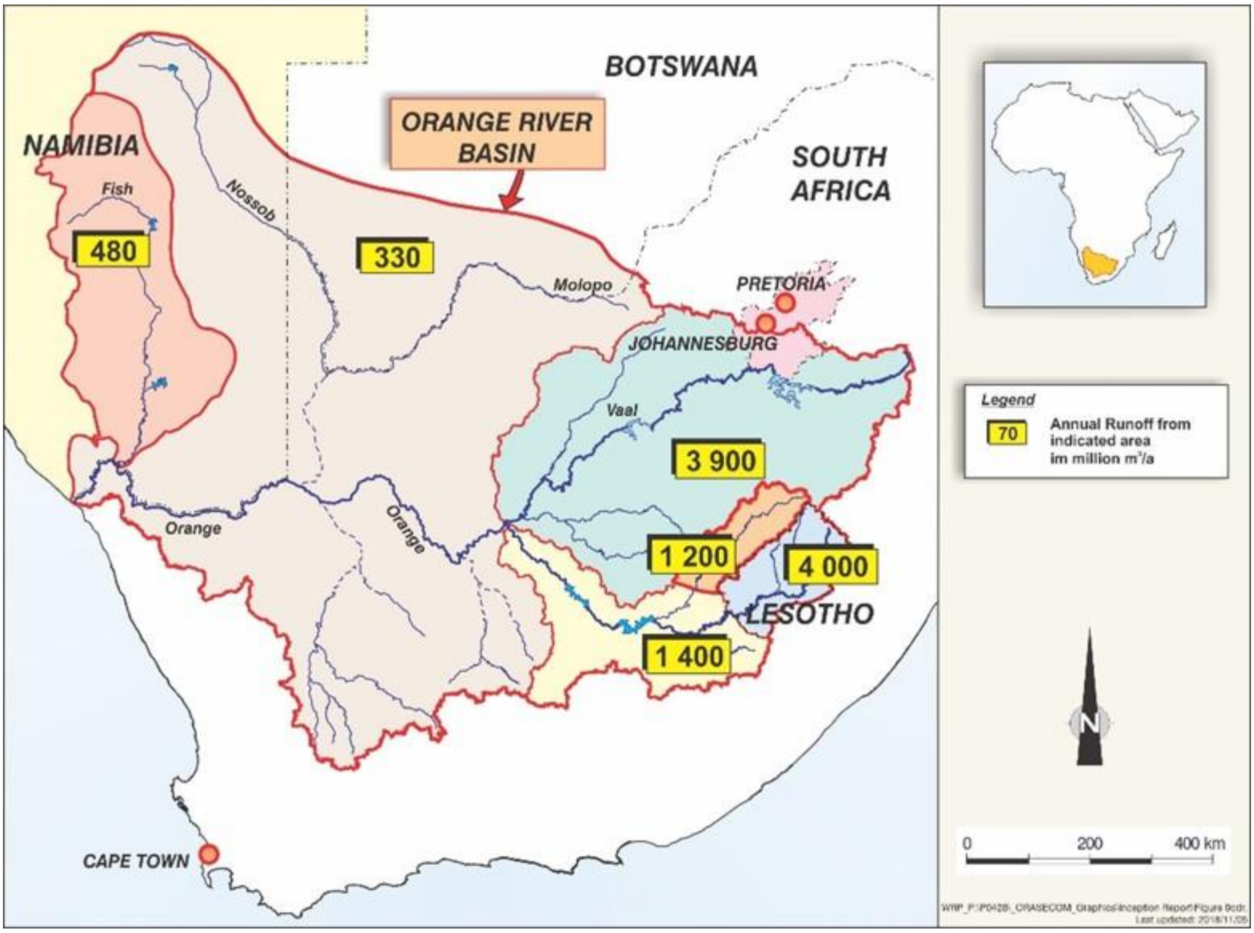
The Orange-Senqu River Basin

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. The Orange-Senqu River originates in the Highlands of Lesotho and flows in a westerly direction for approximately 2,200 km to the west coast of South Africa and Namibia where it discharges into the Atlantic Ocean.



Water Resources of 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 basin in the Lesotho Highlands, 6,500 million m^3/a from the Vaal and Upper Orange, with approximately 800 million m^3/a from the Lower Orange and Fish River (Namibia).



The runoff values provided highlight the highly variable and uneven distribution of runoff from east to west in the basin and the various water demands have already reduced the actual runoff reaching the river mouth to less than half the natural runoff. The Natural Runoff figures refer to the runoff which would have occurred had there been no developments or impoundments in the catchment.

It is important to note that the current demands for water within the basin are basically in balance with the available yields from the many different dams and transfer schemes. As such, it is important to analyse all possible new dam developments to assess their impacts on existing downstream users and to provide additional yield where necessary to rebalance any shortages caused by the new development.

Climate Change

It is generally accepted that southern Africa will be highly impacted by climate change and various studies have been completed which indicate that Climate Change is likely to affect the water resources of the basin to some degree. It is agreed that the temperature and thus also the evaporation will increase throughout the basin. The rainfall is expected to reduce especially in the lower areas to the west of the catchment although there is no clear indication of what will happen in the high laying wetter areas in Lesotho and to the East of the basin. This study therefore aims to enhance investment in transboundary water security and to develop resilience to climate change through strategic projects and actions, some of which are described in the Integrated Water Resource Development Plan.

The Republic of Botswana is an arid country with serious water constraints which will worsen with the expected effects of climate change. Botswana can expect to experience chronic water shortages in the near future unless a major new water source is developed. Gaborone has already experienced a serious drought which caused severe shortages in 2015 and 2016. Droughts are natural events which must be expected from time to time. It is clear, however, that they are becoming more frequent and more severe due to the impacts of Climate Change. The proposed Lesotho to Botswana Water Transfer Project is effectively a Water Resilience Project aimed at protecting the water supply to Southern Botswana by providing a reliable alternative water source to augment the existing local water resources as well as the supply from Northern Botswana through the North-South Carrier.

ORASECOM and the Integrated Water Resources Development Plan

Southern Africa has fifteen (15) transboundary watercourse systems of which thirteen exclusively stretch over the Southern African Development Community Member States. The Orange–Senqu is one of these thirteen transboundary watercourse systems. The Southern African Development Community 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 riparian states. To enhance the objectives of integrated water resources development and management in the region, the Orange–Senqu River Basin Commission (ORASECOM) was established in November 2000.

ORASECOM was established by the Governments of the four States, namely, South Africa, Lesotho, Botswana and Namibia, for managing the transboundary water resources of the Orange-Senqu River basin and promoting its beneficial development for the socio-economic wellbeing and safeguarding the basin environment. This led to the development of a basin level Integrated Water Resources Management Plan adopted in February 2015 by the ORASECOM Member States. The Integrated Water Resources Development 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 project implementation that provides a mutually inclusive transboundary benefit.

The Integrated Water Resources Development Plan recommends strategies and measures for promoting sustainable management of the water resources of the basin and 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 Orange-Senqu River basin is a highly complex and integrated water resource system, characterised by a high degree of regulation and major inter-basin transfers to manage the resource availability between the location of relatively abundant precipitation and the location of greatest water requirements. The infrastructure involves storage and transmission of water to demand centres that are in some cases located outside of the basin through intra and inter basin transfers. The largest interbasin transfer is the Lesotho Highlands Water Project which transfers approximately 800 million m^3/annum water to South Africa through an 80km long transfer tunnel which runs through the Maluti Mountains.

Objective of this Study

The objective of this study is to assist ORASECOM and the riparian countries to implement various elements of the Integrated Water Resource Management Plan developed in 2015. The objective will be met through the following three processes:

- A Climate Resilient Investment Plan for the Orange-Senqu River Basin based on the updated Core Scenario. The Core Scenario is basically a detailed list of new water resource developments which have been planned by the 4 basin states to ensure that future water demands can be supplied into the future taking into account the possible impacts of Climate Change.
- A proposed Implementation Plan for a number (nine separate projects have been identified) of Key Strategic Actions selected from the updated Integrated Water Resource Management Plan. These proposed Strategic Actions are potential projects where ORASECOM will play a key role in the management and funding of the work.
- A Pre-feasibility level report for the Lesotho to Botswana Water Transfer Project, and a feasibility level report for a new dam on the Makhaleng River in Lesotho.

The study is divided into four components namely:

Component I

- 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.

Component II

- Operationalisation of the Integrated Water Resources Management Plan;

Component III

- A Pre-feasibility study of the Lesotho to Botswana Water Transfer Project;

Component IV

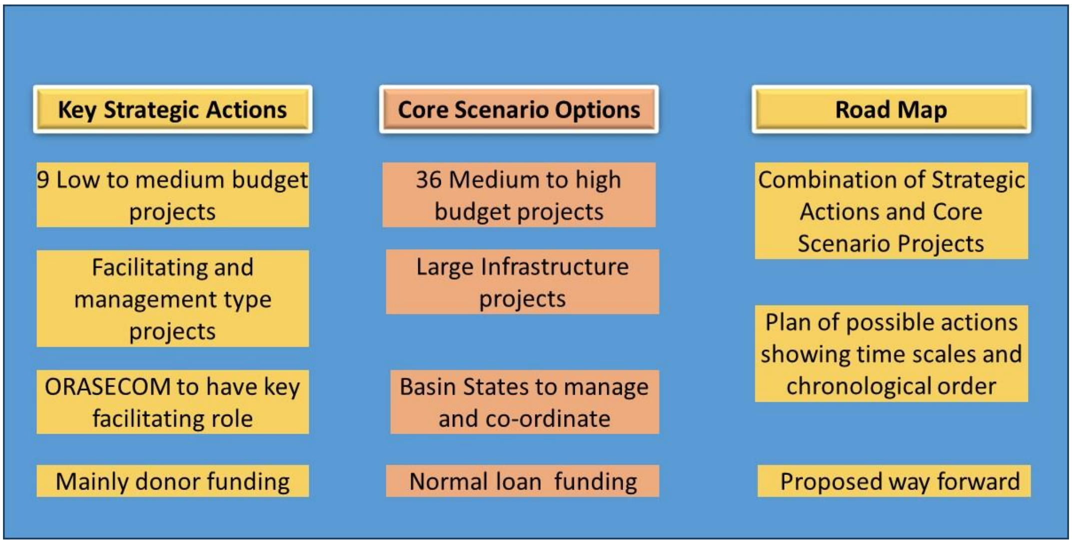
- A Feasibility Study of the Dam on Makhaleng River in Lesotho.

Future Water Resource Developments

As a result of the potential impacts of Climate Change and growing economies, the Governments of Botswana, Lesotho, Namibia and South Africa recently agreed to undertake a Pre-feasibility study on the Lesotho to Botswana Water Transfer scheme (L-BWT) aimed at developing new water infrastructure in Lesotho and through South Africa, to convey water from Lesotho to Botswana at the same time supplying various users in Lesotho and South Africa. This Pre-feasibility (Component III & IV of this study) led to the selection of a technical option which included a possible dam on the Makhaleng River in Lesotho and a water conveyance system to Botswana. It is envisaged that 186 million m^3/a (162 million m^3/a before losses) could be pumped to Botswana which includes supply (approximately 30 million m^3/a) for consumers along the route in Lesotho and South Africa.

Following the completion of Components I & II of this study, a number of possible development options and supporting studies were identified. These have been split into two specific categories namely:

- Key Strategic Actions
- Core Scenario Infrastructure Projects



Key Strategic Actions

The nine Key Strategic Actions discussed in this report are listed below together with the approximate funding requirements for each action:

	Description	Capital Cost ($m)	Running Costs ($m/annum)
1	Agreement and Implementation of Environmental Water Requirements	$1m to $5m	$1m per annum
2	Improvement and Implementation of Monitoring and Information Management	$5m	$1m per annum
3	Development and Implementation of Guidelines for sharing	$1m	
4	Synchronisation and Preparation of Future and Planned Developments	$1m	
5	**Implementation and monitoring of WDM activities**	$1m	
6	**Assurance of Supply and Economic Value of Water**	$1m	
7	**Water Disaster Management – Climate Adaptation**	$2.0m to $3.0m	
8	**Capacity Building**		$2m in 3 years
9	**Hydrology Update and WQ Model Calibration**	$3m	

Core Scenario Projects

The Orange Senqu River basin is one of the most complicated and integrated water resource systems in the world. It covers an area of over 1 million km^2 and includes:

- Over 80 large Dams/Reservoirs
- Over 270 small Dams/Reservoirs
- Over 1200 demand centres (cities, irrigation schemes, power stations etc)
- A system network of over 4 000 links (pipelines, tunnels, river sections etc)
- Over 300 individual naturalised streamflow sequences (monthly records for 90 years)
- Over 300 monthly rainfall records(monthly for 90 years)

In order to effectively manage such a large and complicated water resource system, it is necessary to continually monitor and update the various water demands as well as to plan and commission new water related infrastructure in the form of new dams, pipelines, tunnels etc. The proposed future schemes are discussed by the 4 basin states (Botswana, Lesotho, Namibia and South Africa) on a regular basis and the process is managed and facilitated through ORASECOM which has been created to ensure that all new developments are first discussed and agreed in principle to avoid possible problems in future.

The most likely future development scenario is referred to as the “Core Scenario” and it includes the current and likely future demands for all existing demand centres, as well as all existing water related infrastructure and possible future developments. The future developments include the projected water demands and possible new infrastructure as provided by each of the 4 basin states. Only projects that have been investigated to at least a pre-feasibility level, in that a basic costing has been done, have been included in the “Core Scenario”. When considering the detail provided for each possible future project, it is important to note the following:

- All cost estimates provided are estimated based on 2018 price levels unless otherwise stated.
- The cost estimates were all taken from various reports prepared by others.
- Some of these reports were only at a pre-feasibility level of detail while others were at a feasibility level with the result that some cost estimates are more accurate than others.
- The cost estimates quoted in the various reports were escalated to the 2018 price levels, using published government inflation figures.

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

The 36 Core Scenario Projects have been presented in 9 clusters which are each discussed in this report. The nine clusters and related costs and yields are provided in the table below:

Cluster Name	Capital cost ($ million)	Operational Cost ($ million)	Yield impact (million m^3/a)
1) Orange River Project + Noordoewer/Vioolsdrift Dam intervention options	2 096	6.9	724
2) Lesotho Botswana Water Transfer Scheme	2 856	45.3	162/334*
3) Lesotho Lowland developments	73	0.3	65
4) Integrated Vaal River System intervention options	1 723	84.4	522
5) Caledon to Greater Bloemfontein transfers	15	0.6	11
6) Greater Bloemfontein internal resource improvements	82	8.8	31
7) Gariep to Greater Bloemfontein transfer	226	12.1	43
8) Neckartal Scheme in Namibia	26	0.7	90
9) Integrated Water Management Options	337	67.2	308

Note: * 162 million m^3/a refers to the net transfer volume (186 million m^3/a including losses) and 334 million m^3/a to the local yield of the dam which reduced to 308 million m^3/a in feasibility phase due to repositioning of the dam.

Cluster 1: The Orange River Project + Noordoewer/Vioolsdrift Dam options

The Orange River Project refers to Gariep and Vanderkloof dams and their total supply area. These are the two largest storage dams in the Orange-Senqu basin. The gross storage of Gariep Dam is 4 905 million m^3 and 3 107million m^3 for Vanderkloof Dam. The yield available from this system is currently fully utilised and therefore no new demands can be supplied without adding some additional yield to the system through the construction of new dams/reservoirs or through the reduction of existing demands in some manner. Constructing any new dams upstream of the Orange River Project will reduce the yield available from the system and create water shortages to the existing users. Polihali Dam is currently under construction and will reduce the yield available from the Orange River Project by approximately 280 million m^3/a. Some form of yield augmentation will therefore be required to offset the reduction in yield caused by Polihali Dam when it is finally completed and starts to transfer water to the industrial heartland of South Africa.

Several augmentation options have been identified by Department Water and Sanitation South Africa to rebalance the system and allow for some further development along the Orange River. All these augmentation options form part of the Orange River Project and Noordoewer/Vioolsdrift Cluster. Due to the significant impact of Polihali Dam on the Orange River Project it was included as part of this cluster. These options include:

- Utilise the lower-level storage in Vanderkloof Dam yield increase 137 million m^3/a.
- Noordoewer/Vioolsdrift Dam along Namibia RSA border on the Lower Orange River. Final size of the dam to be determined and agreed on between Namibia and the RSA.
- Polihali Dam and transfer tunnel to Katse Dam forming part of the Lesotho Highlands developments. The local yield of 391 million m^3/a. Construction recently started.
- Verbeeldingskraal Dam upstream of Gariep Dam with an estimated yield of 200 million m^3/a.
- Real time monitoring and modelling, reducing operational requirements by approximately 80 million m^3/a.

More details of the Orange River Project + Noordoewer/Vioolsdrift Dam Cluster are given in the main text of the report.

These include the investment cost of each of the schemes, the yield generated by the project and the Unit Reference Value for each scheme as well as for the Cluster of schemes.

Final sizes and related yield of these dams are still to be determined.

Cluster 2: The proposed Lesotho to Botswana Water Transfer Scheme

This project includes a 3 MAR dam (dam with a gross storage of three times the mean annual runoff generated from the catchment upstream of the dam) on the Makhaleng River. The scheme includes the 688 km pipeline (diameter from 2 200mm to 1 100mm) from Lesotho to Gaborone/Lobatse, which also supplies some towns in South Africa with water. There is a high possibility that water supply to Bloemfontein can be included as part of this transfer scheme. The pre-feasibility study for this transfer scheme was completed with the Feasibility study in progress at the time of writing this report (November 2023) and this scheme is discussed in more detail in various project reports as well as the “Road Map” Report. This dam has a local yield of 308 million m^3/a (was initially 344 million m^3/a in pre-feasibility study but reduced due to change in dam site) of which an annual transfer of 186 million m^3/a (162 million m^3/a before losses) will be transferred to users in Lesotho and the RSA, with the bulk of that transferred to Botswana.

Cluster 3: The Lesotho Lowlands Dams.

These dams comprise two proposed dams, supplying urban/rural demands and irrigation developments within Lesotho, namely:

- Hlotse Dam; and
- Ngoajane Dam.

The final size and yield from these two dams still need to be determined.

Cluster 4: The Integrated Vaal River System Intervention Options.

The Vaal River System Intervention Options include:

- 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.

The proposed further phases of the Thukela River Water Transfer comprise two new dams at Jana on the main tributary of the Thukela River and the Mielietuin Dam on the Bushman’s 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 due to mitigation releases for existing downstream users.

Key information on this water transfer scheme includes:

- The Jana Dam with the incremental yield of 396 million m^3/a and the Mielietuin Dam with the incremental 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 $1 184 million and the annual operations cost at $9.1 million/a, at the 2018 development levels.

Cluster5: Caledon to Greater Bloemfontein Transfer

The intervention options 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 generally 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 were recently completed and the system is already in full operation.
- Increase the total pump capacity at Tienfontein Pump Station to 7 m^3/s by 2040 or later.
- 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 $9.5 million (2018).
- The operational cost is estimated at $0.4 million/a (2018).

Cluster 6: Greater Bloemfontein Internal Resource Improvements

Most of the projects included under Cluster 6 were recommendations from the Mangaung Gariep Augmentation Project (Mangaung, 2018), although there are similarities with the recommendations from the Greater Bloemfontein Reconciliation Strategy (DWS, 2012). Several components form part of Cluster 6 which include the following:

- Raise Mockes Dam – This component is designed 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 Water Treatment Works 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 low quality return flows up to potable standards.
- Indirect re-use of 16 million m^3/a from the Bloemspruit Waste Water Treatment Works 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.

Additional key information on the transfer scheme includes:

- 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 $ 86.2 million
- and the combined operational cost for all components was estimated at $ 77.1 million/a

Cluster 7: Gariep to Greater Bloemfontein Transfer

The projects covered under Cluster 7 are recommendations from both the Greater Bloemfontein Reconciliation Strategy (DWS, 2012) and the Mangaung Gariep Augmentation Project (Mangaung, 2018). The SA Department of Water and Sanitation has, however, confirmed that an independent study has been commissioned to identify the best option from a national perspective. This study had not been completed at the time of writing this report (November 2023).

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 m3/a, to a total transfer capacity of 43 million m^3/a.

Additional key information on the transfer scheme includes:

- Phase 1 capital cost estimated at $200 million.
- Phase 1 operational cost estimated at $9 million/a.
- Phase 2 capital cost estimated at $ 26.3 million.
- Phase 2 operational expenditure estimated at $ 3.1 million/a

The reader is also referred to cluster 2 where another option is listed that can be used to transfer water to the Greater Bloemfontein via the Lesotho-Botswana Water Transfer Scheme. Final decisions in this regard have however not been made.

Cluster 8: Neckartal Scheme

The Neckartal Dam located in the lower Fish River in Namibia was completed in 2018 and has been storing water since that time.

The main purpose of this dam is to supply water to a new irrigation development which has yet to be completed at the time of writing this report. Water will be released from the dam directly into the river and abstracted downstream from a diversion weir. The water will be pumped to a high lying storage reservoir and gravity fed for irrigation. The releases from the dam into the river will take place via hydro-power turbines, which have already been installed.

The planning of the irrigation scheme is behind schedule, and by June 2024 more than 19 000ha had been acquired by the Namibian Government for irrigation development. 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 could be used to support the Environmental Water Requirement downstream of the diversion weir.

Cluster 9: Integrated Water Management Options

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

- Removal of unlawful irrigation.
- Water Conservation and Water Demand Management within irrigation schemes.
- Water Conservation and Water Demand Management 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
- Harmonise policy, legal and institutional frameworks.

The primary integrated water management options are the Water Conservation and Water Demand Management in the irrigation sector and Water Conservation and Water Demand Management in the urban and industrial sectors. The reconciliation strategies prepared for the Integrated Vaal River System (DWAF, 2009), the Orange System (DWS, 2015) and the Greater Mangaung (DWA, 2012) Water Supply systems all include Water Conservation and Water Demand Management as a high priority action needed to maintain a positive water balance in future years. In the Integrated Vaal River System Reconciliation Strategy, it was stated that savings from Water Conservation and Water Demand Management in the irrigation sector will not be available for other water users or water use sectors, but that the savings will be utilised 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 a similar approach regarding Water Conservation and Water Demand Management 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 Water Conservation and Water Demand Management. In such cases, the irrigators might be willing to sell some of the water to other users to obtain some benefit for their Water Conservation and Water Demand Management efforts. For the Orange system, it was estimated that approximately 5% of the current irrigation use can be saved to be utilised by other users. The remainder of the Water Conservation and Water Demand Management saving in the irrigation sector is expected to be utilised by the existing irrigators to increase their irrigation area. The 5% savings through Water Conservation and Water Demand Management in the irrigation sector in the Orange system was estimated at 73 million m3/a. It should be noted 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 $10.5 million with the operational expenditure at about $ 0.11 million/a

It is expected that the largest savings from Water Conservation and Water Demand Management will be from the urban and industrial sectors.

Initial combined savings in the urban and industrial sectors due to Water Conservation and Water Demand Management were estimated at 240 million m^3/a from the different reconciliation strategies. Water Conservation and Water Demand Management 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 had already been achieved. Consequently, a further potential saving of 155 million m^3/a can be saved.

To be able to save the 155 million m^3/a in the urban/industrial sectors through Water Conservation and Water Demand Management, the expected capital expenditure was estimated at $ 322 million with the operational expenditure at $67.1 million/a

Funding Options

The proposed Lesotho-Botswana Transfer Project is one of the main elements of the current study and comprises a possible new dam on the Makhaleng River in Lesotho together with a 700km long pipeline from Lesotho to Botswana. The project has an expected cost of approximately $3 billion at 2018 cost levels based on R18/$ exchange rate. Approximately 10% of the overall project cost is associated with the construction of the dam while the remaining 90% is associated with the pipeline and pump stations. The project can include a small hydropower installation which will require a further $60 million should this be included.

The funding requirements of the Lesotho to Botswana Water Transfer Project as well as many of the Core Scenario Projects are so large that they cannot be secured by any single member of the 4 basin states. The Lesotho to Botswana Water Transfer Project, in particular, will require funding from several countries as well as some form of grant funding and Government Guarantees to support the normal loan funding. This means that even with a Public Private Partnership option, the governments will still be required to underwrite the project.

If the Parties agree to proceed with the Project, then it is recommended that State-Owned Entities such as the Lesotho Highlands Development Authority, Trans Caledon Tunnel Authority and the Water Utility Corporation of Botswana (possible together with Rand Water) be involved with the implementation of components of the scheme in the different countries.

It is clear that the water from the Lesotho to Botswana Water Transfer Project will be expensive when comparing the cost per m^3 of water delivered to most other water supply projects in Southern Africa. The member countries must confirm as soon as possible whether or not water from the Lesotho to Botswana Water Transfer Project is affordable before they agree to continue with its implementation. The funding assessment by the Project Team is in general agreement with the findings from a parallel study recently undertaken by the Climate Resilience Infrastructure Development Fund which also highlighted the issue that lenders be reluctant to lend such large amounts of funding for such water infrastructure projects without the governments of the recipient states giving explicit guarantees for the loans. These funding conclusions apply to both the Lesotho to Botswana Water Transfer Project as well as the various associated water related projects discussed under the “Core Scenario Projects”.

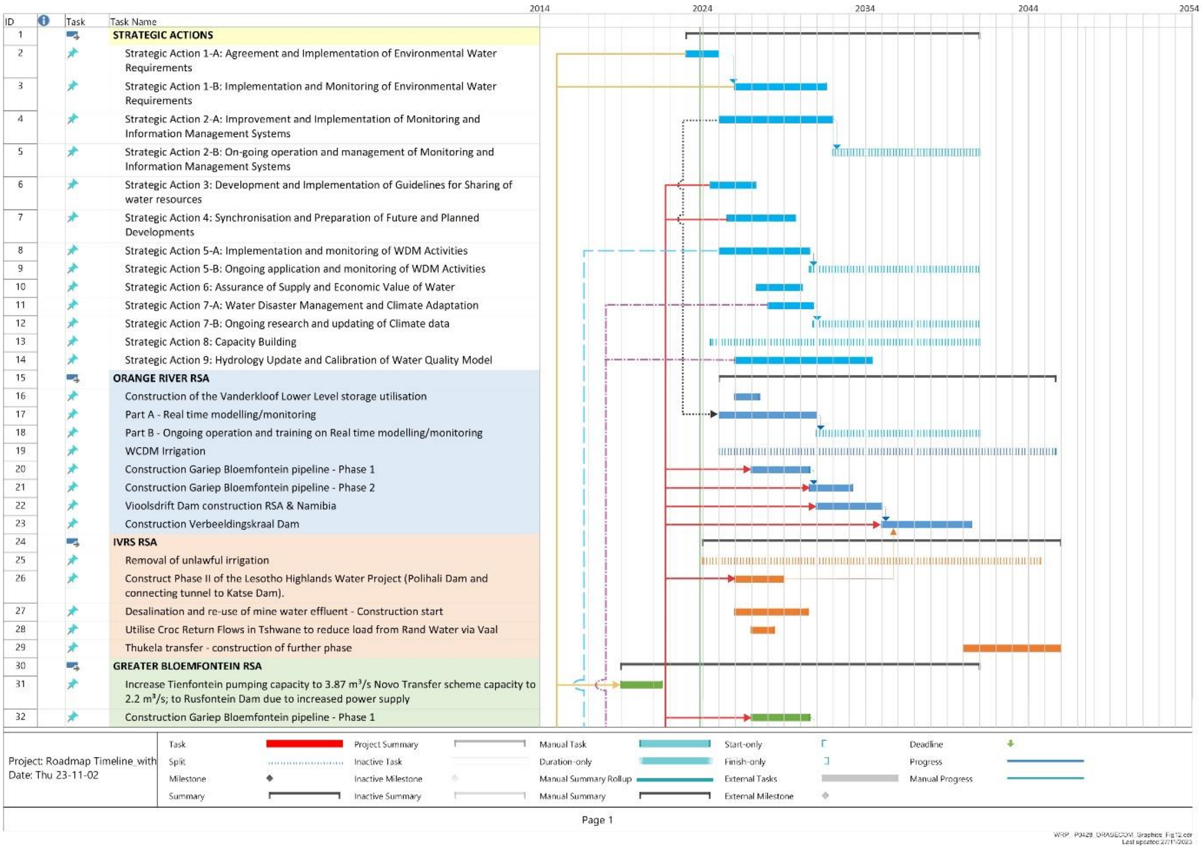
Most standalone infrastructure investments (in the water sector) require a combination of developmental and commercial capital. While the Basin Member States may be able to fully fund components of the core scenario by issuing a bond, it is more likely that the Integrated Water Resource Management Plan core scenario interventions will require a combination of funding sources.

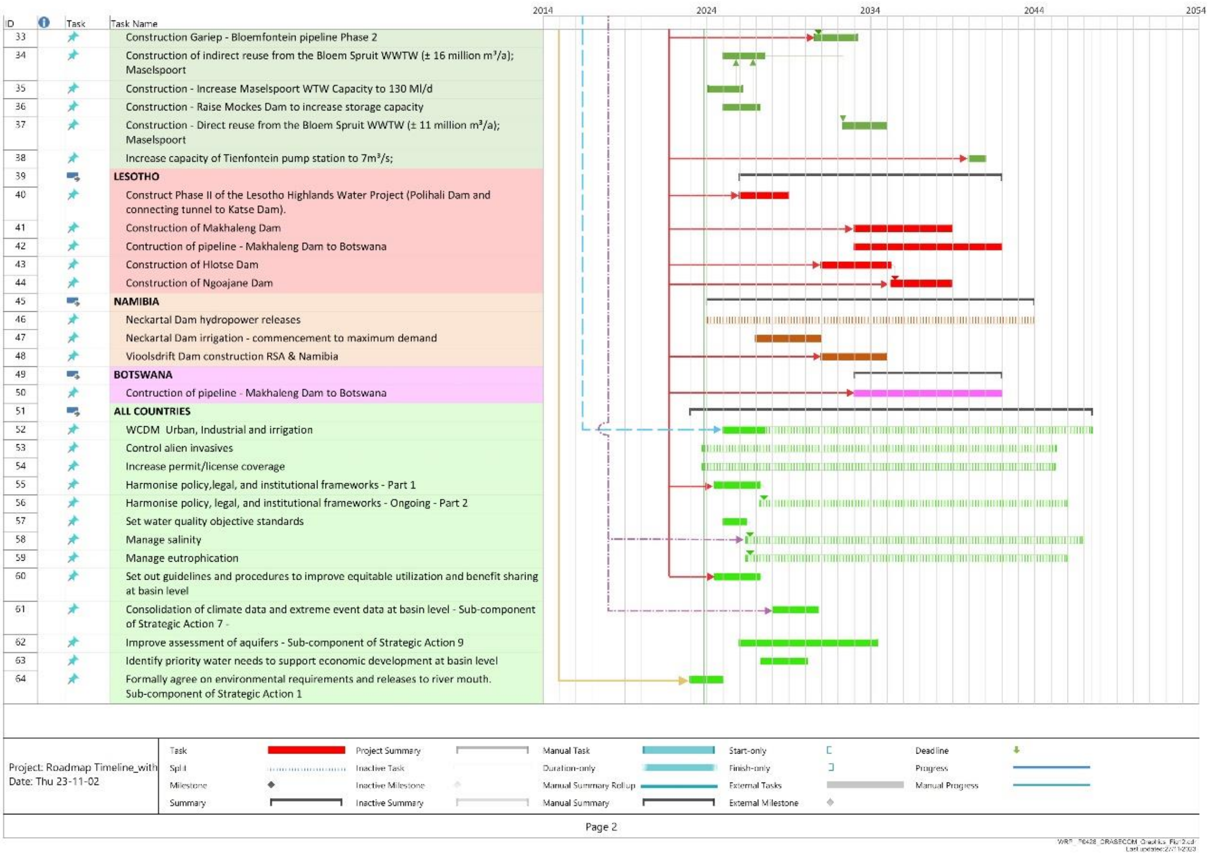
The proposed projects must therefore meet the requirements of both developmental and commercial capital financiers in order to attract such investors. Furthermore, developmental capital and commercial capital are not seen as being mutually exclusive. Even for development capital governments and donors 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. Certain projects proposed in the Road Map are clearly Climate Resilience projects which are designed to supply water to address possible future shortages that are due to the impacts of Climate Change. Such projects may qualify to receive preferential terms or even significant grant funding from one of the various Global Climate Funds which have been established to support such projects in developing countries. This may help to create a viable project which would not be possible without some level of grant funding.

Road Map Report and Way Forward

Each Key Strategic Action and Core Scenario Project is discussed in detail in this “Road Map” report which aims to pull all the proposed projects together into a single coherent plan. Timelines and budgets for each project have been provided to assist possible funding partners to assess the various projects and determine if they wish to participate in them. A key aim of the “Road Map” Report is therefore to summarise the projects through a series of “Concept Notes” (**Appendix B** and **Appendix C**) which provide sufficient information for possible Funding Partners to understand the scope of the project and likely funding requirements without having to digest the many lengthy reports which contain the full detail of each project.

The proposed way forward involves the implementation of the various water related projects in a manner in which they can provide additional yield to users in the river basin without damaging the supply to existing demand centres. A proposed action plan has been developed which is presented in a series of figures (Road Map Timeline) which show the proposed commencement dates for each project together with the duration of each project. Where appropriate, the linkages with other projects have been included to highlight where specific projects are linked to each other to ensure that they are implemented in the correct sequence to minimise any water supply problems to existing users. A full description of the various projects and linkages is provided in the main report.





Road Map Time-Line

Conclusions and Recommendations

- Depending on the availability of funds, political drive and decisions taken, the actual growth of the water requirements, success rate of water conservation and water demand actions etc. the timing and implementation of the projects and key strategic actions will change in future. It is therefore recommended that the Road Map program be regarded as a live document and be updated on an annual basis.
- The Lesotho Botswana Transfer Scheme is expensive, and its financial viability needs to be checked in detail after the completion of the Feasibility Study of both the dam and conveyance system. Based on these financial and economic assessments the member countries will need to confirm if the water from the Lesotho to Botswana Water Transfer Project is indeed affordable to the recipient States and whether or not they agree to continue with its implementation.
- Polihali Dam, currently under construction, as well as the possible future dam on the Makhaleng River will impact significantly on the yield of existing downstream schemes. Based on current planning no compensation/mitigation releases will be made from these two dams to re-balance the existing downstream schemes. It is therefore important to introduce other intervention options to restore the water balance to the downstream system. The cost of these intervention options was not included in the costing of Polihali Dam or the proposed dam on the Makhaleng River. Considerable effort has already been undertaken by DWS RSA on possible options to re-balance the downstream system as result of the impact of Polihali Dam These options have been included in the Core Scenario Schemes and in some of the Key Strategic Actions.
- Some options have already been identified as part of this study to re-balance the impact of that the dam on the Makhaleng River has on the existing downstream developments. A detailed reconciliation strategy study is, however, required to determine the most appropriate intervention option to re-balance the existing downstream systems. This proposed reconciliation study is referred to in Key Strategic Action no. 4.
- The Road map will provide guidance to ORASECOM and the four basin states to implement the Water Resources Investment Strategy and Plan, including the large number of development projects from the Core Scenario as well as the Key Strategic Actions.

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APPENDICES

APPENDIX A: Draft Terms of Reference for the Key Strategic Actions

APPENDIX B: Strategic Actions: Concept Notes

APPENDIX C: Core Scenario Projects: Concept Notes

1 INTRODUCTION

1.1 Background

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. The Orange-Senqu River originates in the Highlands of Lesotho and flows in a westerly direction for approximately 2,200 km to the west coast of South Africa and Namibia where it discharges into the Atlantic Ocean. (See **Figure 1)**

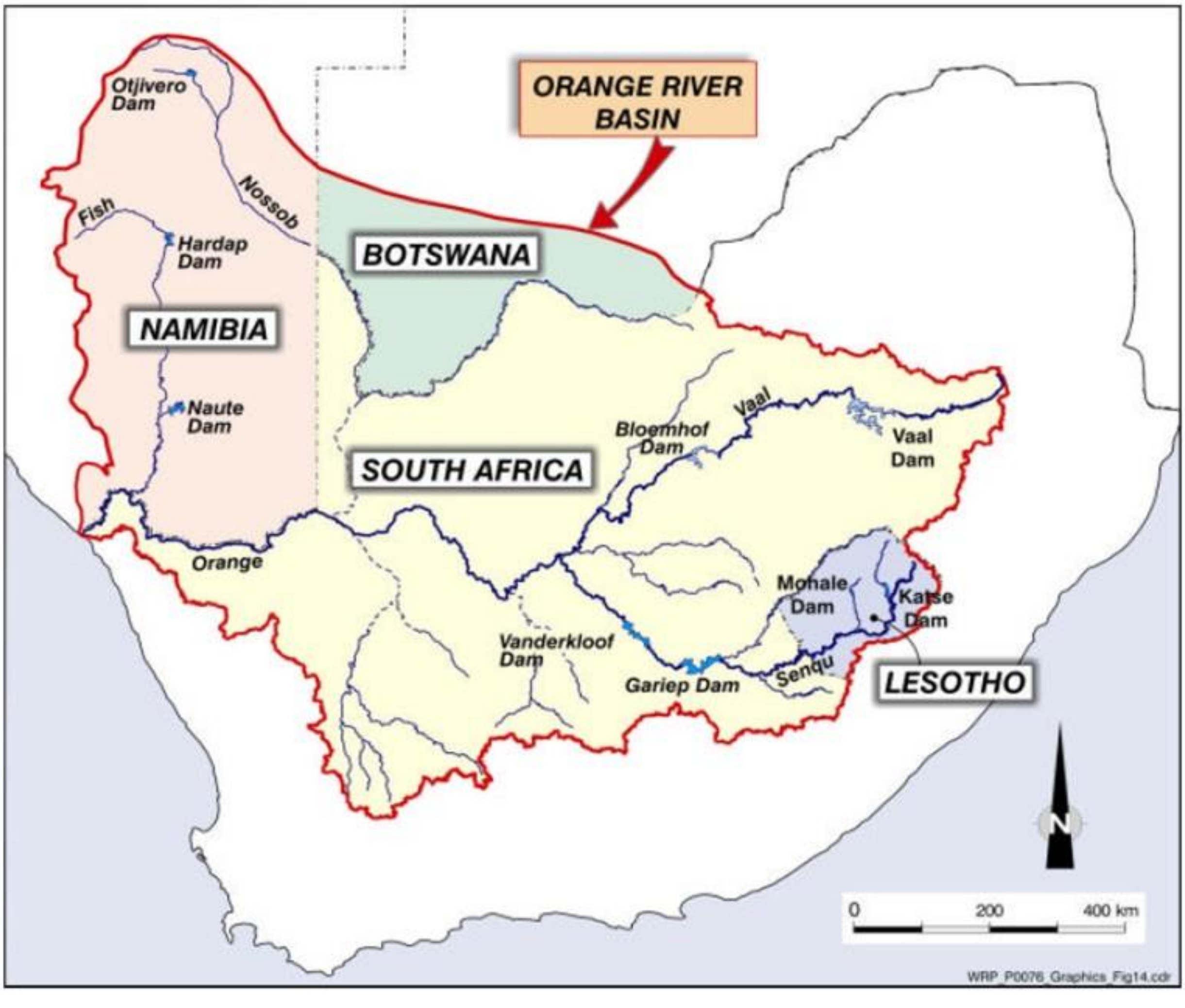

Figure 1: The Orange-Senqu River Basin

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 converge with the Orange River just outside the border of Lesotho, to form one large basin known as the Orange-Senqu River Basin

1.2 Water Resources of 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 basin in the Lesotho Highlands, 6,500 million m^3/a from the Vaal and Upper Orange, with approximately 800 million m^3/a from the Lower Orange and Fish River (Namibia). The basin also includes a portion in Botswana and Namibia (north of Fish River) feeding the Nossob and Molopo rivers.

Figure 2 provides approximate values of the natural run-off in the Orange-Senqu River basin.

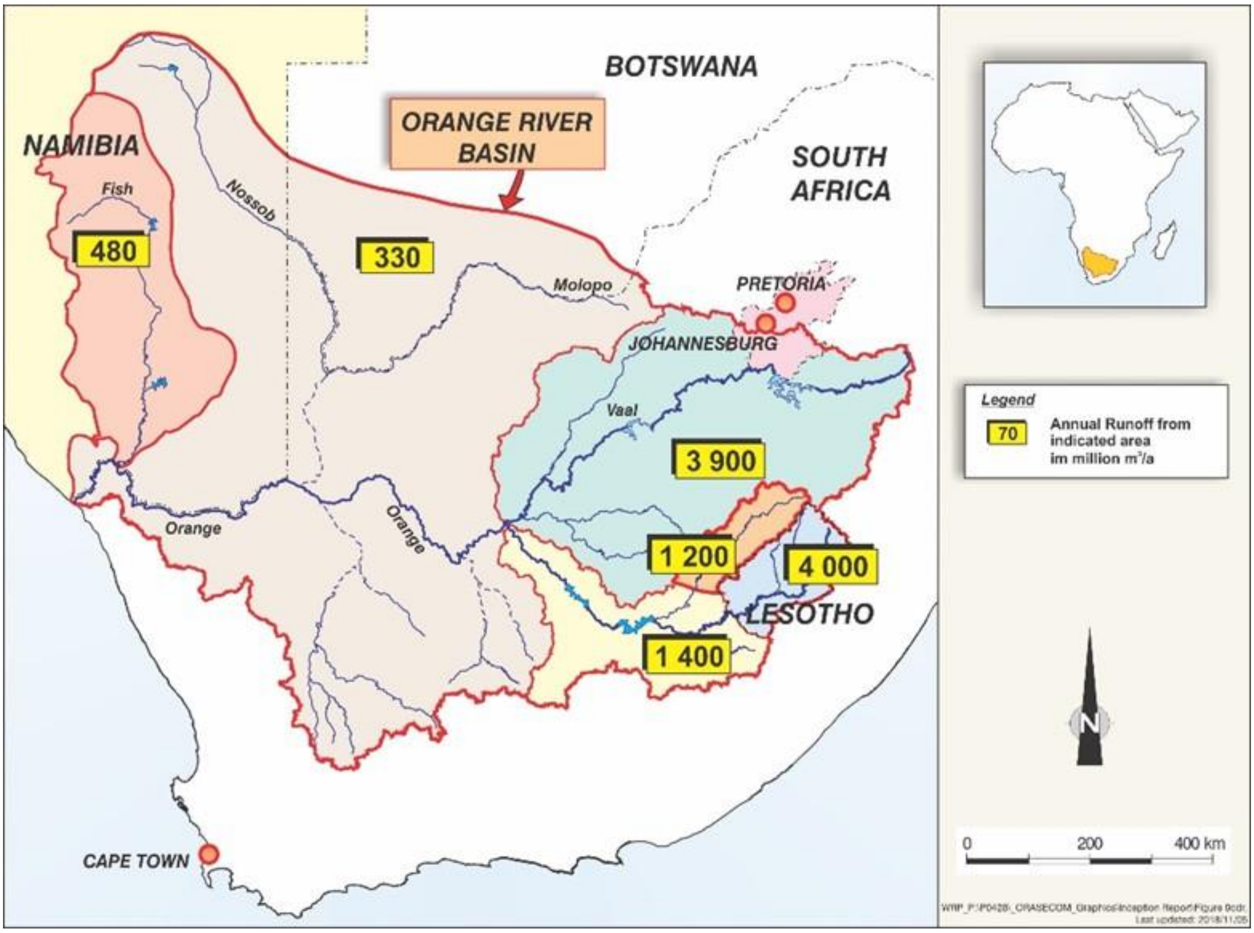

Figure 2: Approximate Natural Run-off in the Basin (million m^3/annum)

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 now estimated to be less than half the natural runoff. The difference is due mainly to the extensive water utilisation in the Vaal River basin, most of which is for domestic and industrial purposes. Several major transfers are used to bring water into the Upper Vaal River catchment to support the high-water requirements, in particular those within the Gauteng area (the industrial heartland of South Africa) 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 confluence, as well as significant irrigation developments in the Eastern Cape, supplied through the 80km long and 5m diameter 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, depending upon the flow rate in the river.

1.3 Precipitation

As already indicated, there are locations of relatively abundant precipitation and water availability and locations of greatest water requirements. Water scarcity in locations of greatest need is the main challenge in the basin and 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 extremely arid in the west. As shown in **Figure 3**, average annual precipitation decreases from more than 1000 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 localised. The temporal and spatial distribution of precipitation within any particular year can be considerable.

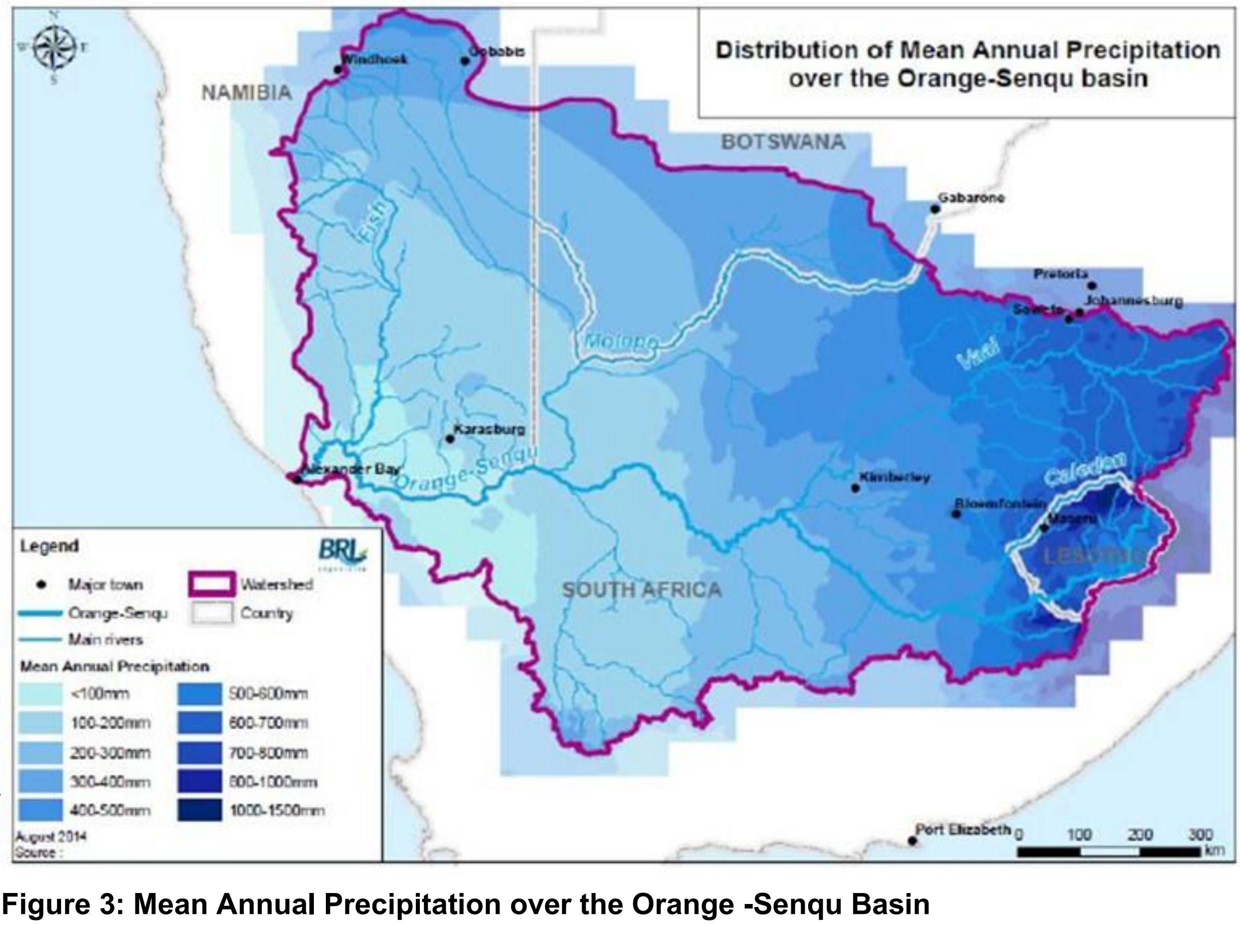

Figure 3: Mean Annual Precipitation over the Orange -Senqu Basin

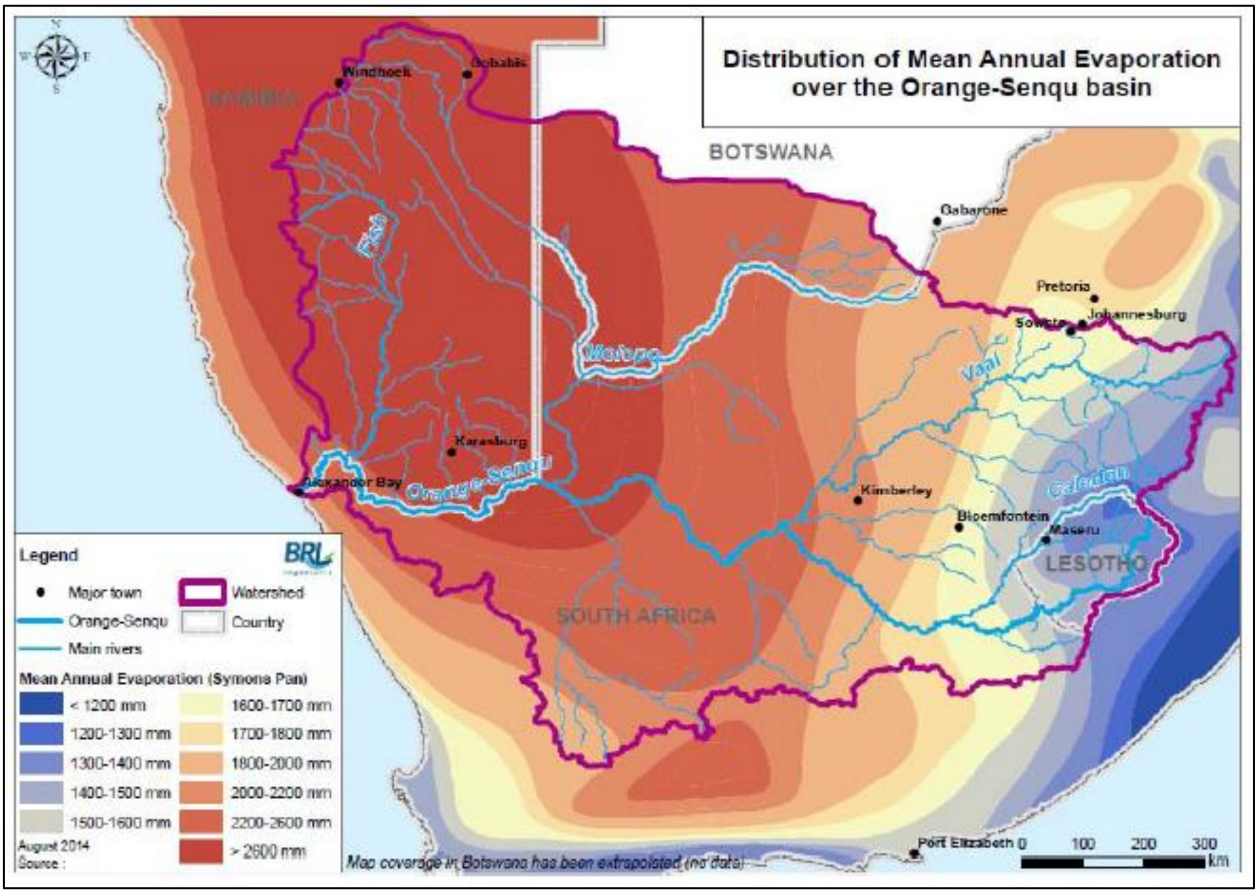

Figure 4: Distribution of mean annual precipitation over the Orange-Senqu basin

In Figure 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.

1.5 Climate Change

It is generally accepted that southern Africa will be highly impacted by climate change. Consequently, there are concerns around the changes in precipitation and temperature due to climate variability and climate change. This study therefore aims to enhance investment in transboundary water security and to develop resilience to climate change through strategic projects and actions, some of which are described in the Integrated Water Resource Development Plan.

The Republic of Botswana is an arid country with serious water constraints which will worsen with the expected effects of climate change. Botswana can expect to experience chronic water shortages in the near future unless a major new water source is developed. Gaborone has already experienced a serious drought which caused severe shortages in 2015 and 2016. Droughts are natural events which must be expected from time to time. It is clear, however, that they are becoming more frequent and more severe due to the impacts of Climate Change. The management of the water resource systems must therefore be improved and developed in order to mitigate the negative impacts of such events.

1.6 ORASECOM and the Integrated Water Resources Development Plan

Southern Africa has fifteen (15) transboundary watercourse systems of which thirteen exclusively stretch over the Southern African Development Community Member States. The Orange–Senqu is one of these thirteen transboundary watercourse systems. The Southern African Development Community 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 riparian states. To enhance the objectives of integrated water resources development and management in the region, the Orange–Senqu River Basin Commission (ORASECOM) was established in November 2000.

ORASECOM was established by the Governments of the four States, namely, South Africa, Lesotho, Botswana and Namibia, for managing the transboundary water resources of the Orange-Senqu River basin and promoting its beneficial development for the socio-economic wellbeing and safeguarding the basin environment. This led to the development of a basin level Integrated Water Resources Management Plan adopted in February 2015 by the ORASECOM Member States. The Integrated Water Resources Development 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 project implementation that provides a mutually inclusive transboundary benefit.

The Integrated Water Resources Development Plan recommends strategies and measures for promoting sustainable management of the water resources of the basin and 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 Orange-Senqu River basin is a highly complex and integrated water resource system, characterised by a high degree of regulation and major inter-basin transfers to manage the resource availability between the location of relatively abundant precipitation and the location of greatest water requirements. The infrastructure involves storage and transmission of water to demand centres that are in some cases located outside of the basin through intra and inter basin transfers. The largest interbasin transfer is the Lesotho Highlands Water Project which transfers approximately 800 million m^3/annum water to South Africa through an 80km long transfer tunnel which runs through the Maluti Mountains.

1.7 Objective of the Assignment

The objective of the study is to assist ORASECOM and the riparian countries in operationalizing the IWRM plan developed in 2015. The objective will therefore be met through three outputs:

- A Climate Resilient Investment Plan for the Orange-Senqu River Basin based on the updated Core Scenario;
- Operationalization Plan for ten, subsequently combined to nine key strategic actions selected from the updated IWRM Plan; and
- Pre-feasibility level report for the L-BWT Project, and the feasibility level report for a new dam, on Makhaleng River in Lesotho.

The study is 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 study of Lesotho-Botswana Water Transfer Project, including the feasibility study of a new dam on Makhaleng River in Lesotho 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.

1.8 Future Water Resource Developments

As a result of the potential impacts of Climate Change and growing economies, the Governments of Botswana, Lesotho, Namibia and South Africa recently agreed to undertake a reconnaissance study on the Lesotho to Botswana Water Transfer scheme (L-BWT) aimed at developing new water infrastructure in Lesotho and through South Africa, to convey water from Lesotho to Botswana at the same time supplying various users in Lesotho and South Africa. This reconnaissance study led to the selection of a technical option which included a possible dam on the Makhaleng River in Lesotho and a water conveyance system to Botswana. It is envisaged that a 186 million m^3/a (162 million m^3/a before losses) could eventually be pumped to Botswana which includes supply for consumers along the route in Lesotho and South Africa.

Following completion of the project, a number of possible development options and supporting studies were identified. These have been split into two specific categories namely:

- Key Strategic Actions
- Core Scenario Infrastructure Projects

Each of these will be discussed separately and they are also fully explained in more detail in various Project Reports and are summarised briefly in **Figure 5**.

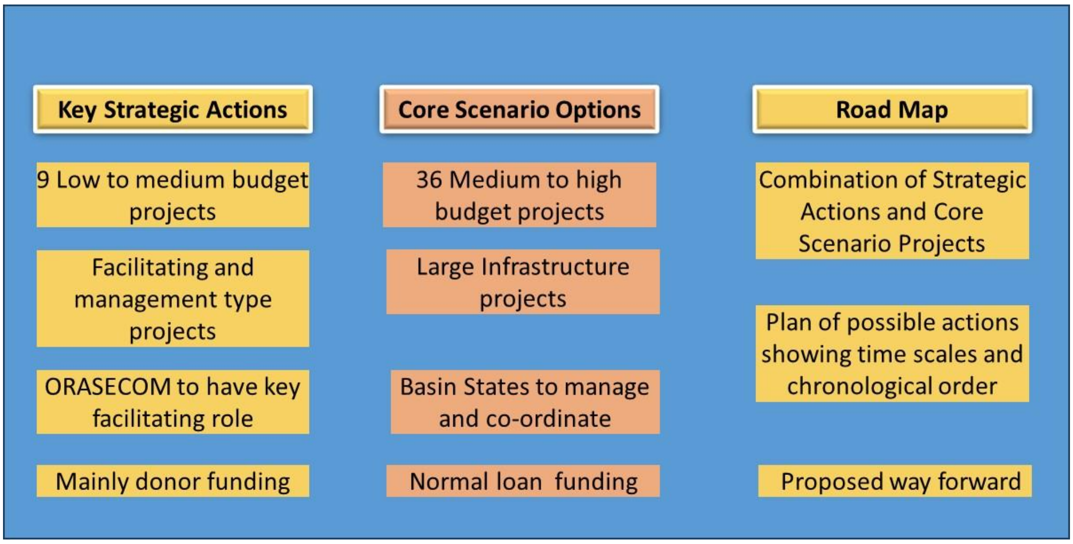

Figure 5: Summary of Project List

2 KEY STRATEGIC ACTIONS

An initial list of 17 Key Strategic actions was developed by the Project Team and presented to members of ORASECOM and the 4 basin states on 7 September 2021. The initial 17 possible projects were later reduced to 10 potential projects through further discussion and the use of a Balanced Scorecard selection process. Several of the actions that were initially rejected were later added as sub-tasks to one of the selected actions after further discussions and debate with the various parties concerned. Eventually it was agreed that 9 combined Strategic Actions would be selected which include most of the original 17 Strategic Actions as well as a number of key actions from the 2014 Integrated Water Resources Development Plan (GEF 2014). The Key Strategic Actions are therefore actions/projects identified by the Project Team through a consultation process together with ORASECOM and the 4 Member States and taking into account the various recommendations from the 2014 GEF study.

It should be noted that the projects identified as Strategic Actions are projects which tend to be relatively small based on their funding requirements. They are, however, important since they represent specific issues which must be addressed before many of the large-scale infrastructure projects (discussed under the Core Scenario section) can be undertaken. The Strategic Action projects can therefore be considered as “enabling” projects which provide some of the tools and guidelines needed to proceed with any new water related infrastructure projects in the Orange-Senqu River Basin.

“Concept Notes” have been prepared for each Strategic Action which effectively summarise each project in a clear and concise 2-page document. Sufficient detail is provided in the “Concept Notes” to allow any potential funding partner to quickly review the project to determine if it is the type of project that it may wish to support through either donor funding or normal loan funding or even a combination of both. The concept notes for each Strategic Action are provided in **Appendix B** while full details are provided in the draft Terms of Reference for each project which are given in **Appendix A.** The 9 Strategic Actions and an estimate of the likely budget required for each action are summarised in **Table 1**.

Table 1: Summary of Key Strategic Actions and Budgets

	Description	Capital Cost ($m)	Running Costs ($m/annum)
1	Agreement and Implementation of Environmental Water Requirements	$1m to $5m	$1m per annum
2	Improvement and Implementation of Monitoring and Information Management	$5m	$1m per annum
3	Development and Implementation of Guidelines for sharing	$1m	
4	Synchronisation and Preparation of Future and Planned Developments	$1m	
5	**Implementation and monitoring of WDM activities**	$1m	
6	**Assurance of Supply and Economic Value of Water**	$1m	
7	**Water Disaster Management – Climate Adaptation**	$2.0m to $3.0m	
8	**Capacity Building**		$2m in 3 years
9	**Hydrology Update and WQ Model Calibration**	$3m	

3 CORE SCENARIO INFRASTRUCTURE PROJECTS

3.1 Introduction

The Orange Senqu River basin is one of the most complicated and integrated water resource systems in the world. It covers an area of over 1 million km^2 and includes:

- Over 80 large Dams/Reservoirs
- Over 270 small Dams/Reservoirs
- Over 1200 demand centres (cities, irrigation schemes, power stations etc)
- A system network of over 4 000 links (pipelines, tunnels, river sections etc)
- Over 300 individual naturalised streamflow sequences (monthly records for 90 years)
- Over 300 monthly rainfall records(monthly for 90 years)

In order to effectively manage such a large and complicated water resource system, it is necessary to continually monitor and update the various water demands as well as to plan and commission new water related infrastructure in the form of new dams, pipelines, tunnels etc. The proposed future schemes are discussed by the 4 basin states (Botswana, Lesotho, Namibia and South Africa) on a regular basis and the process is managed and facilitated through ORASECOM which has been created to ensure that all new developments are first discussed and agreed in principle to avoid possible problems in future.

The most likely future development scenario is referred to as the “Core Scenario” and it includes the current and likely future demands for all existing demand centres, as well as all existing water related infrastructure and possible future developments. The future developments include the projected water demands and possible new infrastructure as provided by each of the 4 basin states. Only projects that have been investigated to at least a pre-feasibility level, in that a basic costing has been done, have been included in the “Core Scenario”. When considering the detail provided for each possible future project, it is important to note the following:

- All cost estimates provided are estimated based on 2018 price levels unless otherwise stated.
- The cost estimates were all taken from various reports prepared by others.
- Some of these reports were only at a pre-feasibility level of detail while others were at a feasibility level with the result that some cost estimates are more accurate than others.
- The cost estimates quoted in the various reports were escalated to the 2018 price levels, using published government inflation figures.

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

These core projects which form part of the basin-wide investment plan were grouped into 9 clusters as summarised in **Table 2.** The location of Clusters 1, 2 and 3 are shown in **Figure 4** and for Clusters 4, 5, 6, 7 and 8 in **Figure 5**. Each cluster includes two or more of the core projects. Details of the core projects applicable to each Cluster are provided in the remainder of Section 3.

Table 2: Summary of Clusters and related costs and yields

Cluster Name	Capital cost ($ million)	Operational Cost ($ million)	Yield impact (million m^3/a)
1) Orange River Project + Noordoewer/Vioolsdrift Dam intervention options	2 096	6.9	724
2) Lesotho Botswana Water Transfer Scheme	2 856	45.3	162/334*
3) Lesotho Lowland developments	73	0.3	65
4) Integrated Vaal River System intervention options	1 723	84.4	522
5) Caledon to Greater Bloemfontein transfers	15	0.6	11
6) Greater Bloemfontein internal resource improvements	82	8.8	31
7) Gariep to Greater Bloemfontein transfer	226	12.1	43
8) Neckartal Scheme in Namibia	26	0.7	90
9) Integrated Water Management Options	337	67.2	308

Note: * 162 million m^3/a refers to the net transfer volume (186 million m^3/a including losses) and 334 million m^3/a to the local yield of the dam which reduced to 308 million m^3/a in feasibility phase due to repositioning of the dam.

3.2 Cluster 1: The Orange River Project + Noordoewer/Viooldrift Dam options

The Orange River Project refers to Gariep and Vanderkloof dams and their total supply area. These are the two largest storage dams in the Orange-Senqu basin. The gross storage of Gariep Dam is 4 905 million m^3 and 3 107million m^3 for Vanderkloof Dam. The yield available from this system is currently fully utilised and therefore no new demands can be supplied without adding some additional yield to the system through the construction of new dams/reservoirs or through the reduction of existing demands in some manner. Constructing any new dams upstream of the Orange River Project will reduce the yield available from the system and create water shortages to the existing users. Polihali Dam is currently under construction and will reduce the yield available from the Orange River Project by approximately 200 million m^3/a. Some form of yield augmentation will therefore be required to offset the reduction in yield caused by Polihali Dam when it is finally completed and starts to transfer water to the industrial heartland of South Africa

Several augmentation options have been identified by Department Water and Sanitation South Africa to rebalance the system and allow for some further development along the Orange River. All these augmentation options form part of the Orange River Project + Noordoewer/Vioolsdrift Dam Cluster. Due to the significant impact of Polihali Dam on the Orange River Project it was included as part of this cluster. Details of the Orange River Project and Noordoewer/Vioolsdrift Dam Cluster are given in **Table 3**. These include the investment cost of each of the schemes, the yield generated by the project and the Unit Reference Value for each scheme as well as for the Cluster of schemes.

Table 3: Details of projects within the Orange River Project and Noordoewer/Vioolsdrift Dam Cluster 1

Project Name	URV($/$m^3$) at 8% discount rate	Investment Cost $ million	Yield (million m^3/a)
Cluster 1 Orange River Project Cluster*	**0.3**	**2 096**	**724**
Utilise the lower-level storage in Vanderkloof Dam	0.01	9.5	137
Noordoewer/Vioolsdrift Dam used as an individual resource. Medium size dam	0.2	232	280
Polihali Dam (Lesotho Highland Water project (LHWP) Phase II and connecting tunnel to Katse Dam	1.5	1 639	107/391
Verbeeldingskraal Dam upstream of Gariep	0.13	230	200
Real Time flow monitoring and modelling		0.32	80

The Unit Reference Value is often used to compare different water resource development projects through a financial evaluation of the proposed infrastructure and associated operations costs.

The Unit Reference Value analyses provide insight into the cost per unit of water supplied by a specific development option. Unit Reference Values represent the financial cost-effectiveness between water projects and their objective is to provide a means of comparing all of the different schemes included in the “Core Scenario”.

Unit Reference Value calculations are generally used to compare and finally rank different water resource development options that are designed to serve the same purpose or supply the same area.

While it is accepted that the projects within a specific cluster are generally comparable, it is also acknowledged that the different clusters are not always directly comparable as they serve different water demand areas. Although it is not always appropriate to use the Unit Reference Values to compare schemes, they can be very useful in providing a first level indicator of the relative cost of each cluster to highlight which clusters might be very expensive or relatively cheap. The Unit Reference Value can also be used by each basin state to compare against other internal options that have not been considered in the investment plan.

The Unit Reference Value 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 Unit Reference Value.

$$\text{Unit Reference Value } \frac{PV(capital\ costs) + PV(operational\ costs)}{PV\ (quantity\ of\ water\ incrementally\ assured)}$$

“Concept Notes” have been prepared for each development option considered in the “Core Scenario” which summarise each project in a clear and concise 2-page document. Sufficient detail is provided in the “Concept Notes” to allow any potential funding agency to quickly review the project to determine if it is the type of project that it may wish to support through either donor funding or a normal loan. The concept notes are provided in **Appendix C** of the Road Map Report while full details are provided in the various Core Scenario reports in **Table 4**.

Table 4: Core Scenario Reports

Report Title	**Report Number**
Core Scenario Update Report: Component I	ORASECOM 003/2019
Core Scenario Supporting Report: Water Requirements and Return flows Report Component I	ORASECOM 004/2019
Core Scenario Supporting Report: Water Conservation, Water Demand management and Re-use Report Component I	ORASECOM 005/2019
Core Scenario Supporting Report: Ground Water Report Component I	ORASECOM 006/2019
Optimized IWRMP Core Scenario Economic Approach Report Component I	ORASECOM 009/2019

If further detailed information is required, the reader is referred to the study reports.

3.3 Cluster 2: The Possible Lesotho Botswana Water Transfer Scheme

The proposed Lesotho to Botswana Water Transfer Scheme includes a 3 MAR dam (dam with a gross storage of three times the mean annual runoff generated from the catchment upstream of the dam) on the Makhaleng River. The scheme also includes the 688 km pipeline (diameter from 2 200mm to 1 100mm) from Lesotho to Gaborone/Lobatse, which also supplies some towns in South Africa with water. There is a high possibility that water supply to Bloemfontein can be included as part of this transfer scheme. The pre-feasibility study for this transfer scheme was completed with the Feasibility study in progress at the time of writing this report (November 2023).

Details of the two main components of the Lesotho Botswana Water Transfer Scheme are provided in **Table 5**.

Table 5: Details of projects forming part of the Lesotho Botswana transfer Cluster 2.

Project Name	URV ($/m^3) at 8% discount rate	Investment Cost $ million	Yield (million m^3/a)
Cluster 2 Lesotho Botswana Transfer Scheme	**2.8**	**2 856**	**162/334**
Dam on the Makhaleng River	0.2	316	334*
Transfer pipeline from Lesotho to Gaborone/Lobatse	2.6	2 540	162

Note: * 162 million m^3/a refers to the net transfer volume (186 million m^3/a including losses) and 334 million m^3/a to the local yield of the dam which reduced to 308 million m^3/a in feasibility phase due to repositioning of the dam.

3.4 Cluster 3: The Lesotho Lowlands Dams

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

- Hlotse Dam; and
- Ngoajane Dam.

Details of the two dams are provided in **Table 6**.

Table 6: Details of projects forming part of the Lesotho Lowlands Cluster 3.

Project Name	URV ($/m^3) at 8% discount rate	Investment Cost $ million	Yield (million m^3/a)
Cluster 3 Lesotho Lowlands	**0.1**	**72.7**	**65**
Hlotse Dam	0.1	46.5	54
Ngoajane Dam	0.1	26.2	11

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 incremental yield of 54 million m^3/a (local yield 85 million m^3/a).

The construction cost is estimated at $46.5 million and the operating annual cost at $ 0.2 million at 2018 development level costs.

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 incremental yield of the system is estimated as 10.6 million m^3/a, with a local yield of 30.8 million m^3/a. The construction cost is estimated at $26 million and the annual operating cost at $ 0.2 million/a.

3.5 Cluster 4: The Integrated Vaal River System Intervention Options.

The Vaal River System Intervention Options include:

- 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.

The proposed further phases of the Thukela River Water Transfer comprise two new dams at Jana on the main tributary 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 due to mitigation releases for existing downstream users.

Key information on this water transfer scheme includes:

- The Jana Dam with the incremental yield of 396 million m^3/a and the Mielietuin Dam with the incremental 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 $1 184 million and the annual operations cost at $9.1 million/a, at the 2018 development levels.

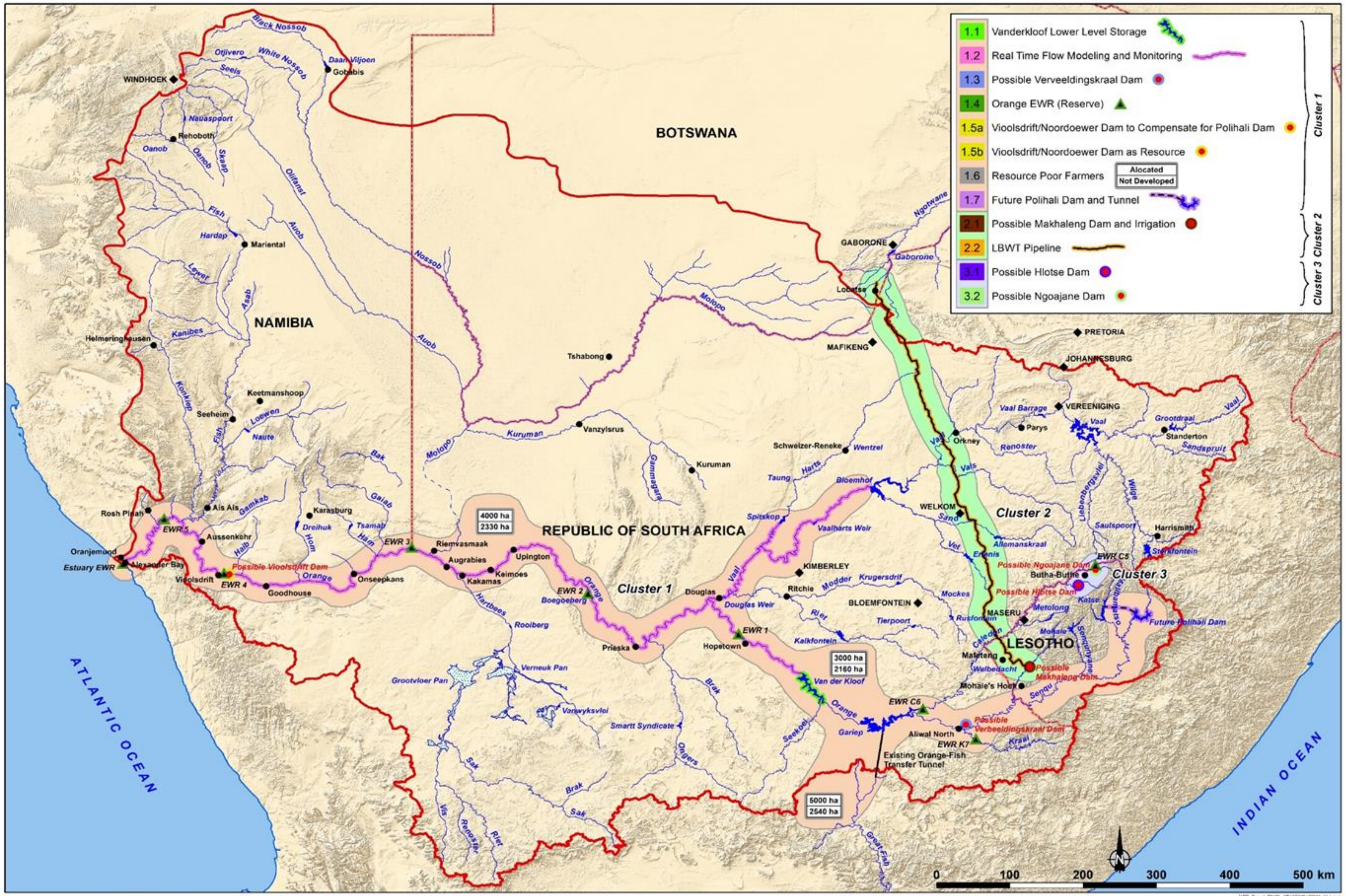

Figure 4: Future development Clusters 1,2 and 3.

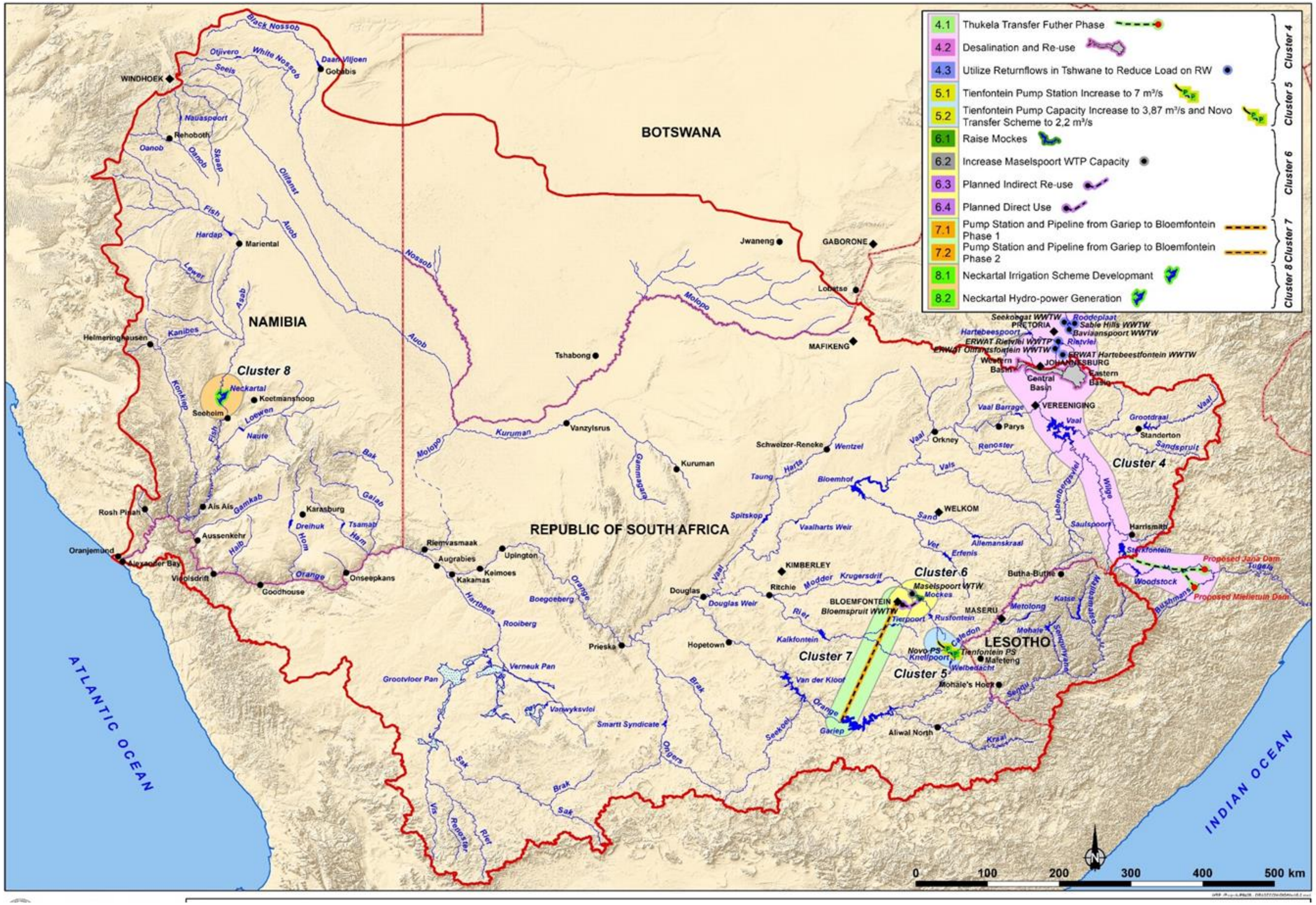

Figure 5: Future development Clusters 4, 5, 6, 7 and 8.

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 Integrated Vaal River System. These 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 imposed on the Integrated Vaal River System, 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, utilising 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. 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, because of the re-use.
- The capital cost to implement this further treatment capacity is estimated at $77.6 million, at the 2018 price level.
- The annual operation costs are estimated to be $6.7 million/a (2018);

Details of the projects considered under Cluster 4 are provided in **Table 7**.

Table 7: Details of projects forming part of the Integrated Vaal River System Cluster 4

Project Name	URV($/$m^3$) at 8% discount rate	Investment Cost $ million	Yield (million m^3/a)
Cluster 4: Integrated Vaal River System Intervention Options	**0.4**	**1 723**	**578**
Further phases of the transfer from the Thukela River	0.5	1 184	522
Utilising the Crocodile River Return Flows in Tshwane	0.3	77.6	56
Desalination and re-use of mine water effluent	0.3	462	500

The desalination and re-use of acid mine drainage were listed as one of the most important intervention options from the Vaal River System Reconciliation Strategy (SA Department of Water Affairs and Forestry, 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 Integrated Vaal River System_Reconciliation Strategy Phase 2 (SA Department of Water and Sanitation, 2018).

In the Integrated Vaal River System, the desalination of acid mine drainage 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 acidic mine drainage in the Vaal River basin.

The pumping and treatment processes introduced through the immediate and short-term solution only neutralize acid mine drainage'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 of the pumped mine water to users should be investigated.

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 acid mine drainage 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 started, but progress has been very slow. Details on what the long-term solution will entail is not yet available.

Initial estimates suggest a positive water contribution to the Integrated Vaal River System_of 500 million m^3/a. Current indications suggest that the actual figure could be lower. Department Water and Sanitation South Africa is currently undertaking further detailed studies in this regard, and a final figure is thus not currently available.

This is an expensive intervention option with total capital expenditure at 2018 price levels estimated at $ 462 million with operating costs at $68.4 million/a.

3.6 Cluster 5: Caledon to Greater Bloemfontein Transfer

The intervention options 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 generally 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 were recently completed, and the system is already in full operation.
- Increase the total pump capacity at Tienfontein pump station to 7 m^3/s by 2040 or later.
  - 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 $9.5 million (2018).
  - The operational cost is estimated at $0.4 million/a (2018).

Some details of the projects included under Cluster 5 are provided in **Table 8**.

Table 8: Projects forming part of the Caledon to Greater Bloemfontein Transfer

Project Name	URV($/m³) at 8% discount rate	Investment Cost $ million	Yield (million m³/a)
Cluster 5: Caledon to Greater Bloemfontein Transfer	**0.2**	**9.5**	**6.0**
Increasing the Tienfontein pump station capacity to 7 m^3/s	0.2	9.5	6.0

3.7 Cluster 6: Greater Bloemfontein Internal Resource Improvements

Most of the projects included under Cluster 6 were recommendations from the Mangaung Gariep Augmentation Project (Mangaung, 2018), although there are similarities with the recommendations from the Greater Bloemfontein Reconciliation Strategy (DWS, 2012). Several components form part of Cluster 6 which include the following:

- Raise Mockes Dam – This component is designed 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 Water Treatment Works 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 low-quality return flows up to potable standards.
- Indirect re-use of 16 million m^3/a from the Bloemspruit Wastewater Treatment Works 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 $ 86.2 million.
- The combined operational cost for all components was estimated at $ 77.1 million/a.

Details of the projects covered under Cluster 6 are provided in **Table 9**.

Table 9: Projects forming part of the Greater Bloemfontein Internal Resource Improvements Cluster 6

Project Name	URV($/m^3) at 8% discount rate	Investment Cost $ million	Yield (million m^3/a)
Cluster 6: Greater Bloemfontein Internal Resource Improvements	0.8	86.2	30

3.8 Cluster 7: Gariep to Greater Bloemfontein Transfer

The projects covered under Cluster 7 are recommendations from both the Greater Bloemfontein Reconciliation Strategy (DWS, 2012) and the Mangaung Gariep Augmentation Project (Mangaung, 2018). The SA Department of Water and Sanitation has, however, confirmed that an independent study has been commissioned to identify the best option from a national perspective. This study had not been completed at the time of writing this report (November 2023).

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.

Additional key information on the transfer scheme includes:

- Phase 1 capital cost estimated at $200 million.
- Phase 1 operational cost estimated at $9 million/a.
- Phase 2 capital cost estimated at $ 26.3 million.

- Phase 2 operational expenditure estimated at $ 3.1 million/a.

The recent study might, however, only consider one phase with an even higher transfer capacity. Details of the Gariep to Bloemfontein projects are provided in **Table 10**.

Table 10: Details of the Gariep to Bloemfontein Transfer Cluster 7

Project Name	URV($/m^3) at 8% discount rate	Investment Cost $ million	Yield (million m^3/a)
Cluster 7: Gariep to Greater Bloemfontein Transfer	**0.8**	**226**	**43**
Gariep transfer Phase 1	0.9	200	32
Gariep transfer Phase 2	0.5	26.3	11

The reader is also referred to cluster 2 where another option is listed that can be used to transfer water to the Greater Bloemfontein via the Lesotho-Botswana Water Transfer Scheme. Final decisions in this regard have however not been made.

3.9 Cluster 8: Neckartal Scheme

The Neckartal Dam located in the lower Fish River in Namibia was completed in 2018 and has been storing water since that time.

The main purpose of this dam is to supply water to a new irrigation development which has yet to be completed at the time of writing this report (November 2023). Water will be released from the dam directly into the river and abstracted downstream from a diversion weir. The water will be pumped to a high lying storage reservoir and gravity fed for irrigation. The releases from the dam into the river will take place via hydro-power turbines, which have already been installed.

The planning of the irrigation scheme is behind schedule and by June 2024 more than 19 000ha had been acquired by the Namibian Government for irrigation development. 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 could be used to support the Environmental Water Requirement downstream of the diversion weir.

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 $26.3 million.
- The operational costs for the irrigation scheme were estimated at $0.8 million/a;

3.10 Cluster 9: Integrated Water Management Options

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

- Removal of unlawful irrigation.
- Water Conservation and Water Demand Management within irrigation schemes.
- Water Conservation and Water Demand Management 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
- Harmonise policy, legal and institutional frameworks.

The primary integrated water management options are the Water Conservation and Water Demand Management in the irrigation sector and Water Conservation and Water Demand Management in the urban and industrial sectors. The reconciliation strategies prepared for the Integrated Vaal River System (DWAF, 2009), the Orange System (DWS, 2015) and the Greater Mangaung (DWA, 2012) Water Supply systems all include Water Conservation and

Water Demand Management as a high priority action needed to maintain a positive water balance in future years. In the Integrated Vaal River System Reconciliation Strategy, it was stated that savings from Water Conservation and Water Demand Management in the irrigation sector will not be available for other water users or water use sectors, but that the savings will be utilised 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 a similar approach regarding Water Conservation and Water Demand Management 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 Water Conservation and Water Demand Management. In such cases, the irrigators might be willing to sell some of the water to other users to obtain some benefit for their Water Conservation and Water Demand Management efforts. For the Orange system, it was estimated that approximately 5% of the current irrigation use can be saved to be utilised by other users. The remainder of the Water Conservation and Water Demand Management saving in the irrigation sector is expected to be utilised by the existing irrigators to increase their irrigation area. The 5% savings through Water Conservation and Water Demand Management in the irrigation sector in the Orange system was estimated at 73 million m^3/a. It should be noted 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 $10.5 million with the operational expenditure at about $ 0.11 million/a

It is expected that the largest savings from Water Conservation and Water Demand Management will be from the urban and industrial sectors.

Initial combined savings in the urban and industrial sectors due to Water Conservation and Water Demand Management were estimated at 240 million m^3/a from the different reconciliation strategies. Water Conservation and Water Demand Management 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 had already been achieved. Consequently, a further potential saving of 155 million m^3/a can be saved.

To be able to save the 155 million m^3/a in the urban/industrial sectors through Water Conservation and Water Demand Management, the expected capital expenditure was estimated at $ 322 million with the operational expenditure at $67.1 million/a. Details of the projects covered under Cluster 9 are provided in **Table 11**.

Table 11: Details of the WCWDM component of Cluster 9

Project Name	URV($/$m^3$) at 8% discount rate	Investment Cost $ million	Yield (million m^3/a)
Cluster 9: Integrated Water Management Options	**0.5**	**332**	**228**
Water Conservation and Water Demand Management Irrigation	0.02	10.5	73
Water Conservation and Water Demand Management Urban and Industrial	0.8	322	155

4 BACKGROUND AND LINKAGES FOR THE INTEGRATED WATER RESOURCES MANAGEMENT PLAN

4.1 Roadmap Introduction

The implementation of the Integrated Water Resources Management Plan will largely be driven by the combination of the identified key Strategic Actions and the Core Scenario Development options which include the major development options already forming part of the envisaged future development in each of the countries. It is therefore important to understand the linkages between them as well as the impact they may have on each other.

The urgency of most of the Core Scenario development options, as identified by the different countries, is in general high, although some can be postponed to later dates in the future depending on the actual growth in water demands imposed on the specific system or development option. The time when construction or work will start on these Core Scenario development options is, for most cases, not readily available from the countries, as it depends on many factors and related uncertainties. The starting dates used for the different development options are therefore the best estimates that can be made at present but will most likely change in future in accordance with the political decisions taken in each country.

4.2 Strategic Action 1: Environmental Requirements

Determining the final agreed **environmental requirements** for the Orange River and its estuary was always one of the tasks Department Water and Sanitation South Africa regarded as a high priority issue. The Department Water and Sanitation South Africa has already determined a preliminary reserve or environmental requirement to be used for planning purposes which is included as part of the Core Scenario. As this is a shared river, the involvement and agreement from the other basin countries is required before an agreed environmental requirement can be finalised. ORASECOM has thus embarked on such a study of which the first phase already started in December 2022.

The follow up work on Phase 1 of this study was captured in Strategic Action 1 in which ORASECOM should again be involved. The follow-up phases of this project should start as soon as possible after the completion of Phase 1. Phase 1 is aimed at achieving agreement on the process to be followed and preparation of the information in accordance with the agreed process and is estimated to be completed by March 2024. The final agreed environmental requirements might lead to a reduction in the current available yield from the main water supply systems and this needs to be considered in any future planning. The final agreed environment requirements are therefore of high importance for the environment as well as for future planning and need to be finalised as soon as possible.

4.3 Strategic Action 2: Monitoring and Information Systems – Real Time monitoring and modelling

The Orange River Project (Gariep and Vanderkloof dams) is already slightly over utilised which suggests that the current water requirements/allocations exceed the firm yield from the dams. This does not mean that there will be immediate shortages since during periods of above average rainfall, the available water from the dams can support the demands. During average and below average rainfall periods, however, shortages are likely to occur. The delicate water balance also means that any new water storage developments upstream of Vanderkloof Dam will compound the problems by adding to the shortage experienced by the system.

Polihali Dam in the Lesotho Highland's (currently under construction) is expected to start inundating water by January 2026. When this dam is commissioned, much of the water previously entering Gariep and Vanderkloof dams will now be stored upstream in Polihali Dam to be transferred to the Integrated Vaal River System. This will in turn reduce the yield available from Gariep and Vanderkloof dams (Orange River Project) and result in deficits in supply to the various users in South Africa and Namibia. To address the potential shortfalls due to Polihali Dam, South Africa has already identified several new developments which can be implemented to re-balance the Orange River Project and include the following:

- Real time monitoring and modelling of flow releases from Gariep and Vanderkloof dams as well as inflows from the Vaal River into the Orange River. This will improve the current operation and management of releases from Vanderkloof Dam in support of the downstream users by saving in the order of 80 million m^3/a of the operating requirements. This can be compared with the current operating requirements of approximately 180 million m^3/a.
- Utilise the lower-level storage in Vanderkloof Dam.
- Construction of the Noordoewer-Vioolsdrift Dam on the Lower Orange to increase the yield of the Orange River Project.
- Construction of a large storage dam in the upper Orange, referred to as the Verbeeldingskraal Dam.
- Imposing water conservation and demand management on irrigation within the Orange River Project supply area.
- Supplying irrigation at a lower assurance.

Real time monitoring and modelling of the flow downstream of Vanderkloof Dam is considered as one of the first intervention options to implement by South Africa Department of Water and Sanitation. This intervention option is discussed under Key Strategic Action 2A (Improvement and implementation of monitoring and information systems) which is thus linked (dotted black lines on the Road Map Timeline show the linkage) to the Real time monitoring and modelling intervention option listed as one of the Core Scenario items.

The start date for Key Strategic Action 2A is suggested as January 2025 so that it can support the linked Core Scenario projects.

4.4 Strategic Actions 3 and 4: Guidelines for Water Sharing and synchronisation and Preparation of Future Planned Developments.

Strategic actions 3 and 4 address the development of "Guidelines for Water Sharing" in the basin amongst the countries and the "Synchronisation and Preparation of Future Planned Developments". These two actions may appear to be relatively soft actions as they do not involve any real construction activity. They are, however, critical as they will help to form the basis for agreement between the 4 basin states and such agreement is essential before any new construction project can be completed.

The water resources in the Orange-Senqu basin, and in particular the upper parts of the basin are highly developed and almost fully utilised. From Components I and II of this study it was shown that any further developments in the upper parts of the basin will impact significantly on the existing downstream users. Indications from the analyses carried out in this study suggest that the reduction in yield to the existing downstream system is approximately 70% of the local yield generated at any new upstream dam. In effect, a new dam constructed in the upper parts of the catchment that can deliver 100 million m^3/a locally will cause a 70 million m^3/a reduction in yield to the downstream users. Compensation or mitigation releases will therefore be required to re-balance the yield reduction in downstream water supply systems for all new dams built in the upper reaches of the river basin.

This issue of possible compensation releases has resulted in considerable discussion and debate between the 4 basin states and Project Team. This in turn, has caused long delays in the approval of the various project reports and added more than 3 years to the study duration. The important issue of compensation or mitigation flow has therefore been included as part of Strategic Action 3 that specifically addresses this issue as part of the development of Guidelines for Water Sharing in the basin amongst the countries. Once the general principles of water sharing have been discussed and agreed by the 4 basin states, disputes on the required mitigation releases will be reduced significantly.

It was also evident from the various water resource analyses, that the operating rules applied to any new dams in the upper reaches of the river basin will have a significant impact on existing downstream users and water supply systems. By following the most efficient operating rules it will be possible to minimise the volume of mitigation releases to some degree. Strategic Action 4 (Synchronisation and preparation of future planned developments) specifically addresses this important issue.

Currently several large to medium size water supply schemes are planned in the upper Orange-Senqu catchment of which the construction already started on Lesotho Highland Water Project Phase II (Polihali Dam and transfer tunnel to Katse Dam). This will most likely be followed by another large dam on the Makhaleng River in Lesotho, to be used to supply water to Lesotho and transfer the balance to Gaborone in Botswana as well as to various towns in South Africa along the pipeline route. There are also two dams planned for the Lesotho Lowlands, Hlotse and Ngoajane dams, to supply water for urban/Industrial and irrigation in Lesotho. The possible future Verbeeldingskraal Dam in South Africa, located not far downstream of the Lesotho border, has been identified as a possible future option to offset the impacts of Polihali Dam on the downstream system.

Key Strategic Actions 3 and 4 have therefore been prioritised to pave the way for the development and operation of these future upstream dams. The solid red lines on the Road Map Timeline show the linkages between Key Strategic Actions 3 and 4 and the associated Core Scenario Developments.

It is interesting to note that some possible future developments relating to the Greater Bloemfontein Water Supply System are also linked to Key Strategic Actions 3 and 4. The reason for this is the significant impact developments in the Caledon-Mohokare River catchment has on the Greater Bloemfontein System, which currently receives about 90% of its water from the Caledon River. These developments will also impact on the water supply to Maseru, as water abstracted directly from the Mohokare River is used to supply part of the Maseru water requirement. For this reason, the starting dates for Key Strategic Actions 3 and 4 are early on the timeline and are proposed to start in July 2024 and July 2025 respectively.

4.5 Strategic Action 5: Implementation and monitoring of Water Conservation and water demand management

Strategic Action 5 covers the Implementation and monitoring of Water Conservation and water demand management activities in the basin. Water Conservation and Water Demand Management have been identified as important components of all future water resource assessments throughout the Orange /Senqu River Basin. The impact of WC/WDM can be very significant in many areas where water losses are known to be high and in some cases the losses are estimated to be in excess of 50% of the municipal water demands. Reducing such water losses is not easy or quick to achieve and cannot be implemented overnight. With proper support both financially and technically, however, it is possible to achieve significant savings, which in turn can have a significant positive impact on the overall water balance in the Orange/Senqu River Basin.

Strategic Action 5 was therefore recommended to set up a system to identify the key focus areas for WC/WDM throughout the Orange/Senqu River Basin and to ensure that the related actions are implemented successfully and maintained over time.

Strategic Action 5 directly links to the water conservation and demand management within irrigation schemes as well as within urban and industrial sectors which forms part of these two components included under Cluster 9 of the Core Scenario development options. Although this is a very important strategic action it can be delayed if necessary to a later date since there are no other strategic actions or Core Scenario Developments directly dependent on this action.

4.6 Strategic Action 6: Assurance of Supply and Economic value of Water

Strategic Action 6 addresses the issue of "assurance of Supply" with regard to the water supplied to the various consumers in the Orange-Senqu basin. Despite the obvious benefits of the assurance of supply-based models available to the 4 basin states, none of the basin states currently applies the assurance of supply on the same basis which creates problems during periods of restriction.

In some cases, users, (in particular irrigation) are supplied at too high assurance. Supplying such users at a lower assurance is one of the many issues that must be investigated under Strategic Action 6. To highlight the significance of the assurance of supply, a simple example can be used. The 95% assured yield of the Naute Dam in Namibia is 12.8 million m³/a, and the 80% assured yield is 21.9 million. An increase of 70%. The question to be considered is which supply (12.8 million m³/a at 95% assurance or 21.9 million at 80% assurance) will yield the greatest income to the farmers. It will depend to some degree on the type of crops being grown, however, there is a strong case to supply irrigation water at lower levels of assurance and apply a higher water allocation.

The Basin States must discuss this issue to determine what level of assurance is affordable in each case so that the available water can be used optimally to the benefit of each country. It is further important that the basin states have the same understanding of what is meant by assurance of supply and how it is determined and used in the assurance of supply-based models currently used by ORASECOM and most of the basin states.

The assurance of supply to irrigation was determined by Department Water and Sanitation South Africa as one of the intervention options to free up more water for use within the Orange River Project. Assurance of supply will therefore play an important role in each of the planned future dams and water supply systems within the Orange-Senqu Basin.

Key Strategic Action 6 will therefore link to the Cluster 1 Core Scenario options assisting with the re-balancing of the Orange River Project due to the impacts of Polihali Dam. This requires a high urgency for the implementation of this key strategic action and the start date for this action was suggested as May 2027. Key Strategic Action 6 will also link to all the future water supply schemes as the role of water supply assurance will become more and more important as the basin is nearing full utilisation of its limited resources.

4.7 Strategic Action 7: Water Disaster Management and Climate Adaptation

Strategic Action 7 investigates the issues of Water Disaster Management and Climate Adaptation which are both highly topical issues within the Orange-Senqu basin. These issues also open possible funding opportunities to the 4 Basin States and ORASECOM since there is significant funding available for Climate Adaptation projects especially in developing countries.

In most integrated water supply systems, there are guidelines and operating rules in place to manage the overall water resource during drought events. Unfortunately, when a very severe drought does occur, it is often the case that the guidelines and operating rules are simply ignored as the water managers and Politicians take over the decision-making process. In such cases the whole water supply system may collapse with severe consequences.

In the case of the Orange/Senqu River Basin, there are many organisations who have some influence on the water allocation in the system. Unless the allocation of water and the curtailment strategies are discussed and agreed properly while the system is operating under normal conditions, it may lead to a disaster in the event of a very severe drought in the region. It is therefore recommended that some form of mock drought disaster event is simulated involving participants from all four basin states to demonstrate exactly what will happen in the event of a severe drought.

Strategic Action 7 is regarded as a high priority and January 2028 was therefore selected as the start date for this project. The start date is, however, flexible since it has no direct linkages to other Strategic Actions or Core Scenario developments.

4.8 Strategic Action 8: Capacity Building

Strategic Action 8 covers the important issue of Capacity Building regarding the water resources of the Orange-Senqu basin. To date, the Orange/Senqu River Basin has not experienced major water shortages resulting in serious disputes between the four basin states and is often used by international organisations as an example where proper planning and discussion can mitigate such problems. While serious conflicts are now emerging in many other parts of the world over the issue of water allocations, the Orange/Senqu River Basin remains operational and generally free from serious disagreements.

To ensure the current status quo of friendly co-operation between the four countries which is facilitated by ORASECOM, it is recommended that regular training sessions and discussions between the states are held on various topics. Training should be provided on the basic hydrological data used to model the basin, as well as training on the yield and allocation models where each country will have access to the same data and same models. It is only through such training that there can be trust and co-operation on the water allocations in the Orange/Senqu River Basin, as the resources near full utilisation.

In order to ensure transparency and to facilitate future co-operation between the four basin states, it is therefore recommended that an annual meeting should take place in which the different countries can each provide any updated information as well as any new or adjusted plans/strategies. This could take place in combination with a training event.

Training is an ongoing process and can thus start any time. July 2024 was selected as the start date for such a project although this is flexible, and it can be started at an earlier or later date.

4.9 Strategic Action 9: Hydrology update and calibration of the Water Quality Model

Strategic Action 9 covers the need to update the hydrology for the whole of the Orange-Senqu basin as well as the calibration of the Water Quality Model.

The current historic hydrology based on observed flows within the Orange Senqu basin covers the period 1920/21 to 2004/05 hydrological years. This means that the current hydrology can be extended by about 16 years to 2020 or possibly even 2022 depending upon the backlog within the various government departments processing the data. Normal practice is to update the hydrology after 15 to 20 years or shortly after a severe drought has passed. During the past 16-year period several extremely dry years have occurred over many parts of the basin. For climate change purposes it is important to capture the latest characteristics of flows and rainfall influenced by climate change.

DWS RSA has already picked up that the existing Water Resource Planning Model outputs with respect to water quality along the Vaal River downstream of Vaal Dam do not agree well with reality. DWS RSA is therefore already planning a study to improve the water quality calibrations as well as the hydrology in the affected area. The update of the hydrology and improvement of water quality calibrations for the remainder of the Orange/Senqu River Basin can be carried out in addition to the DWS RSA work. It is, however, important to select areas where the updating of the water quality component of the Water Resource Planning Model is really required, as it might not be worthwhile for all the areas in the basin.

In previous Climate Change assessments undertaken for the Orange-Senqu basin, the expected rainfall and runoff was estimated from numerous global Climate Models which are also used around the world for such assessments. The models utilise a simple downscaling approach to create the expected rainfall on a local catchment level from the overall global model.

In the most recent assessments of the Climate Change models undertaken for the Orange/Senqu basin, it was found that the various globally accepted Climate Change Models provided rainfall estimates that were generally slightly lower than the current values, but they also lost some variability during the downscaling process. This seemingly trivial observation is in fact critical to any future planning because the predicted rainfall records are in turn used to generate likely future streamflow records. The lower variability of the rainfall from the Climate Change Models results in synthetic streamflow records that have significantly lower variability which in turn results in higher yields. The generated streamflow sequences were expected to exhibit lower yields when, in fact, they gave higher yields which are considered unrealistic. It would be foolish to base any future allocations or planning on such optimistic figures. It is generally accepted worldwide that Climate Change will increase the severity of droughts and floods which implies greater variability and not lower variability.

From the above, it is clear that updating the hydrology and water quality models is becoming a priority, specifically in some areas. The loss of variability in the downscaling process is a critical issue which needs to be addressed as soon as possible. The work from this strategic action will add very valuable information to any future studies, although it has been regarded as a medium priority time wise. The start date for such a study is given as January 2026 although it can be earlier or later.

4.10 Other Important Linkages and Related Background.

The integrated water management options forming part of Cluster 9 of the Core Scenario includes 13 different components. These components represent ongoing water related actions that should take place in all the basin countries. Most of the actions are already taking place to some extent, but need to be followed up, evaluated, or continued. Most of these components or actions were taken up in one or more of the Strategic actions as indicated in **Table 12**.

Table 12: Some Cluster 9 Items covered under Proposed Strategic Actions

Removal of unlawful irrigation	Strategic Action 2 provides valuable inputs.
Water conservation and demand management within irrigation schemes	Strategic Action 5 includes important projects.
Water conservation and demand management within urban and industrial sectors .	Strategic Action 5 includes important projects
Increasing the area of water use permits/licence coverage	Strategic Action 2 provides valuable inputs
Improve assessments of aquifers (storage capacities, recharge rates, sustainable yields, etc.)	Strategic Action 2 provides important inputs
Manage salinity	Covered under Strategic Action 9.
Manage eutrophication.	(covered under Strategic Action 9).
Management and control of alien and invasive species and problem pests	Strategic Action 2 provides valuable inputs
Consolidation of climate data and extreme event data at basin level	Strategic Action 2 provides valuable inputs
Set out guidelines and procedures to improve equitable utilisation and benefit-sharing at the basin levels	Strategic Action 3 provides valuable inputs
Harmonise policy, legal and institutional frameworks.	Strategic Actions 3 and 4 provide valuable inputs

Water Conservation and Demand Management within the irrigation sector and within the urban and industrial sectors was regarded as one of the primary integrated water management options. Strategic Action 5 was thus entirely focused on this aspect.

4.11 Roadmap Timeline

The activities included in the Roadmap Timeline have been grouped under specific headings to make it convenient for the reader to place them geographically. These headings are:

1. Selected Strategic Actions, nine in total – over the whole basin.
2. Core Scenario projects in the following regions:
   a. Orange River in South Africa (blue shaded)
   b. Integrated Vaal River System, South Africa (light pink shaded)
   c. The Greater Bloemfontein Area – South Africa (green shaded)
   d. Lesotho (light red shaded)
   e. Namibia - Lower Orange River and Fish River (light brown shaded)
   f. Botswana (light purple shaded)
   g. Core scenario projects common to all Basin States. (light green shaded)

Timelines indicated with a solid bar are projects that can be allocated a specific start and end date. Typically, these are construction projects such as the Construction of the Gariep – Bloemfontein Pipeline.

Timelines indicated with a vertically hatched bar are projects of an ongoing nature. Typically, this would be Water Conservation and Demand Management (WCDM) for irrigation. This will be an ongoing activity continually trying to improve water use efficiency.

Where it makes sense to link projects, and where sufficient information is available, links were included. These links may be subject to revision in the future as priorities develop and change, as well as when demand projections are updated.

4.12 Commencement Dates for the Strategic Actions

The commencement dates of the selected Strategic Actions have been chosen considering the time required to:

i. Source funding.
ii. Finalise Terms of Reference.
iii. Prepare Request for Proposals and appoint consultants.
iv. Completion of consultants' assignments, and approval of Reports.

v. Linkage with Core Scenario Items.

Important linkages between the key strategic actions with some of Core Scenario development options are indicated by several lines:

i. Solid red line → Strategic actions 3 and 4 links with a high number of Core Scenario development options showing the importance of completing, in particular Strategic Action 3 before starting with these developments.
ii. Dashed black line ·········▸ Strategic Action 2 directly links to the real time modelling and monitoring, a Core Scenario Item in the Orange River RSA.
iii. Solid orange line → Strategic Action 1 directly links to the river mouth environmental requirement forming part of the Core Scenario Items listed under "All Countries".
iv. Dashed blue line - - - -▸ Strategic Action 5 directly links to the water conservation and demand management, a Core Scenario item listed under "All Countries".
v. Dashed dotted purple line —·—▸ Strategic Action 7 and 9 directly links to the "Consolidation of climate change data and extreme event data", and Management of Salinity, Core Scenario items listed under "All Countries".

By taking all factors into account the following are the estimated commencement dates for the Strategic Actions:

i. Strategic Action 1: Agreement and Implementation of Environmental Water Requirements - January 2023 – This project has already commenced and needs to be followed up by its next phase.
ii. Strategic Action 2: Improvement and Implementation of Monitoring and Information Management Systems – January 2025.
iii. Strategic Action 3: Development and Implementation of Guidelines for Sharing of water resources – July 2024.
iv. Strategic Action 4: Synchronisation and Preparation of Future and Planned Developments – July 2025.
v. Strategic Action 5: Implementation and monitoring of WDM Activities – January 2025.
vi. Strategic Action 6: Assurance of Supply and Economic Value of Water – May 2027.
vii. Strategic Action 7: Water Disaster Management and Climate Adaptation – January 2028
viii. Strategic Action 8: Capacity Building – July 2024. Ongoing project.
ix. Strategic Action 9: Hydrology Update and Calibration of Water Quality Model – January 2026.

The following Core Scenario projects are scheduled to commence within the next two years.

ORANGE RIVER RSA

i. Real time modelling/monitoring – development and testing of a real time hydraulic model
ii. Construction of the Vanderkloof Lower-Level storage utilisation. The timing for the commencement of this project will depend on the level of storage available in the system, in particular, the Gariep and Vanderkloof dams.

INTEGRATED VAAL RIVER SYSTEM RSA

i. Removal of unlawful irrigation to commence as soon as possible.
ii. Construct Phase 2 of the Lesotho Highlands Water Project (Polihali Dam and connecting tunnel to Katse Dam).
iii. Construction to start with desalination and re-use of mine water effluent.

GREATER BLOEMFONTEIN RSA

i. Increase Tienfontein pumping capacity to 3.87 m^3/s, Novo Transfer scheme capacity to 2.2 m^3/s to Rustfontein Dam, due to increased power supply. This project has been completed.
ii. Construction - Increase Maselspoort Water Treatment Works capacity to 130 Mℓ/d.
iii. Construction of indirect reuse from the Bloem Spruit Waste Water Treatment Works (± 45 Mℓ/d).
iv. Construction - Raise Mockes Dam to increase storage capacity.

LESOTHO

i. Construct Phase 2 of the Lesotho Highlands Water Project (Polihali Dam and connecting tunnel to Katse Dam).

NAMIBIA

i. Neckartal Dam irrigation.

ALL COUNTRIES – TO BE GUIDED AND MONITORED BY ORASECOM

i. WCDM Urban and Industrial;
ii. Control alien invasives;
iii. Increase permit/license coverage;
iv. Harmonise policy, legal, and institutional frameworks - Part 1;
v. Set water quality objective standards;
vi. Manage salinity;
vii. Manage eutrophication;

viii. Set out guidelines and procedures to improve equitable utilization and benefit sharing at basin level;

ix. Improve assessment of aquifers - Sub-component of Strategic Action 9;

x. Formally agree on environmental requirements and releases to river mouth. Sub-component of Strategic Action 1.

The Timelines are shown graphically in Figure 6.

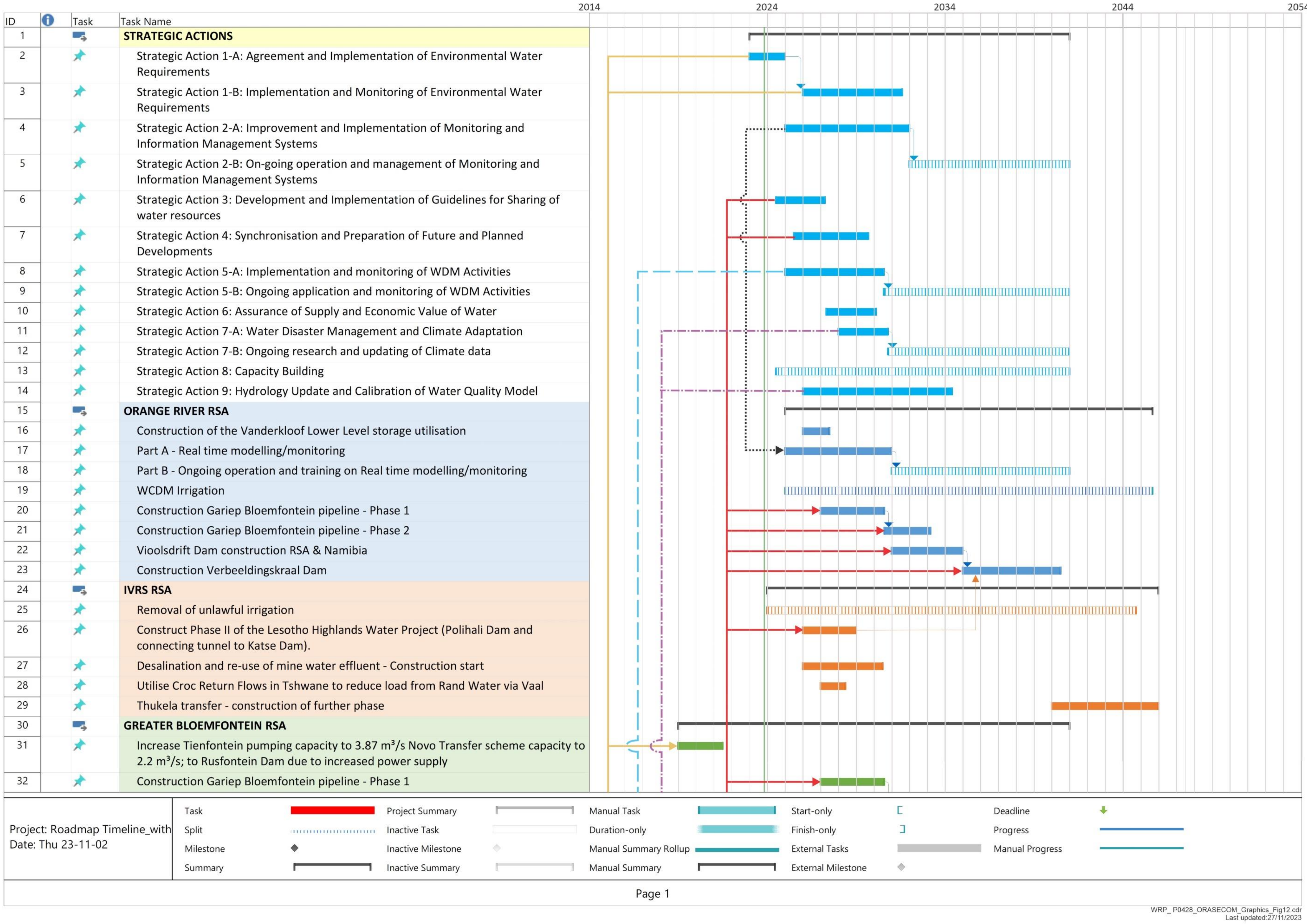

Figure 6: Road Map Timeline 1

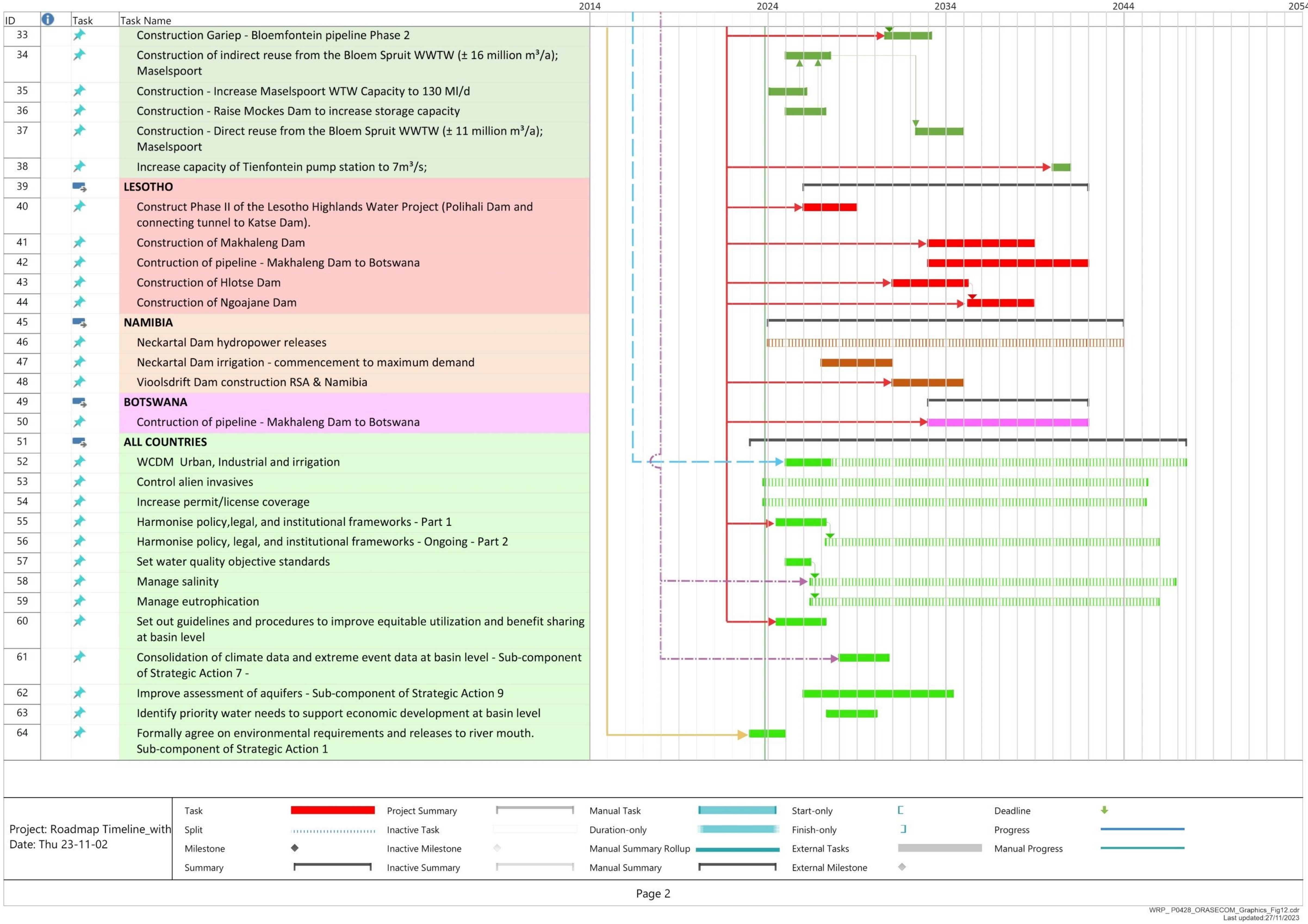

Figure 7: Road Map Timeline 2

5 FUNDING CONSIDERATIONS

5.1 GENERAL

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. **Table 13** provides some details of the water infrastructure development financing from the Basin Member States national budgets.

The table presents a summary of the water sector budgets for each country based on their 2019 National budgets. These figures provide a guide to the relative size of water infrastructure budgets available annually for each country which is helpful when looking into the possible funding requirements for the various projects mentioned in this report.

Table 13: Water Sector Budgets in Basin States for 2019

Country	**Water sector budget (USD millions) in 2019**
Botswana	255
Lesotho	56
Namibia	15
South Africa	854
Total	**1 180**

The proposed Lesotho-Botswana Transfer Project is expected to cost approximately $3 billion to implement (based on R18/$ exchange rate). The details provided below aim to provide some context to this figure and to offer possible funding options that may be viable to fund such a project.

It is clear that such large projects as the Lesotho-Botswana Water Transfer Project 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, commercial capital and blended financing as shown in **Figure 8.**

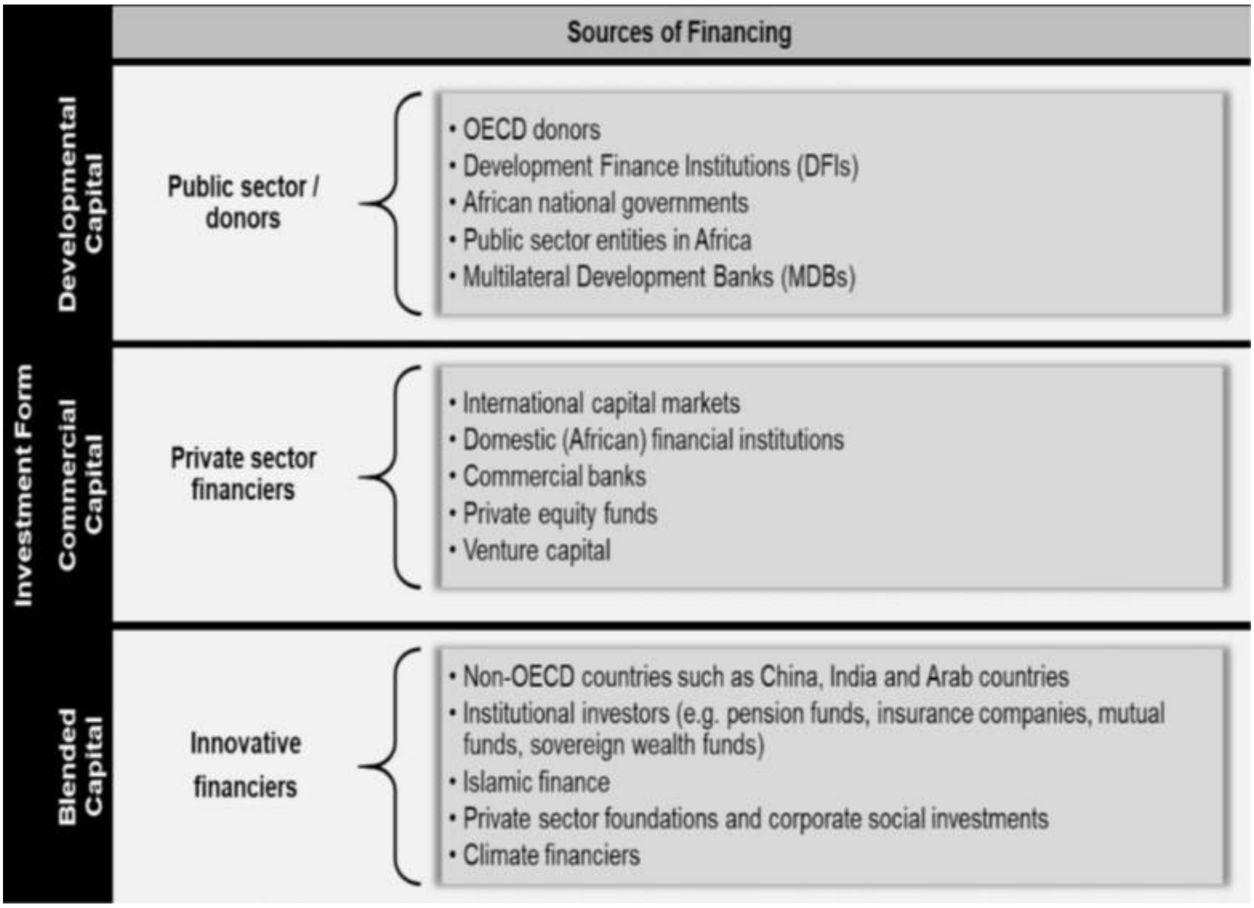

Figure 8: Potential Funding Options

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.”

5.2 DONOR FUNDING

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.

5.3 COMMERCIAL LOAN FUNDING

The updated core scenario financing strategy will 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 underutilised 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 mobilisation of locally sourced capital.

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 9** shows the main instruments and different categories within each instrument.

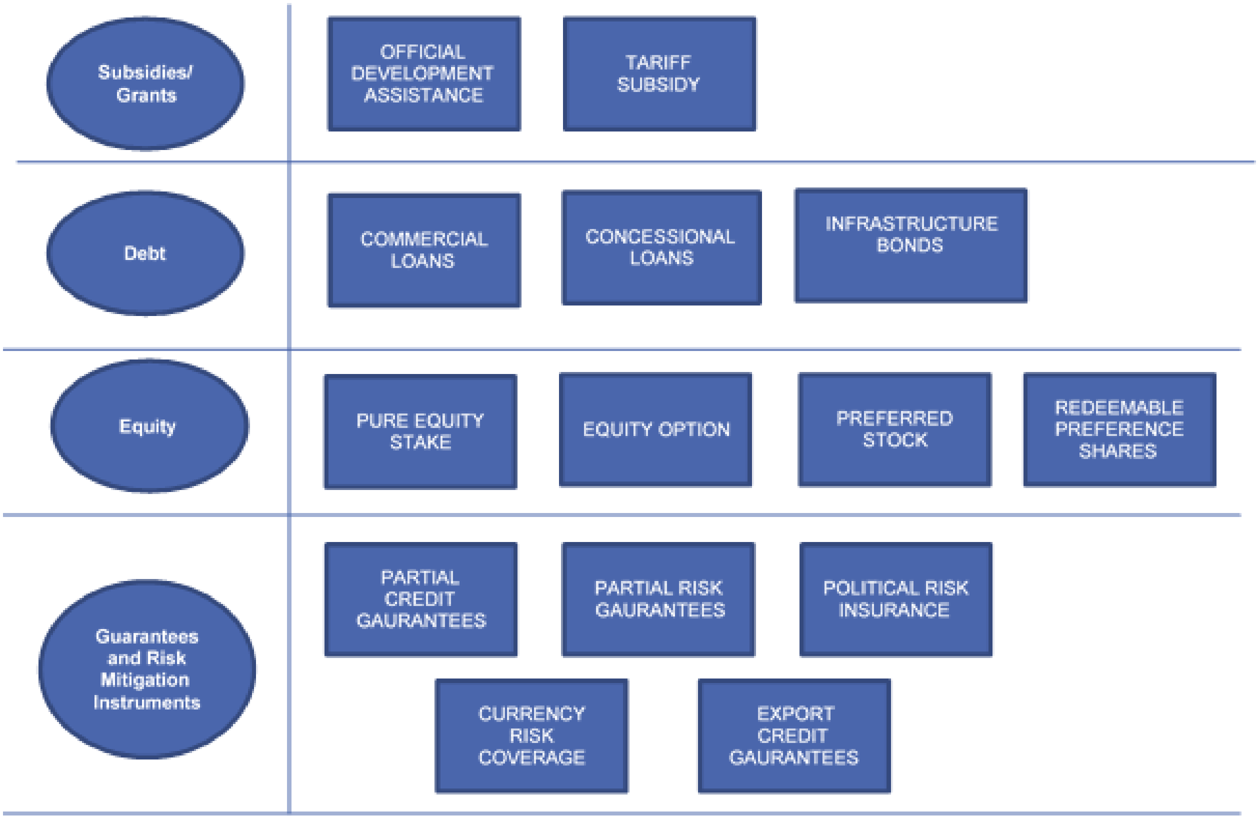

Figure 9: Types of Funding

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 grant-making functions.

5.4 Institutional Funding Considerations

The recommendations on the institutional and funding arrangements for the L-BWT made in this study should be considered as preliminary suggestions made by the Project Team which must be refined through further dialog with the relevant departments within the 4 Basin States.

A separate institutional and funding study was funded by SIWI and CRIDF from which some useful observations and recommendations were made which have been included in this section for completeness. The details provided below have been taken from the Basin Wide Investment Plan of June 2023 (Report Number: ORASECOM 010/2019) which can be examined for a more comprehensive explanation of the funding issues and proposed Institutional Arrangements. It should be noted that the final institutional and funding recommendations for the L-BWT must still be agreed upon and the recommendations provided below will have to be revisited and properly aligned with the proposed Road Map.

SIWI and CRIDF study

In the SIWI and CRIDF study, the following was 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 therefore be to utilise these three 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. A new Commission, similar to the LHWP Joint Commission, would also 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.

Existing Corporation or Special Purpose Vehicle

As an alternative to mandating LHDA, TCTA, and WUC to build and operate the L-BWT, there could be benefits in appointing a single corporation such as Rand Water for example, 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.

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.

Private Public Partnerships

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.

CRIDF Conclusions

The parallel study undertaken by the Climate Resilience Infrastructure Development Fund (CRIDF) to assess the viability and cost of the Lesotho to Botswana Water Transfer Project drew various conclusions that 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.

A key finding of the CRIDF study 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.

The member countries 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 agree to proceed 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. There is general agreement that an incorporated Special Purpose Vehicle is unlikely to manage the expropriation and other regulatory hurdles required to implement a project traversing three countries and private land in South Africa. As a result it is suggested involvement of existing State-Owned Entities such as LHDA, TCTA and WUC (possible together with Rand Water) to implement components of the scheme in the different countries.

5.5 FUNDING CONCLUSIONS

In summary, the sources of capital for projects are a critical component once the project reaches an advanced stage of development, where the financing component becomes critical to achieving financial closure on the project. Most standalone infrastructure investments (in the water sector) require a combination of developmental and commercial capital. 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 Integrated Water Resource Management Plan core scenario interventions will require a combination of funding sources.

The proposed projects must therefore 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. Certain projects proposed in the Road Map are clearly Climate Resilience projects which are designed to supply water to address possible future shortages that are due to the impacts of Climate Change. Such projects may qualify to receive preferential terms or even significant grant funding from one of the various Global Climate Funds which have been established to support such projects in developing countries. This may help to create a viable project which would not be possible without some level of grant funding.

It is evident that the water from the Lesotho to Botswana Water Transfer Project is expensive in terms of the cost of water delivered per m^3. The member countries need to confirm whether water from the Lesotho to Botswana Water Transfer Project is indeed affordable to the recipient States and whether they agree to continue with its implementation. The funding assessment by the Project Team is in general agreement with the findings from the parallel study undertaken by the Climate Resilience Infrastructure Development Fund which indicated 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 is therefore recommended that ORASECOM should already approach the Trans Caledon Tunnel Authority and request that it tests the willingness of its bankers to fund the project.

6 CONCLUSIONS AND RECOMMENDATIONS

- Depending on the availability of funds, political drive and decisions taken, the actual growth of the water requirements, success rate of water conservation and water demand actions etc. the timing and implementation of the projects and key strategic actions will change in future. It is therefore recommended that the Road Map program be regarded as a live document and be updated on an annual basis.
- The Lesotho Botswana Transfer Scheme is expensive, and its financial viability needs to be checked in detail after the completion of the Feasibility Study of both the dam and conveyance system. Based on these financial and economic assessments the member countries will need to confirm if the water from the Lesotho to Botswana Water Transfer Project is indeed affordable to the recipient States and whether or not they agree to continue with its implementation.
- Polihali Dam, currently under construction, as well as the possible future dam on the Makhaleng River will impact significantly on the yield of existing downstream schemes. Based on current planning no compensation/mitigation releases will be made from these two dams to re-balance the existing downstream schemes. It is therefore important to introduce other intervention options to restore the water balance to the downstream system. The cost of these intervention options was not included in the costing of Polihali Dam or the proposed dam on the Makhaleng River. Considerable effort has already been undertaken by DWS RSA on possible options to re-balance the downstream system as result of the impact of Polihali Dam These options have been included in the Core Scenario Schemes and in some of the Key Strategic Actions.
- Some options have already been identified as part of this study to re-balance the impact of the dam on the Makhaleng River has on the existing downstream developments. A detailed reconciliation strategy study is, however, required to determine the most appropriate intervention option to re-balance the existing downstream systems. This proposed reconciliation study is referred to in Key Strategic Action no. 4.
- The Road map will provide guidance to ORASECOM and the four basin states to implement the Water Resources Investment Strategy and Plan, including the large number of development projects from the Core Scenario as well as the Key Strategic Actions.

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

COMPONENTS I AND II

APPENDIX A

ROADMAP SUPPORTING REPORT

STRATEGIC ACTIONS & TERMS OF REFERENCE

Prepared for

Orange-Senqu River Commission (ORASECOM)

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Prepared by

in association with

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. The Orange River originates in the Lesotho Highlands and flows in a westerly direction approximately 2 200 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, 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 infrastructure involves most of the largest water storage reservoirs in Southern Africa as well as the associated transmission infrastructure, transmitting water to more than 250 major demand centers that are in some cases located outside of the Orange-Senqu River basin through intra and inter basin transfers.

The Republic of Botswana is an arid country facing serious water constraints which are exacerbated by the effects of climate change and land use change due to population growth and improved living standards. It is predicted that Botswana will experience chronic water shortages by about 2025, unless major new water sources are developed. Gaborone already relies on long-distance water transfers via the North-South Carrier and its water supply faces many risks including pipeline breakages and normal drought events. The 2015-2016 drought was particularly severe in Botswana and demonstrated the potential impacts of a severe drought compounded by climate change and infrastructure problems. As a consequence, the Governments of Botswana, Lesotho and South Africa signed a memorandum of agreement to undertake a reconnaissance study on a possible transfer scheme from Lesotho to Botswana (the L-BWT) aimed at developing water resources in Lesotho and the necessary conveyance infrastructure (pipelines, canals etc.). The proposed transfer scheme will convey water from Lesotho to Botswana and also supply various users in Lesotho and South Africa on route. This reconnaissance study has identified a number of possible development options which include a new dam on the Makhaleng River in Lesotho and a piped conveyance system to Botswana. The proposed dam has a local yield of 344 million m^3/a of which an annual gross transfer of 156 million m^3/a will be transferred to Botswana and approximately 30 million m^3/a to users in Lesotho and the RSA (186 million m^3/a in total).

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.

To co-ordinate and facilitate the water resources development and management in the region, the Orange–Senqu River Basin 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 Member States. The Integrated Water Resource Management 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.

The objective of the current study is to update the Integrated Water Resources Management (IWRM) Plan of 2015 and identify an agreed and updated core scenario which includes the L-BWT project. Furthermore, the project aims to assist the Orange Senqu River Commission (ORASECOM) and the riparian countries in formalising the updated Integrated Water Resource Management Plan.

The study is divided into two main components:

- 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 (Components III & IV of the study)

This report falls under Component II: Climate Resilient Water Resources Investment Plan. This report is part of the final deliverable from Component II of this study. The main purpose of this report is to provide details of potential Strategic Actions which support the road map and operational plan for ORASECOM to rollout the implementation thereof, over the coming years for activities under its direct operational responsibility.

Following the completion of the first phase of the project, 17 possible strategic actions were identified by the project team which it considered could be included in future projects to be undertaken through ORASECOM.

The 17 Strategic Actions which were initially identified were discussed and through a lengthy selection process which is fully described in this report. Following these discussions, two of the 17 Strategic Actions were eliminated and the other 15 were consolidated into a short-list of 9 key Strategic Actions which are discussed in detail in Sections 5 to 13 of this report. These 9 key Strategic Actions are provided in the table below together with a preliminary estimate of the budget that will be required to complete the work. It should be noted that the costs provided are very preliminary at this stage and must be further refined through further discussions with ORASECOM and representatives from the 4 Basin States.

Table 1: Key Strategic Actions Discussed in this Report

	Description	Capital Cost ($m)	Running Costs ($m/annum)
1	Agreement and Implementation of Environmental Water Requirements	$1m to $5m	$1m per annum
2	Improvement and Implementation of Monitoring and Information Management	$5m	$1m per annum
3	Development of Guidelines for sharing	$1m	
4	Synchronisation and Preparation of Future and Planned Developments	$1m	
5	Implementation and monitoring of WDM activities	$1m	
6	Assurance of Supply and Economic Value of Water	$1m	
7	Water Disaster Management – Climate Adaptation	$2m to $3m	
8	Capacity Building	$2m	$2m every 3 years
9	Hydrology Update and WQ Model Calibration	$3m	

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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. The Orange-Senqu River originates in the Highlands of Lesotho and flows in a westerly direction for approximately 2,200 km to the west coast of South Africa and Namibia where it discharges into the Atlantic Ocean. (See **Figure 1.1)**

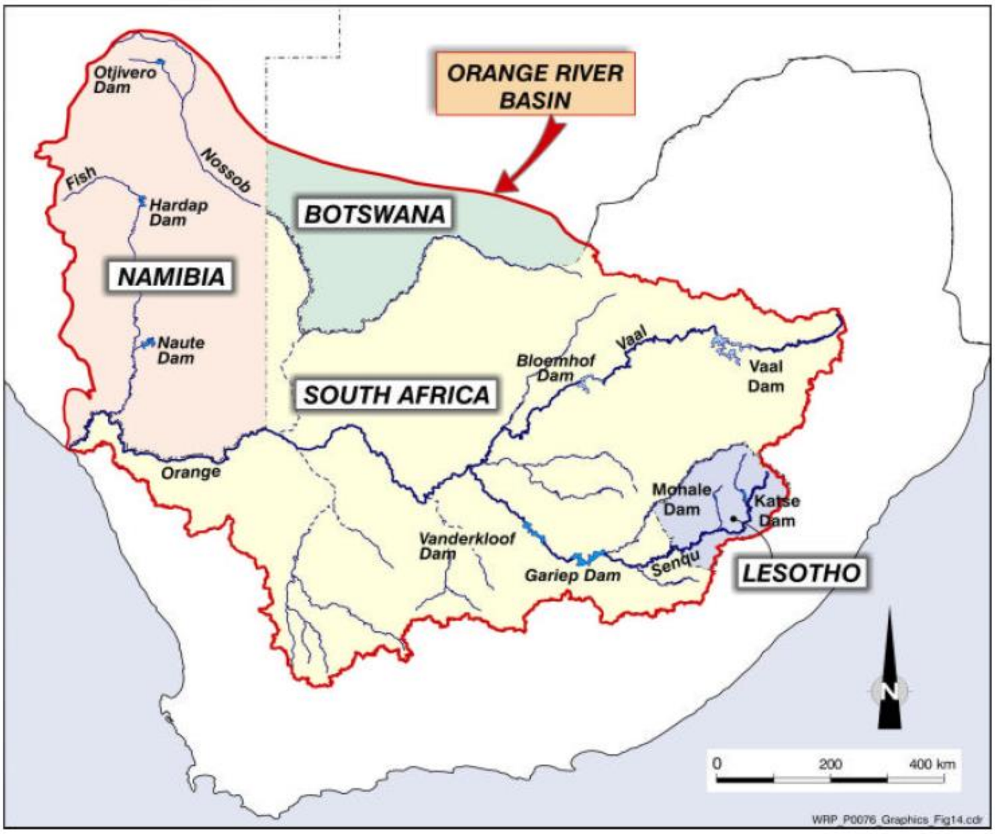

Figure 1-1: Orange River Basin

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 flows in the westerly direction and converge with the Orange River, outside the border of Lesotho, 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 originate in the Senqu basin in the Lesotho Highlands, 6,500 million m^3/a from the Vaal and Upper Orange, with approximately 800 million m^3/a from the Lower Orange and Fish River (Namibia). 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 exclusively stretch over SADC Member States. The Orange–Senqu is one of these thirteen transboundary watercourse systems. The Southern African Development Community (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 riparian states. The region has demonstrated a great deal of goodwill and commitment towards collaboration on water issues. Thus, SADC 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 Basin Commission (ORASECOM) was established in November 2000.

ORASECOM was established by the Governments of the four States, namely, South Africa, Lesotho, Botswana and Namibia, for managing the transboundary water resources of the Orange-Senqu River basin and promoting its beneficial development for the socio-economic wellbeing and safeguarding the basin environment. 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 project implementation that provides a mutually inclusive transboundary benefit.

The IWRM Plan recommends strategies and measures for promoting sustainable management of the water resources of the basin and 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 of this study, was not included in the 2015 IWRM Plan as one of the strategic actions.

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 to manage the resource availability between the location of relatively abundant precipitation and the location of greatest water requirements. The infrastructure involves storage and transmission of water, to water 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 transfers to the Vaal Basin.

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 utilisation in the Vaal River basin, most of which is for domestic and industrial purposes. Several major transfers 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 confluence, as well as significant irrigation developments in the Eastern Cape, 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, depending upon the flow rate in the river.

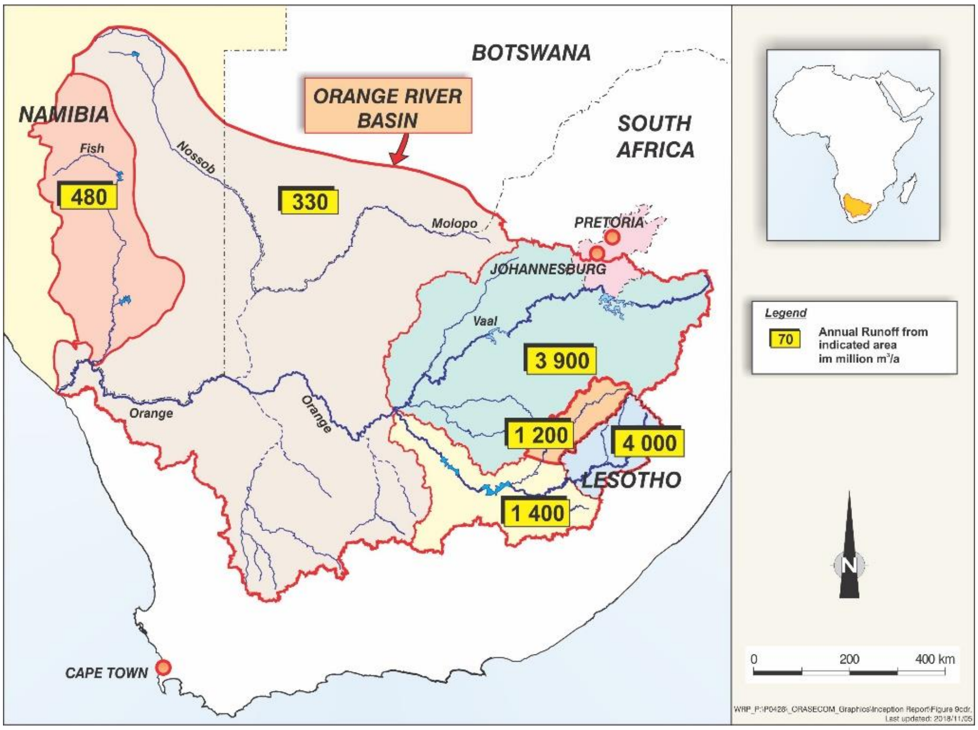

Figure 1-2: Approximate Natural Run-off in the Basin

As already indicated, there are locations of relatively abundant precipitation and water availability and locations of greatest water requirements. Water scarcity in locations of greatest need is the main challenge in the basin and 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 west. As shown in **Figure 1.3**, average annual precipitation decreases from more than 1000 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 localised. The temporal and spatial distribution of precipitation within any particular year can be considerable.

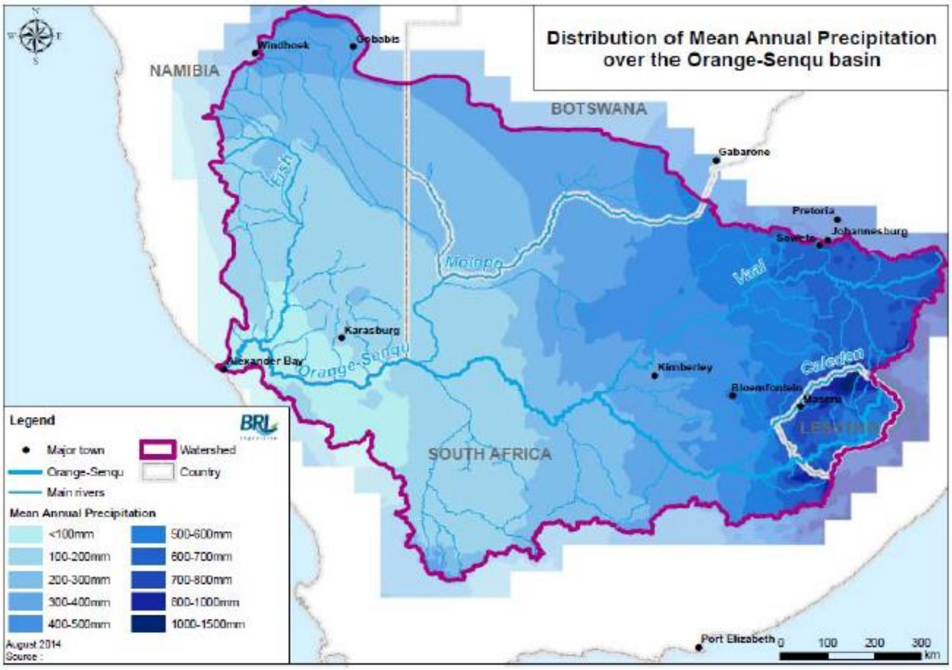

Figure 1-3: Distribution of Mean Annual Precipitation

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, evapotranspiration exceeds precipitation. Temperature and evapotranspiration follow a similar distribution with coolest temperatures in the Lesotho Highlands and the hottest in the western Kalahari.

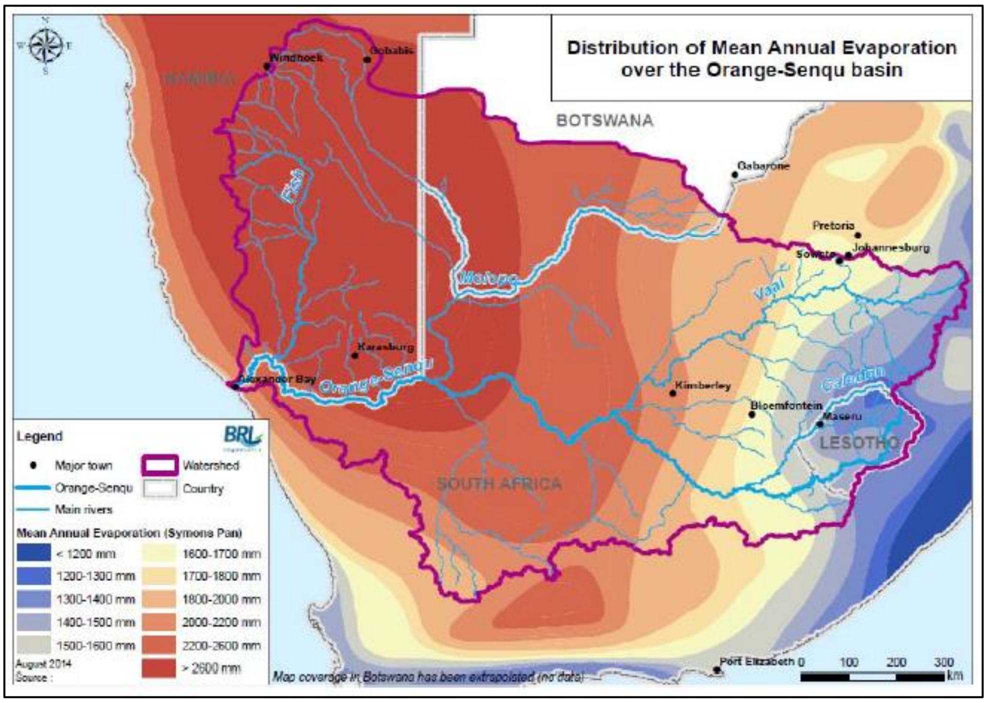

Figure 1-4: Distribution of mean annual precipitation over the Orange-Senqu basin

It is generally accepted that southern Africa will be highly impacted by climate change. Consequently, there are concerns around the changes in precipitation and temperature due to climate variability and climate change. 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.

The Republic of Botswana is an arid country with serious water constraints which will worsen with the expected effects of climate change. Botswana can expect to experience chronic water shortages in the near future unless a major new water source is developed. Already Gaborone was badly effected by a serious drought event which caused severe shortages in 2015 and 2016. Droughts are natural events which must be expected, however, they will become more frequent and more severe due to the impacts of Climate Change and the water resource systems must therefore be improved and developed in order to mitigate the negative impacts of such events.

As a consequence, the Governments of Botswana, Lesotho and South Africa signed a memorandum of agreement to undertake a reconnaissance study on the Lesotho to Botswana Water Transfer scheme (L-BWT) aimed at developing new water infrastructure in Lesotho and through South Africa, to convey water from Lesotho to Botswana at the same time supplying various users in Lesotho and South Africa. This reconnaissance study led to the selection of a technical option which included a new dam on the Makhaleng River in Lesotho and a water conveyance (pipeline) system to Botswana. It was envisaged that eventually 150 million m^3/a will be pumped to Botswana with additional supplies for consumers along the route in Lesotho and South Africa.

1.2 Objective of the Assignment

The objectives of the study are:

- to update the IWRM Plan endorsed in 2015,
- to propose an updated Core Scenario including the L-BWT project,
- to study the L-BWT Project at pre-feasibility level including the feasibility of the dam,
- and to assist ORASECOM and the riparian countries in operationalizing the updated IWRM Plan.

The objectives will therefore be met through three outputs:

- A climate resilient investment plan for the Orange-Senqu River Basin based on the updated Core Scenario;
- Operationalizing for key priority actions selected from the updated IWRM Plan; and
- Pre-feasibility level report for the L-BWT, and the feasibility level report for a new dam on Makhaleng River in Lesotho.

The study is 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 study of the Lesotho-Botswana Water Transfer Project, including the feasibility study of a new dam on Makhaleng River in Lesotho as Components III & IV of the study.

The four components 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 which is being further exacerbated by climate variability and change, necessitates 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 when technically and environmentally feasible, is both expensive and complex. Economic considerations of water use have been identified as a key part in the planning and optimum use of what will 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 will ensure the development of short, medium- and long-term solutions to address basin water resources need and development challenges.

The study includes water resource studies in the Botswana, Lesotho, Namibian and South Africa. This will include updating of inputs from the Reconciliation Strategy Studies, updating of inputs with more recent results from the Reconciliation Strategy Maintenance Studies as well as other recent water resource related studies conducted in the basin countries. The study will establish comprehensive basin wide analyses which will be integrated with economic analyses to determine the most efficient development options as part of setting the long-term development investment strategy and plan for the basin.

Components I & II will thus address the water resources investment plan and the updated IWRM Plan with the following outputs:

- Updated Core Scenario of the IWRM Plan, which includes the Lesotho-Botswana Water Transfer Scheme and any other new projects identified;
- Assessment of the impacts of Climate Change on the updated Core Scenario;
- Optimised IWRM Plan Core Scenario based on an economic approach;
- Financial Strategy for the Core Scenario;
- Updated Basin Wide Investment Plan approved by ORASECOM including new projects and the likely impacts of climate change;
- An assessment of existing policies, institutional arrangements and structures;
- Selection of the key strategic actions and the associated Terms of Reference and cost estimates for each and
- A road map for the implementation of the key strategic actions contained in the updated Integrated Water Resource Management Plan.

1.2.2 Lesotho-Botswana Water Transfer Project (Components III and IV)

The south-eastern urban complex of Botswana centered around the capital city, Gaborone, has experienced rapidly increasing growth over the last few decades, and this growth is expected to continue. The water demands for the area have long since outstripped the local bulk water resources, which are already augmented from sources in the north-east of the country. The country has experienced several severe droughts in the past which have resulted in water restrictions. Despite efforts to alleviate the water challenges, indications are that the water sources will not be able to support the growing demand as early as 2025.

The solution for addressing the water security challenges and the increasing impacts of Climate Change lies in more efficient use of existing infrastructure, developing additional water resources and improving the management systems, based on availability and usage.

A Reconnaissance Study to identify possible water resources was completed in October 2015, which outlined various options of water sources and conveyance routes to supply water from Lesotho to Botswana. The various sources covered by the study include the Lesotho Highlands Water Project, the Makhaleng River and the Orange/Senqu in the south of Lesotho. The preferred supply scheme recommended in the Reconnaissance Study was a dam on the Makhaleng River, and a conveyance system to bring the water from Lesotho, across South Africa to Botswana.

A Pre-feasibility Study is required to determine water demands for up to 2050 for specified areas in Botswana, Lesotho and South Africa, from available relevant information in all countries, and further investigate suitable dam site(s) by analyzing the Makhaleng catchment hydrology, determining the size of dam(s) on the basis of topography, geology, yield, sedimentation, hydropower generation and water demands for specific areas in Botswana, Lesotho and South Africa. For the conveyance system, the study is only required to investigate pipeline options along the shortest route, to either Gaborone or Lobatse in Botswana, preferably along existing road servitudes.

Depending on the results and recommendations from the Pre-feasibility Study, a Feasibility Study for the dam on the Makhaleng River will follow, but this depends on a final decision by the State Parties to the project. **Figure 1.5**, is the topographic map of the catchment, showing the Lesotho to Botswana water transfer project stretch and the major topographic features of the two end points of the water transfer scheme.

Components III & IV of this study focus on the Lesotho-Botswana Water Transfer Multipurpose Trans-boundary Project (L-BWT) and address:

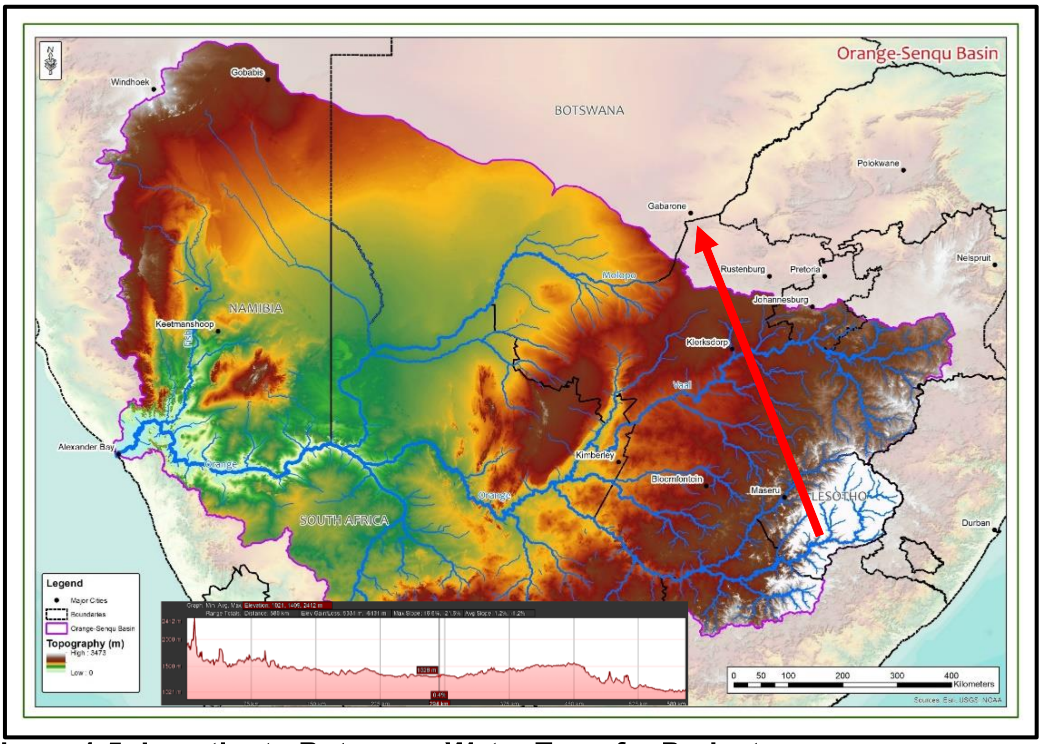

Figure 1-5: Lesotho to Botswana Water Transfer Project

<u>Component III - Phase 1 – Initial components of the Pre-feasibility study for Makhaleng Scheme</u>

- Validation of the water requirements for irrigation in Lesotho, the demand in South Africa along the pipeline route, and the demand in Botswana;
- Assessment of the water resource in the Makhaleng catchment;
- Dam site selection; and
- Conveyance route selection.

<u>Component III - Phase 2 – Pre-feasibility of the Makhaleng Scheme</u>

- Pre-feasibility study of a dam on the Makhaleng River;
- Pre-feasibility study of the water conveyance pipeline from Makhaleng to Gaborone/Lobatse;
- Assessment of environmental and social impacts;
- Economic assessment of the dam and the Lesotho-Botswana conveyance pipeline; and
- Multi-criteria analysis (MCA) of the options.

<u>Component IV - Feasibility of the Makhaleng Dam (Depending on the outcomes from the Pre-Feasibility Study)</u>

- Hydrological analysis, including impacts of climate change;
- Feasibility Study of the Makhaleng Dam:
- Economic, Social and Financial analysis update; and
- Preparation of project implementation plan.

1.3 Purpose and Structure of this report

This report is the final deliverable from Component II of this study. The main purpose of this report is to provide details of the key Strategic Actions that in turn support a road map and operational plan for ORASECOM to rollout the implementation thereof, over the coming years for activities under its direct operational responsibility.

This will require inputs from several sources, reports and specific task outputs such as:

- A review of the existing IWRMP endorsed in 2015, followed up by an analysis of the strategies and activities listed in the IWRMP. This formed part of Task 2a of Component II of this study and is summarised in this report.
- Selection of strategic or specific actions from the Updated Core Scenario which are aligned with strategic objectives and strategic actions, specific actions and activities as captured in the existing IWRMP. The selection of the key strategic or specific actions were selected through a participatory screening process. This was carried out as part of Task 2a of this study and will be described as an Appendix to the final report.
- Background to the selected strategic actions, the rationale behind each action, the specific tasks and activities related to each action, the timeline, implementation arrangements, cost estimates and possible financing sources. These were sourced from the reports completed as part of Component I of this study as well as from Task 2a of Component II of this study. Summarised key information and background will be provided as an appendix to the final version of this report.
- Preparation of an implementation road map that includes a description of the concepts, an outline of the Terms of Reference as prepared for the selected Key Strategic Actions as well as the related cost estimates for the selected actions.
- The preparation of a consolidated operational action plan to serve as guideline for the implementation of the IWRM Plan strategies.

Section 2 provides details of the original 17 Strategic Actions suggested by the project team as well as the results of the screening/selection process which was used to identify the 10 most important issues. It was later decided to add back some of the actions initially rejected and to combine certain actions into a single “Key Strategic Action. This resulted in 9 Key Strategic Actions which covered most of the original 17 actions initially discussed.

Section 3 provides summaries of the Key Strategic Actions (9) which were selected through the short-listing process.

Section 4 provides details of the various sections in the Terms of Reference which are basically generic to all of the Terms of Reference. In order to reduce the size of this report, they have been provided only once in **Section 4** rather than being copied in each of the subsequent sections where each section represents one Terms of Reference.

Sections 5 to 13 provide the technical elements for each of the 9 Terms of Reference.

It should be noted that initially it was proposed to provide 10 Terms of Reference which were selected from an initial list of 17 separate tasks. During the selection process, some tasks were identified as Key Strategic Tasks while others were eliminated from the final list. Subsequent discussions resulted in the inclusion of some discarded tasks into the final list as well as the consolidation of some tasks to creates larger project which would be easier to manage and finance as opposed to numerous smaller projects. The final list of Terms of Reference is therefore provided in **Sections 5** to **13** and contains 9 individual Terms of Reference. Each of these Terms of Reference will eventually incorporate the common details provided under **Section 4**. Once the common text has been reviewed and amended, where required, it can then be incorporated into each of the 9 Terms of Reference.

2 SUMMARY OF STRATEGIES AND ACTIVITIES LISTED IN THE 2015 IWRMP

2.1 Strategic Action Selection Process

2.1.1 Background

The main purpose of this report is to provide draft Terms of Reference for a number of Strategic Actions that ORASECOM can take forward as projects which can be funded through various Development Banks and/or Funding Agencies. The Strategic Actions have been selected through a detailed selection process involving many meetings where representatives from the 4 basin states were able to provide their views on each issue. The initial list of 17 proposed projects was reduced to a short-list of 10 projects after which further discussions with the members from each basin state and Orasecom were held. It was subsequently agreed with ORASECOM to combine some of the short-listed projects and in addition, to expand the scope of the proposed projects in order to capture some of the additional issues listed in the Integrated Water Resources Management Plan (Report ORASECOM 19/2014). The final outcome of this process is presented in this report and comprises 9 key Strategic Actions, each of which is discussed to some extent in the remainder of **Section 2** while the details required to develop the Terms of Reference are provided in **Sections 4 to 13**.

After the completion of Component I of the study, **Task 2a** of Component II requires the selection of key Strategic Actions and the development of the draft Terms of Reference and cost estimates. Details of the requirements as outlined in the original Terms of Reference are provided for clarity in **Figure** 2-1**.**

Section 7 – Terms of Reference Standard Request for Proposals - SRFP

4.2 Component II: Operationalisation of the Integrated Water Resources Management Plan

This component is aimed at preparing a Road Map and operational action plan for the implementation of the IWRM Plan to rollout implementation over the coming years.

The implementation of the IWRM Plan is centered on 11 core strategic objectives for achieving the water resources development goals and vision of the basin. The central strategic objectives are defined as optimization of water use for socio-economic development while ensuring environmental sustainability and water security that enhances resilience to water related disasters including climate variability and change impact.

The enabling strategic objectives relate to creating knowledge, capacity building and institutional strengthening, stakeholders' engagement and M&E. Cross-cutting strategic objectives are set as mainstreaming climate change and mainstreaming gender. The IWRM Plan has identified 43 strategic actions, 136 specific actions and 349 activities for implementing the strategic objectives.

There is a need for road map and operational action plan for ORASECOM to rollout implementation over the coming years for activities under its direct operational responsibility. The main tasks to be undertaken shall include, but not limited to:

(i) A review of the IWRM Plan and background documents should be undertaken to understand the process and underlying assumption of the actions development. This should be followed by an analysis of the strategies and activities listed in the IWRM Plan to consolidate the actions and differentiate the in house and outsourced activities.

(ii) Selection of 10 strategic or specific actions (or consolidated set of specific actions in certain cases) through a participatory screening process.

(iii) Development of, for each of the selected actions, concept notes that provide background, rationale, specific tasks, activities, timeline, implementation arrangements and cost estimates and possible financing sources. Terms of references should be prepared particularly for actions that need to be outsourced. The 'target' for these concept notes are donors.

(iv) Preparation of an implementation road map that incorporate concept notes, outline TORs and cost estimate for operationalization of selected specific actions.

(v) Elaboration of institutional arrangements required for operationalization and monitoring of implementation under ORASECOM Secretariat. The financing arrangement and resource mobilization approaches should be developed as part of the institutional framework.

(vi) Preparation of a consolidated operationalization action plan to serve as guideline for the implementation of the IWRM Plan strategies.

(vii) Assessment of donors' support for financing the selected options and preparation of requests for 10 priority actions for consideration on the donors' conference. This should be done through engaging with donors face-to-face or through conference calls in the presence of ORASECOM when possible.

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Figure 2-1: Details from the TOR relating to the key Strategic Actions

The process followed to select the key Strategic Actions was to:

- Review the existing IWRM Plan background information as compiled by the previous ORASECOM Study (The Support to Phase 3 of the ORASECOM basin-wide Integrated Water Resources Management Plan) dated December 2014.
- Identify actions obtained from the Component 1 related work and assign them to relevant action areas within the Strategic Action Framework developed as part of the Phase 3 ORASECOM basin-wide Integrated Water Resources Management Plan developed and finalized in 2014 .
- Summarise and provide brief descriptions of each of the identified key actions.

- Identify various key criteria to be used to prioritise and rank the selected key actions using a simplified balanced scorecard system.
- Obtain agreement from the basin state members and ORASECOM on the proposed criteria and scores before the identified strategic actions are assessed and ranked.
- Prepare presentation and relating material to be distributed before the screening workshop.
- Arrange a screening workshop with the basin state members and ORASECOM. The purpose of the workshop is to screen and rank the proposed strategic actions and to obtain consensus on the selected 10 strategic actions.
- Prepare cost estimates for each of the final agreed 10 key strategic actions.
- Prepare Terms of Reference for the work from the 10 strategic actions that need to be outsourced.

2.1.2 ORASECOM Strategic Action Framework

The Strategic Action Framework from the ORASECOM Phase III basin-wide Integrated Water Resources Management Plan from 2014 as referred to in **Section 2.1** contains

- 11 Strategic Objectives which include
- 12 Main Strategic Actions as well as
- other additional specific actions.

The eleven (11) Strategic Objectives comprise the following:

- Ensure optimized sustainable management of the basin's water resources
- Support socio-economic upliftment and eradication of poverty
- Ensure that adverse effects of catchment degradation are reduced, and the sustainability of resource use is improved.
- Maximise security from water related disasters
- Put an adequate knowledge base in place
- Build sufficient capacity and institutional strength
- Promote high level of stakeholder engagement
- Ensure appropriate financing mechanisms are in place
- Promote adaptive management and effective monitoring and evaluation systems
- Promote mainstreaming of adaptation to potential impacts of climate change into planned actions
- Ensure mainstreaming of gender considerations into planned actions

The twelve (12) Main Strategic Action areas (numbering as given in 2014 report) are:

- 1.1) Surface and groundwater assessments
- 1.2) Optimising efficient utilisation development adaptive management of the basins water resources.
- 1.3) Inter/Intra sectorial planning and coordination
- 2.1) Equitable utilization of the basin's water resources
- 2.2) Water Resources Development
- 3.1 Improving water resources quality
- 3.2 Catchment degradation, watershed management, settlement and land use planning.
- 3.3 Environmental water requirements
- 4.1 Flood and drought mitigation extreme events, climate proofing
- 5.1 Water resources and associated environmental data and information
- 5.2 Water use and demand data information
- 6.1 -11.1 Promotion/maximizing mainstreaming of key cross-cutting and enabling actions.

The involvement of ORASECOM in any strategic action is important and needs to be identified. The ORASECOM involvement was sub-divided into four different levels as defined in the 2014 ORASECOM Phase 3 Study as given in the **Table 2-1**.

Table 2-1: ORASECOM Levels of Involvement

Strategic Action X	• High level of ORASECOM involvement. For the majority of activities under the specific action, ORASECOM bodies (TTT, CTT[1] etc and Secretariat) will be involved in execution or management during project/programme implementation
	• Significant level of ORASECOM involvement. For some of the activities under the specific action, ORASECOM bodies (TTT, CTT etc and Secretariat) will be involved in management, for most in the facilitation role during project/programme implementation
	• Medium level: For the majority of activities under the specific action ORASECOM bodies (TTT, CTT etc and Secretariat) will be involved only in facilitation or support of project/programme implementation
	• Limited level: ORASECOM involvement limited to review or none in most of the activities under the specific action

ORASECOM is in general more involved in certain action areas referred to as the Primary Action Areas which include the following seven action areas:

- **Action Area 1.2**: Optimizing efficient development and adaptive management of water resources
- **Action Area 2.1**: Equitable utilisation of (the basin's) water resources
- **Action Area 3.2**: Catchment degradation, watershed management, settlement and land-use planning
- **Action Area 3.3**: Environmental flow requirements catchment degradation, watershed management, settlement and land-use planning
- **Action Area 4.1**: Flood and drought mitigation, extreme events, climate proofing
- **Action Area 5.1**: Water resources and associated environmental data and information
- **Action Area 6.1 to 11.1**: Promotion/maximizing mainstreaming of key cross-cutting and enabling strategic actions
    - **6.1.1**: Ensure sufficient capacity building
    - **6.1.2**: Ensure effective policy, legal and institutional arrangements
    - **6.1.3**: Undertake research to support sustainable water resources
    - **7.1.1**: Ensure appropriate and effective stakeholder participation
    - **7.1.2:** Mainstream promotion of transboundary cooperation
    - **8.1.1:** Ensure adequate financing mechanisms and funding
    - **9.1.1**: Ensure effective and appropriate monitoring and evaluation
    - **10.1.1**: Promote mainstreaming of adaption to climate change all areas
    - **11.11** Ensure appropriate effective mainstreaming of Gender

Each of the Primary Action Areas were disaggregated into Strategic Actions and Specific Actions. A typical example of the disaggregation for **Action Area 1.2** is given in **Table 2.2**.

The colour coding as given in **Table 2-1** is used to indicate the level of ORASECOM involvement on each of the specific actions.

ORASECOM is further involved in the management of some specific actions or at least for some activities under these specific actions. **These are referred to as the Secondary action areas of which there are the following three areas**:

- **Action Area 1.1:** Surface and groundwater assessments
- **Action Area 3.1**: Improving water resources quality
- **Action Area 5.2:** Water use and demand data and information

Table 2-2: Disaggregation of Primary Action area 1.2

Action Area 1.2: Optimizing efficient development and adaptive management of water resources	
Strategic Action	**Specific Action**
1.2.1: Utilisation of an adaptive management approach including application and continuous/regular use of surface and groundwater resources planning/allocation tools (e.g. WRPM[1]), including proactive, transparent and coordinated approach with empowered regional participation	• Incorporate upgrades and improvements to the model setup
	• Regularly review management options and plans and associated capacity building
	• Implement, continuously update and review chosen water resource management and development scenarios, and associated capacity building
	• Incorporate groundwater resources into the overall planning model starting with transboundary aquifers and (potential) conjunctive use aquifers
	• Consider aspects related to economic accounting of water

Action Area 1.2: Optimizing efficient development and adaptive management of water resources	
Strategic Action	**Specific Action**
1.2.2: Planning (reconnaissance, Investigation, feasibility study, design of water resources development and management infrastructure)	• Real-time monitoring for better management of Vanderkloof etc
	• Vioolsdrift Dam and alternatives
	• Polihali Dam (LHWP Phase 2)
	• Botswana supply via Gamagara
	• Lesotho (via South Africa) - Botswana water transfer
	• Metolong Dam and distribution system
	• Lowlands dam sites in Lesotho
	• Dual/multi-purpose dam sites in Lesotho
	• Neckartal Dam and irrigation scheme
	• Desalination of acid mine drainage (AMD)
	• Welbedacht pump station pipeline to Knelpoort Dam
	• Increase Tienfontein pumping capacity
	• Increase Novo Transfer scheme capacity
	• Utilize Vanderkloof Lower level storage
	• Raise Gariep Dam or construct Verbeeldingskraal Dam /other alternatives

The last category of action areas is referred to as the **Other Action Areas**. These Action areas largely driven at the National Level but there are some specific actions where ORASECOM will have active interest. These action areas include:

- **Action Area 1.3**: Inter/Intra-sectoral planning and coordination
- **Action Area 2.2**: Water resources development

2.2 Screening Workshops

The first screening workshop took place on 7 September 2021. A summarized version of the 2014 Strategic Action Framework from the ORASECOM Phase lll as well as the related Main Action Areas, Strategic and Specific Actions were presented and explained at the screening workshop. This was followed by a presentation and discussion on the selection criteria to be used to select the 10 key strategic actions (later some additional issues were added and others were combined which resulted in 9 key strategic actions). In depth discussions took place during this workshop on the proposed criteria to be used to prioritise and rank the selected key actions as well as on some of the proposed strategic actions. Time for the workshop was limited and the screening and final selection process could not take place. Based on the feedback and comments received during the first screening workshop the criteria were updated as well as some of the proposed strategic actions. These were then distributed to the different countries for further suggestions in preparation of a follow up screening workshop on 28 October 2021.

During the October 2021 screening workshop, it was initially intended to carry out a detailed Balanced Scorecard ranking process which was relatively complicated and required considerable input from the four basin states in order to agree on the weightings to be allocated to each item that would subsequently be reviewed and ranked. In order to try and simplify the process it was agreed at the October 2021 meeting that a preliminary screening would be undertaken in an attempt to identify certain strategic actions that could either be placed in the "must do" category or alternatively the "must not do" category. All 17 of the initial proposed strategic actions were therefore presented and discussed at the meeting and a preliminary score was tabled by each country representative from which a basic first level ranking was achieved. Although the original intention was not to identify the final 10 Strategic Actions from this process, the result was quite clear and it was found that 10 Strategic Actions could be identified from the original list of 17 through this screening process. Some additional issues were added and others were combined which resulted in 9 key strategic actions)

A draft document was subsequently prepared in April 2022 summarising the key strategic actions and the processes adopted in their selection.

Terms of Reference recently prepared and or advertised by ORASECOM were also been obtained and reviewed to ensure that there is no overlap between the selected Strategic Actions and the work to be covered in projects which have already been either advertised or awarded.

Further details of the identified and final selected key strategic actions and the related processes are given in **Section 3** of this report

2.3 Strategic Action Selection

2.3.1 Initial List of Strategic Actions

Following the completion of the first phase of the project, 17 possible strategic actions were identified by the project team which it considered could be included in future projects to be undertaken through ORASECOM. These 17 actions are summarized in **Table 2-3**.

Table 2-3: Summary of Initial Strategic Actions

1	Economic Analysis of Reserve
2	Real Time Monitoring and Modelling
3	Development of Guidelines for Sharing
4	Proper Integration of Future Developments
5	Implementation and monitoring of WDM Measures
6	Assess how Assurance of Supply is Applied Basinwide
7	Carry out Mock Drought Disaster Event
8	Assessment of Irrigation Areas
9	Capacity Building on Annual Operating Analyses
10	Assessment of Monitoring Needs for Irrigation
11	Providing Basic Hydrology and Systems Analysis Training
12	Assessment of Potential for Trading Water Rights
13	Assessment of Supplying Gaborone from Vaal System
14	Impacts of Climate Change
15	Hydrology Update and Calibration of Water Quality Model
16	Addressing Discrepancies on Groundwater Maps
17	Assessment of Impacts of Covid 19 on Development Options

2.3.2 Strategic Action 1: Economic Analysis of Reserve

The desired EWRs from an environmental point of view were already determined in previous studies. System analysis showed that these EWR's, in particular those for Augrabies and downstream, including the estuary environmental requirements, significantly reduce the yield available from the resources (Gariep and Vanderkloof dams). These EWRs do not represent the final EWRs to be implemented and adhered to, according to the RSA law. Another process still needs to be carried out to find a balance between achieving the desired ecological state and the impact on the economy of the region. This balance needs to be agreed on by all role-players. Only then can the final agreed EWRs be imposed on the system. These EWRs are then referred to as the Reserve and are published in the Government Gazette so that it can be lawfully implemented and enforced.

The reserve for the Orange River is currently unknown, and the old and outdated estuary environmental requirements determined as part of the Orange River Replanning Study (DWAF, 1996) is currently still released (287.5 million m^3/a) from Vanderkloof Dam. Based on the latest EWR studies carried out, a Preliminary Reserve for the Lower Orange was determined and approved by DWS RSA (DWS, 2017). The Preliminary Reserve used the latest EWR estimations but were adjusted so that it does not impact negatively on the current ORP system yield.

The final agreed Reserve still needs to be determined and is expected to be somewhere between the preliminary Reserve requirements (average of ±533 million m^3/a) and those of the preferred EWR (average of ± 942 million m^3/a) as defined by the environmentalists.

The impact of the desired/preferred EWR (not the Reserve) on the ORP yield is quite significant. The selection of the final Reserve will also 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, also to Lesotho dams such as Makhaleng Dam and other Lesotho Lowland Dams.

The cost of the study to establish the final agreed EWRs or Reserve to be implemented in the Orange River System is estimated to be in the order of Euro 1 mil. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the development of the TOR for the study.

(IWRMP Action 3.3.3) –

2.3.3 Strategic Action 2: Real Time Monitoring and Modelling

Real time modelling and monitoring is 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 Gariep Dam and especially from Vanderkloof Dam, in order to determine when, and to what extent releases need to be made to supply all the users downstream of

Vanderkloof Dam to the river mouth, over a distance of approximately 1300 km, also taking into account possible spills from the Vaal River.

It will also be very useful to have a proper aerial survey of the Orange River, particularly from Van der Kloof Dam to the mouth. This will be valuable when planning irrigation projects to keep them out of the flood plain. A 2-D hydraulic model will assist in disaster management during times of flooding as early warning, predicting flood levels and areas of inundation well ahead of the flood.

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 (2022/23). 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.

Real time modelling and monitoring is also a requirement to effectively supply EWRs/Reserve on Orange River and to the Estuary. The Lower Orange along the Namibia/RSA border is over the last couple of years periodically experiencing very low or zero flows in particular during summer months and too high flows in the winter months which is the exact opposite of the EWRs.

The anticipated costs for Strategic Action 2 are estimated as follows:

- Setting up model based on previous models and cross-sectional data = Euro 750 000
- Capital expenditure for computers and some monitoring equipment = Euro 500 000
- Annual operating costs and data transfer costs etc = Euro 300 000

It should be noted that these costs are very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study.

(IWRMP Action 5.1.1 & 1.2.2)

2.3.4 Strategic Action 3: Development of Guidelines for Sharing

Possible new dam developments have been proposed which will help to supply water to both users in the upstream areas as well as users in adjacent countries including Namibia, South Africa and Botswana. It is important to recognise that any new development in any upstream area will have some impact on the downstream users which must be taken into consideration during the planning process. Analyses has shown that in many cases, a significant portion of the gross yield available from a new dam in the upstream areas may have to be released to compensate for the negative downstream impacts. In such cases it suggests that not all of the gross yield can be utilised. This leads to costly water supply systems, as a much bigger dam needs to be built; leading to negative economic impacts on the upstream areas due to the costly water supply systems. Agreed guidelines are required to address this problem.

The anticipated costs for Strategic Action 3 are estimated as follows:

- Development of guidelines for sharing – Study costs = Euro 500 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study.

(IWRMP Action 2.1.1)

2.3.5 Strategic Action 4: Proper Integration of Future Developments

Based on a number of recent studies, it is clear that there are a large number of proposed future water resource developments in various parts of the Orange/Senqu River Basin. Some of these are planned many years in the future while others are planned for the near future. The proposed near future developments include the Makhaleng Dam and transfer scheme, Hlotse Dam, Noordoewer/Vioolsdrift Dam, Polihali Dam and Verbeeldingskraal Dam, as well as possible hydro-power schemes in Lesotho. In addition, the potential to supply water to Bloemfontein from a new dam in Lesotho appears to be a viable option that requires some additional investigation. All of these schemes are interlinked, as they are all utilising the same resource, namely the Senqu/Orange River. All of these schemes will impact on each other to some degree, with some of the impacts being significant and others relatively small. Due to the associated impacts, it will not be possible to operate these schemes as stand-alone schemes, and they must therefore be operated and managed as part of the larger system. Results from the Core Scenario analyses already highlight that the operating rules used for each scheme, as well as operating rules between the schemes, significantly impacts on the water supply to the different users, as well as to the overall optimal utilisation of the system as a whole.

It is therefore recommended that a study is commissioned to identify and harmonise the different development options to the benefit of the system as a whole. The proposed study will address the correct sizing of the dams where still required, as well as the operating rules covering the individual dams as well as the system as a whole, including any related compensation or mitigation releases. It is envisaged that the proposed study will focus on the following near future developments:

a) Determine the operating rules for Makhaleng Dam users and its compensation/mitigation releases to Verbeeldingskraal/Gariep and Vanderkloof dams, to optimise water availability from these sub-systems and to ensure an equitable utilization and benefit sharing of the resources between the different users. This will depend on the final selected size and maximum transfer volume from Makhaleng Dam, as well as whether another sub-system will be used to support Makhaleng Dam or to release compensation/mitigation requirements on behalf of Makhaleng Dam.

b) Determine the required operating rules and procedures for the Noordoewer/Vioolsdrift Dam in relation to Gariep and Vanderkloof dams, as well as for the EWRs (Reserve) releases.

c) Determine operating rules for Hlotse and Ngoajane dam users and their compensation/mitigation releases to users along the Caledon/Mohokare River as well as to Verbeeldingskraal/Gariep and Vanderkloof dams to optimise water availability from these sub-systems and to ensure an equitable utilisation and benefit sharing of the resources between the different users. This will depend on the final selected size and yield available from Hlotse and Ngoajane dams as well as whether another sub-system will be used to support Hlotse and/or Ngoajane Dam or to release compensation/mitigation requirements on behalf of these two dams.

It should be noted that the operating rules for Polihali Dam have already been analysed and are (May 2020) in the process of being finalised. The final agreed operating rules for Polihali Dam need to be confirmed and should be included in this proposed study.

The anticipated costs for Strategic Action 4 are estimated as follows:

- Proper integration of future developments – Study costs = Euro 200 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 1.2.1).

2.3.6 Strategic Action 5: Implementation and monitoring of WDM Measures

Water Conservation and Water Demand Management have been identified as important components of all future water resource assessments throughout the Orange /Senqu River Basin. The impact of WC/WDM can be very significant in many areas where water losses are known to be high and can sometimes be in the order of 30% to 40% of the total municipal water demand. Reducing such water losses is not easy, and cannot be implemented overnight, but with proper support both financially and technically, it will be possible to achieve significant savings, which in turn will have a significant impact on the overall water balance in the Orange/Senqu River Basin.

Results from the WRPM Core Scenario analyses highlighted that failure to successfully implement the WC/WDM interventions will result in significant deficits in water supply in the main water supply systems within the Orange/Senqu basin. This will include all users, irrigation, industry and urban.

A study is therefore recommended to set up a system to identify the key focus areas for WC/WDM throughout the Orange/Senqu River Basin and to ensure that the related actions are implemented successfully and maintained over time.

The anticipated costs for Strategic Action 5 are estimated as follows:

- Implementation for monitoring of WDM measures – Study costs = Euro 300 000
- Annual data capture and transmission costs = Euro 50 000 per annum.

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 1.2.3 & 1.2.4)

2.3.7 Strategic Action 6: Assess how Assurance of Supply is Applied Basin-wide

In most parts of the world the water resources in a river basin are distributed by simply cutting up the available historical system yield as required, to meet the various demands. No recognition is given to the issue of assurance of supply, which is a serious oversight. In Southern Africa, the system models used to assess and allocate the available resources to the different users does take the assurance of supply into account in some cases, but not in others.

It is currently clear that none of the four basin states currently applies the assurance of supply on the same basis. Some counties only use the assurance of supply during the planning and designing stage of water supply schemes, but not at all during the management and operation of these schemes. In some cases, users, in particular irrigation are supplied at a too high assurance. Supplying these users at a lower assurance will most probably not have a significant impact on the economic performance of the irrigators, but this needs to be determined and confirmed. As an example, the 95% assured yield of the Oanob Dam in Namibia is 3.6 million m^3/a and the 80% assured yield is 4.7 million. An increase of 30%. The Basin States must discuss this issue to determine what level of assurance is affordable in each case so that the available water can be used optimally to the benefit of each country. In some cases it may be decided to accept a lower level of assurance and abstract at a higher rate which will result in greater need to manage the supply and restriction measures during dry periods.

It is therefore recommended that a study be undertaken to:

- Agree on a standard approach regarding assurance of supply (stand-alone schemes and integrated systems)
- Provide training on the concepts of assurance of supply
- Agree on how restrictions will be determined and applied during drought periods throughout the whole basin?
- Agree on drought emergency measures for all stand-alone schemes so that the measures tie in with those that will be applied to the overall system

The anticipated costs for Strategic Action 6 are estimated as follows:

- Assessment of Assurance of Supply – Study costs = Euro 200 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 1.2.1 & 2.2.3)

2.3.8 Strategic Action 7: Carry out Mock Drought Disaster Event

In most integrated water supply systems, there are guidelines and operating rules in place to manage the overall water resource during drought events. Unfortunately, when a very severe drought does occur, it is often the case that the guidelines and operating rules are ignored as the water managers try to deal with specific problem areas and in such cases the whole allocation system can collapse with severe consequences. This issue arose recently in the Western Cape area where the City of Cape Town was within a few months of completely running out of water. Part of the problem was the fact that there were conflicting demands, mainly between the irrigators and the municipality – both of which had their own allocations at specific levels of assurance as defined through many years of rigorous modelling. Unfortunately having two masters (The Department of Water and Sanitation and also the City of Cape Town Metropolitan Municipality) with their hands both on the tap, led to confusion and ultimately a near disaster for the whole region. The agreed operating rules were in many cases not applied, and if a retrospective analysis is undertaken, it will show that the agreed levels of assurance provided to the irrigators and the municipality were not as originally agreed.

In the case of the Orange/Senqu River Basin, there are many organisations who have their hand on some tap somewhere in the system. Unless the allocation of water and the curtailment strategies are discussed and agreed upon properly while the system is under no real stress, it may lead to a disaster in the event of a very severe drought in the region when not agreed on. It is therefore recommended that some form of mock drought disaster is undertaken involving participants from all four basin states to demonstrate exactly what will happen in the event of a severe drought. It will be less painful to identify the possible conflicts during a simulation exercise, rather than wait until the real event takes place and a new “day-zero” in the Orange/Senqu River Basin becomes a reality.

The anticipated costs for Strategic Action 7 are estimated as follows:

- Setting up and undertaking mock drought disaster event – Study costs = Euro 200 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 4.1.3)

2.3.9 Strategic Action 8: Assessment of Irrigation Areas

Due to the various water transfer schemes in which natural river courses are being used to convey the water transferred from another part of the Orange/Senqu River Basin, farmers with land adjacent to the rivers have started to use the water for irrigation in contravention of their water rights. It is very important that these water users be strictly controlled. If not, their water use can significantly impact on the water availability from the downstream resource. These will typically include rivers such as:

- Ash, Liebenbergsvlei, Wilge rivers (between Lesotho and Vaal Dam)
- Orange Senqu River and tributaries from Katse, Mohale, Makhaleng to Gariep.
- Vaal River from Heyshope to Grootdraai Dam
- Orange River downstream of Gariep and Vanderkloof dams to the Orange River Mouth.
- Fish and Sunday rivers between Gariep and Nelson Mandela Bay.

It is therefore recommended that this issue be investigated in some detail to assess the level of the “water theft” and where possible to recommend remedial actions in cases where such actions are not already in process. One such measure to control such theft could involve the curtailment of the water transfer in the month or two during which planting of crops takes place, and water is essential for a sustainable crop. If this can be managed together with the elimination of on-site farm dam storage, then the theft of water for illegal irrigation can be stopped or significantly reduced.

The anticipated costs for Strategic Action 8 are estimated as follows:

- Purchase of satellite data imagery = Euro 200 000
- Assessment of irrigation areas and data processing = Euro 300 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 5.2.2).

2.3.10 Strategic Action 9: Capacity Building on Annual Operating Analyses

In order to ensure transparency and to facilitate future co-operation between the four basin states, it is recommended that an annual meeting should take place in which the different countries can each provide any updated information as well as any new or adjusted plans/strategies. The proposed project will help to:

- Monitor progress with the implementation of the activities defined for the IWRMP and relating to the water balance of the Core Scenario:
- Facilitate the sharing of information that is required to ensure the IWRMP remains relevant;
- Evaluate the implication of new initiatives or plans and revised information (pertaining to the water balance) have on the Core Scenario and recommend reviews or updates of the IWRMP;
- Discuss the implications of these changes and updates, the progress or lack in progress of individual system strategy implementation programmes, as well as that of the ORASECOM IWRMP implementation programme, on the entire Orange-Senqu River System, as indicated or supported by WRPM scenario analyses (when required). It might be that in some cases only simple water balance graph adjustments would be required;
- Provide recommendations on possible adjustments to the Core Scenario and IWRMP, as well as whether specific components/issues or problem areas require more in depth investigation/study by specialised task groups;
- Keep the model up to date with the latest information, plans and implementation progress of existing strategies and or water resource plans, from all the basin states as well as the status regarding the ORASECOM IWRMP implementation;
- Determine or table specific training/capacity building requirements; and
- Discuss & evaluate existing monitoring activities, to recommend additional monitoring sites or components with focus on IWRMP implementation monitoring.

The anticipated costs for Strategic Action 9 are estimated as follows:

- WRPM updates relating to updated water requirements, infrastructure changes and possible changes to the Core Scenario and possible scenario analysis. Study costs = Euro 75 000
- Capacity Building on Annual Operating Analyses – Study costs = Euro 25 000
- Annual updating, meeting and analysis and training – Costs = Euro 50 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Actions 6.1.1, 6.1.3, 7.1.1, 7.1.2 & 9.1.1).

2.3.11 Strategic Action 10: Assessment of Monitoring Needs for Irrigation

When the large irrigation schemes downstream of Gariep Dam were initially designed and developed, there was sufficient excess water in the Orange River to ensure that the water abstracted by the farmers was not of major concern, even in cases where the farmers did not apply the water in the most efficient manner. In many cases, the amount of water that can be abstracted is limited by the capacity of the associated canals or pumps, with the result that it has never been necessary to measure the actual water any specific farmer abstracts accurately. This situation has now changed, and it has become necessary to measure and restrict all abstractions to their legal allocations, which in turn requires some form of metering at each abstraction point.

The proposed study is not intended to deliver a specific measuring or monitoring solution, but rather to analyse and try to establish what will be required in each scheme to ensure that all future irrigation abstractions are monitored and measured accurately. Such a system will also help to improve the water use efficiency for the irrigation schemes, which is currently thought to be a problem in some areas.

The anticipated costs for Strategic Action 10 are estimated as follows:

- Assessment of monitoring needs for irrigation monitoring – Study costs = Euro 100 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 5.2.1)

2.3.12 Strategic Action 11: Basic Hydrology and Systems Analysis Training

Managing the water allocation in a river basin of more than 1 million km^2 is not a trivial issue and involves significant support to establish a realistic hydrological data base. In addition, the planning and allocation tools (computer support models) must be continually improved and the demand data updated each year to ensure that the results and proposed water allocations are realistic.

To date, the Orange/Senqu River Basin has not experienced major water shortages resulting in potential disputes between the four basin states and is often used by international organisations as an example where proper planning and discussion can mitigate such problems. While serious conflicts are now emerging in many parts of the world over the issue of water allocations, the Orange/Senqu River Basin remains operational and generally free from serious disagreements.

In order to ensure that the current status quo of friendly co-operation between the four countries through the ORASECOM membership, it is recommended that there is regular training and discussion on the basic hydrological data used to model the basin, as well as training on the yield and allocation models where each country will have access to the same data and same models. It is only through such training that there can be future agreement and co-operation on the water allocations in the Orange/Senqu River Basin, as the resources near the point of full utilisation.

The anticipated costs for Strategic Action 11 are estimated as follows:

- Provision of training on hydrology and system analysis – Study costs = Euro 100 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 6.1.1)

2.3.13 Strategic Action 12: Assessment of Potential for Trading Water Rights

The Orange/Senqu river basin provides water to approximately 28 million residents located in four countries over an area of more than 1 million km^2. The water is used mainly for irrigation, industry and domestic purposes, each of which has its own tariff structure as well as reliability of supply. For example, farmers may be charged 10% or less than the industrial users but their water will be supplied at a 1 in 20 year risk of failure while the industrial users may receive their water at a higher level of assurance – perhaps 1 in 100 year risk of failure. This price differential between the different types of user presents an opportunity for the trading of water rights.

Such trading is a global phenomenon and has been successfully applied in many countries around the world. As water becomes scarce and expensive, the opportunity for water trading will only increase and it is inevitable that certain farmers will eventually find that they can generate more income by selling their water to an industry or municipality, than they can generate from planting crops.

It is therefore recommended that a study is undertaken to assess the potential for water trading throughout the Orange/Senqu River Basin. To place this issue in perspective, it is clear that in many cases, farmers are abstracting water at less than Pula1/m^3 while some industrial users are purchasing water at more than Pula 50 m^3. With such a differential, the trading of water rights is likely to increase in the near future.

The anticipated costs for Strategic Action 12 are estimated as follows:

- Assessment of potential for trading of water rights – Study costs = Euro 100 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 6.1.2).

2.3.14 Strategic Action 13: Assessment of Supplying Gaborone from Vaal System

The current study being undertaken through ORASECOM looks specifically at the possible transfer of water from Lesotho to Botswana. Various options have been investigated involving conveyance through a new pipeline with and without using some river sections to reduce costs. The original plan of a bi-lateral scheme between only Lesotho and Botswana has altered to include some use by South Africa in order to create a more cost effective and viable solution.

In light of the results from the pre-feasibility studies, it may be appropriate to investigate an alternative supply from the Vaal River System as it effectively utilises water originating from both Lesotho and South Africa and it may offer a cost effective supply to Gaborone, which would have the full support of the main Vaal River System which is one of the largest and most integrated river systems in Southern Africa.

The anticipated costs for Strategic Action 13 are estimated as follows:

- Assessing potential for supplying Gaborone from Vaal River System – Study costs = Euro 0.5 mil

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 2.2.2)

2.3.15 Strategic Action 14: Impacts of Climate Change

The issue of Climate Change remains one of the key issues to be addressed in every water resource assessment undertaken anywhere in the world today. Considerable work has already been undertaken to assess the possible future impacts of Climate Change on the overall water resources of the Orange/Senqu River Basin. The results, to date, have been relatively vague and in some cases inconclusive. While there is general agreement on the likely temperature increase throughout the Orange/Senqu River Basin, the overall impact on the streamflow remains uncertain.

It is therefore recommended that further work is undertaken on the potential impacts of Climate Change on the overall water resources of the Orange/Senqu River Basin.

1) Water demands need to be divided into –
    a) Climate dependant water requirements
    b) Climate independent water requirements.
2) Investigate and evaluate a new approach towards climate change “bottom-up approach” using observed data in combination with stochastic generated flows for planning and operating purposes. Check the spread of results versus those from climate change models. This can include a stand-alone stochastic model to quickly carry out the required analyses and checks.
3) Rainfall records and evaporation data produced from current climate change models are in general very unrealistic, specifically regarding the variance produced in the records. In general, the Standard Deviation and CV is much lower than the observed records, although the MAP is decreasing. This results in higher yields from the resources instead of the lower yield that is expected. More research and development are required in this area.

The anticipated costs for Strategic Action 14 are estimated as follows:

- Assessment of impact of Climate Change – Study costs = Euro 0.5 mil

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 4.1.2 & 4.1.3)

2.3.16 Strategic Action 15: Hydrology Update and Calibration of Water Quality Model

The current naturalised historic hydrology based on observed flows within the Orange Senqu basin covers the period 1920/21 to 2004/05 hydrological years. This means that the current natural hydrology can be extent by about 16 years to 2020. Normal practice is to update the hydrology after 15 to 20 years or shortly after a severe drought has passed. During this 16-year period quite a number of severe dry years occurred over most parts of the basin. For climate change purposes it is of high importance to capture the latest characteristics of flows and rainfall influenced by climate change. These characteristics will then also be captured in the generation of the generated stochastic flows used for modelling and planning purposes. Work carried out as part of the climate change task of the current study showed that the stochastic flow band with was in general wide enough to capture the spread of expected flows and yield results obtained from the different climate change models. Capturing the latest rainfall and rainfall runoff characteristics will only further enhance the capability of the stochastic model for future planning and operating analysis to account for possible changes due to climate change. Due to climate change impacts, it is advised to rather carry out hydrology updates on shorter intervals than that indicated by previous guidelines.

DWS RSA already picked up that the existing WRPM outputs with respect to water quality along the Vaal River downstream of Vaal Dam do not agree well with reality. DWS RSA is thus already planning a study to improve the water quality calibrations as well as the hydrology in the affected area. The update of the hydrology and improvement of water quality calibrations for the remainder of the Orange/Senqu River Basin can be carried out in addition to the DWS RSA work. It is, however, important to select areas where the updating of the water quality component of the WRPM is really required, as it might not be worthwhile for all the areas in the basin.

The anticipated costs for Strategic Action 15 are estimated as follows:

- Hydrology update and calibration of water quality model – Study costs = Euro 1.0 mil

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 1.1.1 & 3.1.2):

2.3.17 Strategic Action 16: Addressing Discrepancies on Groundwater Maps

The South African Groundwater data are available electronically on the NGA for over 200 000 boreholes. In Lesotho the data are available in spreadsheet format for limited data points, with coverage primarily in the lowlands. Relatively large amounts of data are available for Namibia, with sparse coverage in the western portion of Botswana. This variation in data coverage in different countries is problematic for data analysis and results in ‘border effects’ when interpreting conditions on both sides of international borders.

There is also a significant discrepancy in how the individual countries collect data, which complicates cross-border mapping and results in ‘edge effects’ at borders, or different classification. These problems can be summarised as:

- The National geological maps are based surficial geology in South Africa, Namibia and Lesotho, and mapped as pre-Kalahari Geology (sub-Kalahari Basement) in Botswana
- The same geological formations have different names across borders, and boundaries do not always align
- Borehole data coverage is dense in South Africa and Namibia, and sparse in Lesotho and the western portion of Botswana, making statistical characterisation difficult
- Low yielding boreholes do not appear to be incorporated into the Botswana and Lesotho databases, resulting in average and median yields being skewed towards higher yields, and resulting in discontinuities at borders
- South Africa manages groundwater based on groundwater management units, which are based on quaternary catchment boundaries, with the exception of the dolomites. Lesotho and Botswana define aquifers based on lithology while Namibia utilises groundwater drainage basins.

It is therefore recommended that a study be undertaken to resolve the discrepancies and to deal with the issues mentioned above.

The anticipated costs for Strategic Action 16 are estimated as follows:

- Addressing discrepancies on groundwater maps – Study costs = Euro 150 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

(IWRMP Action 5.1.3)

2.3.18 Strategic Action 17: Assessment of Impacts of Covid 19 on Development Options

The crisis created by the COVID19 virus will have severe and long-lasting effects on most countries around the world. Southern Africa will not be the exception and there will be major impacts on many aspects of “normal business”. The results and conclusions from the first two phases of the current project were derived “pre-COVID19” with the result that they were based on the situation before the virus impacted on the four basin states. Since the virus has been evident in Southern Africa, certain currencies have devalued against most of the major currencies by approximately 50% in dollar terms and 30% in Euro terms and stock markets have been adversely affected. In addition, some governments have taken drastic actions to contain the pandemic resulting in major changes to fiscal policy and availability of funds to develop new infrastructure projects.

In light of these developments, it is recommended that an assessment of the results and conclusions from the study be undertaken to assess their relevance and reliability based on the latest financial situation experienced by each of the four basin states.

The anticipated costs for Strategic Action 17 are estimated as follows:

- Assessment of impacts of COVID on Development Options–Study costs = Euro 250 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the TOR for the study

2.4 Selection Process to Identify Key Strategic Actions

It was initially anticipated that a relatively complicated balanced scorecard approach would be required to try and identify the 10 key strategic actions from the original list of 17 actions suggested by the project team. Before going through what would have been a very complicated process, it was decided to discuss the 17 strategic actions with the representatives from the four basin states in order to gauge their support for each item in an attempt to eliminate specific items that were clearly not favoured or to identify issues that all four member states were clearly in favour of supporting. By adopting this initial screening process, it became clear which items were favoured by the four basin states and which were clearly not popular. As a result of this initial screening process, 10 strategic issues were clearly identified and the need to proceed with a more complicated selection process was eliminated.

The selection process was based on a simple points system where each basin state ranked each of the 17 proposed strategic actions with a score from 0 to 5 where zero is used to indicate an issue of low priority and 5 is used to indicate a high priority issue. The results from the ranking process were as shown in

Table 2-4

It should be noted that in some cases (Climate change for example) the strategic issue has been given a relatively low score despite the fact it is clearly a very important issue. In certain cases, this is due to the fact that the issue in question is already being addressed though another project which has already been commissioned or started.

Table 2-4: Scoring for the 17 initial Strategic Actions.

Item	Description	Bot	Les		Nam	RSA	Average
1	Economic Analysis of Reserve	4	2		3	4	3.25
2	Real Time Monitoring and Modelling	3	4		3	4	3.5
3	Development of Guidelines for Sharing	4	4		5	4	4.25
4	Proper Integration of Future Developments	2	3		3	4	3
5	Implementation and monitoring of WDM Measures	4	4		3	4	3.75
6	Assess how Assurance of Supply is Applied Basinwide	3	3		3	3	3
7	Carry out Mock Drought Disaster Event	2	2		2	2	2
8	Assessment of Irrigation Areas	2	2		3	3	2.5
9	Capacity Building on Annual Operating Analyses	4	4		4	3	3.75
10	Assessment of Monitoring Needs for Irrigation	2	2		3	3	2.5
11	Providing Basic Hydrology and Systems Analysis Training	2	4		2	2	2.5
12	Assessment of Potential for Trading Water Rights	2	1		2	2	1.75
13	Assessment of Supplying Gaborone from Vaal System	1	1		3	2	1.75
14	Impacts of Climate Change	2	3		3	3	2.75
15	Hydrology Update and Calibration of Water Quality Model	4	5		5	5	4.75
16	Addressing Discrepancies on Groundwater Maps	4	3		3	4	3.5
17	Assessment of Impacts of Covid 19 on Development Options	3	4		3	4	3.5

2.5 Final Key Strategic Actions Selected

Based on the screening assessment, the 10 key strategic actions that were selected by representatives of the four basin states are as given in **Table 2-5.**

Table 2-5: 10 Strategic Issues Selected for Investigation

Item	Description	Bot	Les	Nam	RSA	Average
1	Economic Analysis of Reserve	4	2	3	4	3.25
2	Real Time Monitoring and Modelling	3	4	3	4	3.5
3	Development of Guidelines for Sharing	4	4	5	4	4.25
4	Proper Integration of Future Developments	2	3	3	4	3
5	Implementation and monitoring of WDM Measures	4	4	3	4	3.75
6	Assess how Assurance of Supply is Applied Basinwide	3	3	3	3	3
9	Capacity Building on Annual Operating Analyses	4	4	4	3	3.75
15	Hydrology Update and Calibration of Water Quality Model	4	5	5	5	4.75
16	Addressing Discrepancies on Groundwater Maps	4	3	3	4	3.5
17	Assessment of Impacts of Covid 19 on Development Options	3	4	3	4	3.5

Following the initial selection of the 10 most important Strategic Actions, it was agreed that the scope of each action should be reviewed in order:

- to try and accommodate some of the actions that were initially identified but not finally selected:
- to review and modified where necessary to ensure that there is no overlap with any projects that have recently been put out to tender or awarded during the 4 years that the project has been running;

- To try and incorporate additional tasks/issues that are documented in the “Integrated Water Resources Management Plan of December 2014 (Report number ORASECOM 019/2014).
- To highlight the role that ORASECOM can play in the proposed action.

Based on the above points, the initial 17 actions were reviewed and in some cases “lumped” together to provide 9 Key Strategic Actions that now also include certain additional items from the Integrated Water Resources Management Plan which are considered appropriate to link into the proposed “Road Map” actions. The 10 proposed Key Strategic Actions have therefore been consolidated into 9 more comprehensive Key Strategic Actions that now also include many of the actions that were initially omitted.

3 SUMMARY OF STRATEGIC ACTIONS

3.1 Numbering Convention

In the **Section 3**, each Strategic Action is briefly discussed and where appropriate certain issues raised in the Integrated Water Resources Management Plan have been identified as possible additions to the specific Strategic Action. In order to provide some form of referencing system, the relevant reference number from the Integrated Water Resource Management Plan is provided and is highlighted in red. The different numbering systems may appear to complicate this report but it is important that the proposed future Strategic Actions are seen to support the management plan and for this reason the different reference numbers are required.

For example, below Strategic action 1, the first main bullet point 3.3.1 refers to strategic action 3.3.1 from the Integrated Water Resources Management Plan. Full details of this item are given in the management plan and are not repeated in detail in this report.

3.2 Strategic Action 1: Agreement and Implementation of Environmental Water Requirements

- **3.3.1: Basin Wide Implementation**
  - 3.3.1a. Agree on preliminary EFR's. It is important to ensure that the outcomes from the GEF study are taking into account in any future ORASECOM study. The first task of any future EFR project will therefore be to study and collect all information on the agreed EFR's from the GEF study.
  - 3.3.1b. Approval of implementation plan including mechanisms for review and revision.
  - 3.3.1c: Implement preliminary EFR's. Implementing the EFR's requires a system to measure and control releases etc. This then ties in with the hydraulic river model for releases from Vanderkloof Dam and from the Neckertal Dam in Namibia.
- **3.3.2: Management of Orange River Mouth**
  - Implement measures to improve floodplain
  - Create Orange River Mouth Management Plan to address:
    - Remove remnant causeway
    - Control of alien plants
    - Remove old earth moving equipment
    - Dust control of mining activities
    - Lydar survey of the mouth
    - Revise existing dirt road network

This sub task is one that can be included as part of a larger Action and completely managed and coordinated by ORASECOM. The sub-task actions that involve the implementation will not form part of the project but ORASECOM will monitor and help to co-ordinate their completion.

- **3.3.3g: EFR Capacity Building**
    - Extend the capacity building efforts from the GEF study to provide a sustainable process.
- Assess potential impacts of Climate Change on the Environmental Flow Requirements. This is an issue that threads through all Actions and allows each action to tap into global climate change funding. Questions that need to be answered can include but are not limited to:
    - Will the increased temperatures result in increased evaporation and transpiration losses along the Orange River and if so by how much
    - Is the variability of extreme events expected in future likely to create problems
    - Will climate change result in health issues due to spread of disease such as Malaria and certain tick-borne diseases.
- **3.3.3h. Set up and implement Compliance Monitoring for EFRs**
- Identify key EFR sites that impact flows between states. This must tie in with the GEF study which aims to document the necessary EFR sites and flows required. The monitoring system is essential for this and ORASECOM is ideally positioned to either be custodian of the data or simply co-ordinator of the data.
- Set up and implement compliance monitoring for the key EFR sites. The implementation will depend on what the basin states decide they want regarding who collects and collates the data. There are several models that can be considered varying from the current status quo where each country monitors and processes its own hydrological data from its existing network or if a new network of equipment is introduced specifically for the EFR monitoring. In the case of a new system, ORASECOM may consider a change in its mandate if it decides that it would like to play a key role as custodian and/or manager of the equipment and data dissemination.

The budget for this task will depend upon the actions to be included and the time-frame of the project. It also requires an annual cost as it is an action that will continue indefinitely. It is likely that the initial project will cost \$1mil to \$5 mil with an annual operation and maintenance budget of \$1m.

3.3 Strategic Action 2: Improvement and Implementation of Monitoring and Information Management Systems

- **5.1.1: Improve Basin Wide Monitoring Systems**
- **5.2.1: Improve Monitoring and Reporting of water use and return flows basinwide**
  - Develop Data Portal System (Existing system on steroids)
  - Operationalise transboundary system
  - Update water use data
  - Increase coverage on water use and water monitoring
  - Monitor actual consumption for all permitted users
  - Volumetric measurement and monitoring of irrigation use
  - Develop capacity building plan for monitoring activities

- **5.1.2: Climate Monitoring**
  - Identify and agree on key hydro-meteorological stations for climate monitoring
  - Develop a Climate Monitoring Plan for the Orange/Senqu river basin
  - Implement hydro-meteorological Climate Change monitoring plan

- **3.1.1: Water Quality Monitoring**
  - Consolidation of existing water quality data basinwide. Water quality issues are becoming very important and will cause friction between the basin states if not managed properly. Poor water quality in the lower Orange River can be catastrophic for the export table grape industries of both South Africa and Namibia and it is therefore essential that the water quality issues are addressed which in turn requires accurate monitoring. A co-ordinated approach is needed and this is an issue where ORASECOM can play the key facilitation role. This sub-task therefore involves identifying a network of key monitoring points and agreeing on the parameters to be measured and consolidating the available infrastructure from each country as well as identifying where more is needed to ensure that there is a proper and sustainable system in place going forward. This task should also cover the development of monitoring, assessment and reporting processes required for river quality compliance which can be undertaken by ORASECOM.
  - Collate and analyse basin quality data over 10-year historic period. It will be very valuable to examine existing water quality trends in the basin to identify if

there are problem areas that need to be addressed. A 10-year period or longer would be ideal for such an assessment as it will entail identifying points where water quality data are available and what parameters are being measured.

- **3.1.2: Management of Increasing Salinity**
  - Set up salinity monitoring programme for irrigation schemes.
  - Set up monitoring system for Acid Mine Drainage (new) .
- **3.1.3: Management of Eutrophication**
  - Monitoring of Phosphorus where needed.
- **3.1.4: Understanding the Extent and Impact of POP's**
- **5.1.4: Improve basin wide water quality monitoring networks**
  - Recommend additions to the WQ monitoring network
  - Co-ordinate laboratories for analysis basin-wide and standards etc
  - Undertake regular 5-year surveys
  - Capacity building for whole process and lab analysis

- **1.2.2: Real Time Monitoring and Modelling**
- **4.1.3: Develop Early Warning Signals and Evaluation Systems**
  - Implement Plan: i.e. Implement hydraulic river model and monitoring system for the better utilisation of Vanderkloof Dam and Neckertal Dam. This will involve selecting a model for the hydraulic modelling – There are two options here – firstly to buy a commercial model that has significant costs each year or a public domain model which is available freely. The various options should be considered and discussed with the basin states. A decision must be taken after which the model can be implemented. There are also two important factors to be considered which have a huge impact on costs. If the river cross-sections are to be surveyed at say 1km intervals, then the costs will be astronomical. If the available satellite images from Google etc., can be used, then it is possible to create a functional model at a fraction of the cost. The decision on using satellite imagery or real surveys is therefore a key issue that must be dealt with before this task can progress.
  - Monitoring of results. The results from any hydraulic model must be monitored using either existing streamflow gauging stations or a network of new monitoring points or some combination of both. Since setting up a new monitoring station is prohibitively expensive, it is assumed that the process will involve monitoring existing points within the network. If there is a need for a new monitoring station, then it should be identified as this is something that

ORASECOM can help to facilitate and can possibly be funded through some Climate Change budget since the resulting data will be of value for any future Climate Change assessment/monitoring.

- **5.1.3: Groundwater Monitoring**
  - Draw up plan for monitoring all significant aquifers basin--wide
  - Install and maintain groundwater monitoring equipment
  - Review and correct discrepancies on groundwater mapping
  - Identify users abstracting ground water and their quality requirements (new) The previous item considered the surface water resources while this item considers the groundwater resources. Although groundwater is not as significant as surface water in the Orange/Senqu basin, it is nonetheless very important in specific areas where there is no alternative source of water. It is therefore necessary to quantify and measure quality of groundwater in selected key locations and determine if the groundwater resource is changing due to either abstraction trends or Climate Change. This task must also aim to develop monitoring system for borehole abstractions basinwide and evaluate monitoring requirements to protect aquifers against high salinity.

- **5.2.2: Irrigation License Monitoring**
  - Assessment of Irrigation Areas
  - Improve monitoring and enforcement of licensed irrigation users

3.4 Strategic Action 3: Development and Implementation of Guidelines for Sharing of water resources

- **Undertake reconciliation Strategy study for new developments already agreed or in feasibility phase (Core Scenario)**
    - Reconciliation to obtain a positive water balance for the ORP/Greater Bloem etc. due to impacts of upstream developments
- **1.2.1: Optimise Efficient Development and adaptive management of water resources.**
    - Develop guidelines and protocols for data collection, sharing and storage
- **2.1.1: Development of Guidelines for Sharing**
    - Develop Guidelines and Procedures for Benefit Sharing
- **2.1.2: Equitable Utilisation of Basin Resources**
    - Develop monitoring and evaluation framework and agreement of ORASECOM therein
    - Implement monitoring guidelines etc
- **2.2.3: Ensure Optimised Availability of Water**
- **Develop guidelines for co-ordinated response to Climate Change**

3.5 Strategic Action 4: Synchronisation and Preparation of Future and Planned Developments

- **Monitoring and evaluation systems for Implemented Projects.** Any new dams will require some form of streamflow monitoring to measure releases from the dam. It is important to plan for such monitoring and this may require the construction of new weirs which are expensive. If weirs are not possible, then it is necessary to identify and calibrate rated river sections and the sooner this process is started the better as it can take years to build up a calibrated Discharge Table for a new river section. This requires specialist technical input from an experienced hydraulic river modeller.
- **1.2.1: Optimising Efficient Development**
    - Undertake annual joint operation of model
    - Review management options and plans basin-wide
    - Achieve and maintain basin-wide consensus
    - Incorporate aquifers into basin-wide models
- **1.2.2: Planning and Management of Infrastructure**

  - Analyse and model all possible development options using system models. This is where some of proposed projects in clusters 1 to 8 of investment plan can be included e.g. ORASECOM assisting with reconnaissance, prefeasibility and feasibility studies of those, as in the case of L-BWT
    - Identify impacts of possible Climate Change on development options

3.6 Strategic Action 5: Implementation and monitoring of WDM Activities

- **1.2.3: Implement WC/WDM in Agriculture**
  - Selection of 2 full scale projects
  - Monitoring system requirements for water accounting in WC/WDM projects (previously action 10)
  - Set up and implement real case study (use Nico Benade type modelling)
- **1.2.4: Implement WC/WDM in Municipal and Industrial (inc mining) sectors**
  - Selection of 4 pilot projects
    - Monitoring systems for water accounting in WC/WDM projects
    - Develop an inventory of WC/WDM initiatives and prioritise them for use basin-wide. Take note of the 2008 Marginal Waters Study, which also proposed about 6 priority possible projects, with proposed scopes of work for those (2 possible basin wide projects and 4 national projects, with project for each country)
  -
  - Implement priority WC/WDM case studies (Reduction of losses in Municipalities using case studies such as Mariental, Maseru and Emfuleni)
  - Create awareness for Water Demand Management
  - Draw up implementation plan
    - Assess impact of possible Climate Change on future WC/WDM activities

3.7 Strategic Action 6: Assurance of Supply and Economic Value of Water

- **1.2.1: Aspects Relating to Economic Value of Water**
  - Collect and collate pricing mechanisms around basin states (all user groups irrigation, urban, industrial) from resource to end user (example Lesotho to RSA to Rand Water Johannesburg to end users)
  - Study opportunities towards more efficient and cost-effective use of water in the basin

- Impact of Assurance of supply economics on the economic performance of the users, in particular irrigators.
  - Investigate how assurance of water supply is applied in the Orange/Senqu basin to the different water use sectors.
  - Agree on a standard approach regarding assurance of supply (stand-alone schemes and integrated systems.
  - Training in different concepts to form part of the study
  - How are restrictions being determined and applied during drought periods
  - Agree on drought emergency measures (Stand-alone schemes and integrated systems)
  - May also be good to include activities on establishment of water accounts for the different parts of the Basin. See specific action 1.2.1.5, namely "Consider aspects related to economic accounting of water" in the IWRM Plan.

3.8 Strategic Action 7: Water Disaster Management and Climate Adaptation

- **4.1.1:Improve Knowledge, Understanding and communication of extreme events**
  - **Consolidation of climate data**
  - **Updating of regional downscaling and other Climate Change Models**
  - **Investigate loss of variability when using downscaling models.**
- **4.1.2:Main-streaming of climate adaptation into design of development activities**
  - **Review of existing regional and national guidelines**
  - **Develop Climate Change Guidelines for the basin**
  - **Implement Climate Change Guidelines for the basin**
- **4.1.3: Main-streaming Climate Adaptation into Drought and Flood Management Mitigation**
  - Set up and carry out Mock Drought Disaster Event (Previously Action 7)
  - Set up guidelines for Flood Management Plans
  - Assess possible Climate Change scenarios on rainfall and streamflow

3.9 Strategic Action 8: Capacity Building.

- **6.1.1: Ensure Effective Capacity Building at Various Levels**
  - Review current Capacity Building programme of ORASECOM
  - Create 3 year Capacity Building programme for whole basin
  - Implement Capacity Building Programme
  - Provide training on Basic Hydrology and Systems Analysis (was Action 11)
- **6.1.3: Set up ORASECOM Information and Sharing Hub**
  - Consolidate and integrate basin-wide research and knowledge on water issues
  - Update and populate the Water Information System
  - Identify research gaps
  - Co-ordinate and integrate research opportunities
- **7.1.1: Ensure appropriate stakeholder participation**
  - Review and improve ORASECOM Communication Strategy
  - Develop and implement system to measure the level of stakeholder participation
- **7.1.2: Promotion of Transboundary Co-operation**
  - Identify programmes and type of co-operation required
  - Regular reporting on Transboundary co-operation
  - Develop ORASECOM oversight programme for shared communication basin-wide
- **10.1.1: Preparation of Materials to Educate on Climate Change**
  - Prepare materials to explain Climate Change for all sectors throughout basin.

The various Capacity Building initiatives can possibly be included as part of the various different actions mentioned above and below rather than as a single task.

3.10 Strategic Action 9: Hydrology Update and Calibration of Water Quality Model

- **1.1.1: Updating of Hydrology**
  - Updating of surface water hydrology where required
  - Updating of groundwater/surface water interaction
  - Updating of Eastern Cape Hydrology where required, Nossob/ Molopo
  - Assess impact of Climate Change on hydrological data.
- **3.1.3: Management of Eutrophication**
  - Calibrate the phosphorus model

3.11 Costs of Proposed Actions

	Description	Capital Cost ($m)	Running Costs ($m/annum)
1	Agreement and Implementation of Environmental Water Requirements	$1m to $5m	$1m per annum
2	Improvement and Implementation of Monitoring and Information Management + Hydraulic Model	$5m	$1m per annum
3	Development and Implementation of Guidelines for sharing.	$1m	
4	Synchronisation and Preparation of Future and Planned Developments	$1m	
5	Implementation and monitoring of WDM Activities	$1m	
6	Assurance of Supply and Economic Value of Water	$1m	
7	Water Disaster Management and Climate Adaptation	$2m to $3mil	
8	Capacity Building (3 year programme)	$2m	$2m every 3 years
9	Hydrology Update and WQ Model Calibration	$5m	

4 TERMS OF REFERENCE : GENERIC COMPONENTS

4.1 Generic Template

In order to create the Terms of Reference for the selected Key Actions discussed earlier in this report it was considered appropriate to adopt a standard template in which certain items can be repeated since they will apply to each document. In this regard it is suggested that each Terms of Reference will comprise the following 8 sections, 7 of which are generic and will be broadly similar for all Terms of Reference. **Section 3** will provide the technical details for each Strategic Action and will be tailored to meet the objectives of each action. The proposed sections to be included in each Terms of Reference are as follows:

- TOR 1: Introduction to the Orange/Senqu River Basin
- TOR 2: Background to ORASECOM and ORASECOM AGREEMENT
- TOR 3: Scope of the Assignment.
- TOR 4: Support and data to be provided by the Client
- TOR 5: Organisation, Coordination and Management
- TOR 6: Evaluation of Tenders
- TOR 7: Other Provisions
- TOR 8: Submission process

The items that are common to all projects are discussed further in **Section 4** of this report while the details specific to each project are presented in **Section 5 for Project 1, Section 6 for Project 2, etc**.

4.2 TOR 1: Introduction to the Orange/Senqu River Basin

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. The Orange-Senqu River originates in the Highlands of Lesotho and flows in a westerly direction, approximately 2,200 km to the west coast of South Africa and Namibia, where the river discharges into the Atlantic Ocean as shown in **Figure 1**.

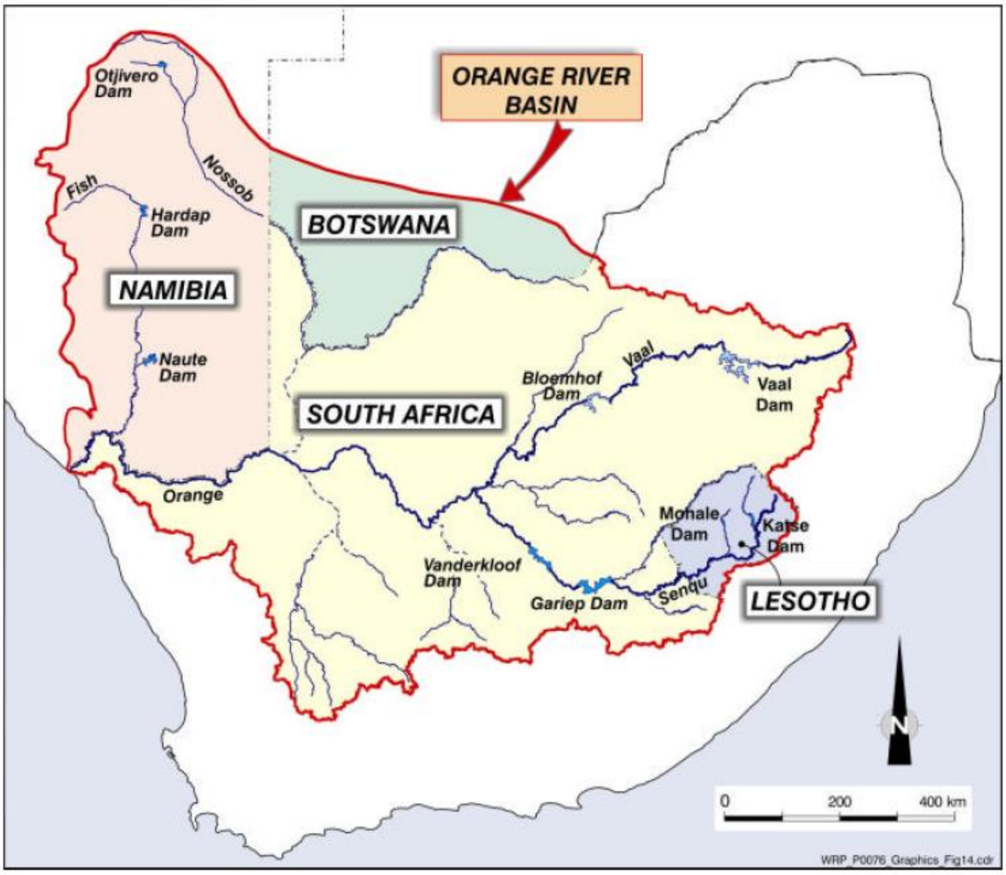

Figure 4: Orange-Senqu River Basin

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 rivers, with approximately 800 million m^3/a from the Lower Orange and Fish River in Namibia. The basin also includes a portion in Botswana and Namibia (north of Fish River) feeding the Nossob and Molopo Rivers.

The Orange-Senqu River basin is a highly complex and integrated water resource system which is one of the most complicated and integrated river systems in the world. It is characterised by a high degree of regulation with numerous major inter-basin transfers to manage the resource availability between areas of relatively abundant precipitation and the areas of greatest water requirements. The infrastructure involves water storage and transmission infrastructure, transmitting water to demand centers that are in some cases located outside of the basin through some of the largest and longest water transfer tunnels in the world. The existing infrastructure includes the Lesotho Highlands Water Project (LHWP) which transfers water to South Africa from Lesotho as well as many other major inter-basin transfers to the Vaal Basin which support the industrial heartland of South Africa and the largest water demand centres in Africa.

Figure 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 sum of the natural values and is estimated to be in the order of half the total natural runoff from the basin.

The difference is due mainly to the extensive water utilisation in the Vaal River Basin, most of which is for domestic and industrial purposes. Several major transfer systems are used to bring water into the Upper Vaal River catchment to support existing water requirements, in particular those within the Gauteng area as well as for many coal-fired power stations and the largest synthetic fuel plant in the world.

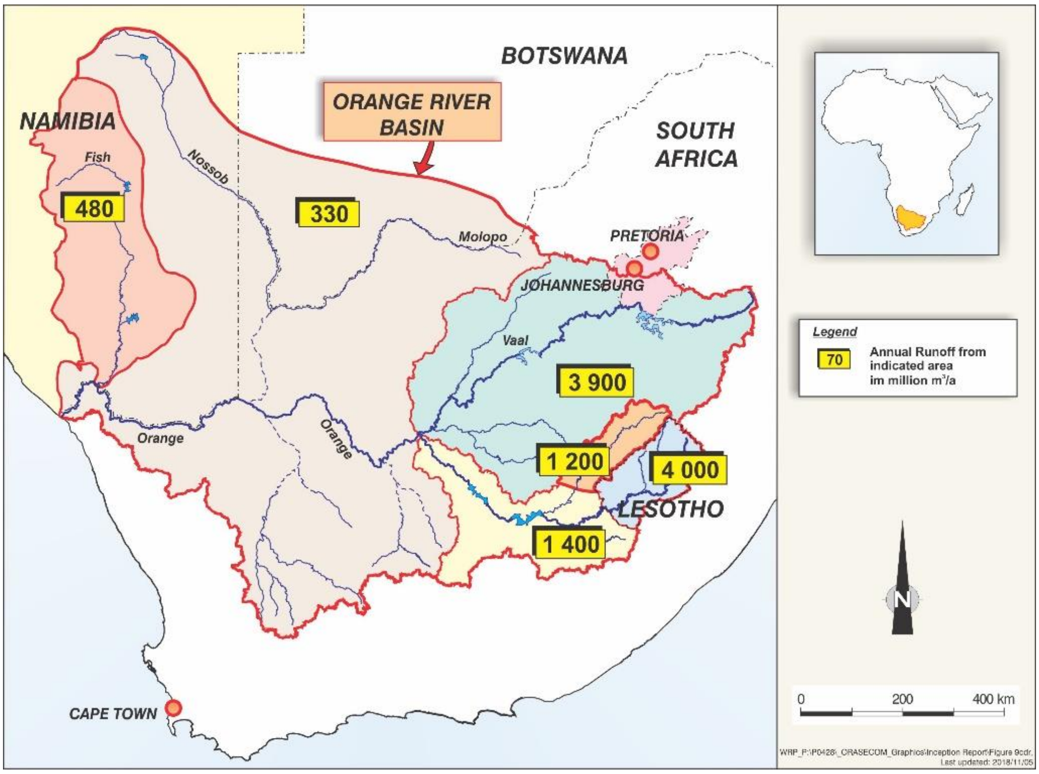

Figure 2: Approximate Natural Run-off in the Basin

Large volumes of Orange/Senqu water are also used to support extensive irrigation and some mining demands along the Orange River downstream of the Orange-Vaal confluence, as well as significant irrigation developments in the Eastern Cape 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 between 500 million m^3/a and 1 000 million m^3/a.

As already indicated, there are locations of relatively abundant precipitation and water availability and the locations of greatest water requirements. Water scarcity in locations of greatest need is the main challenge in the basin, and 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 very arid in the western areas. As shown in **Figure 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 localised. The temporal and spatial distribution of precipitation within any particular year can be considerable.

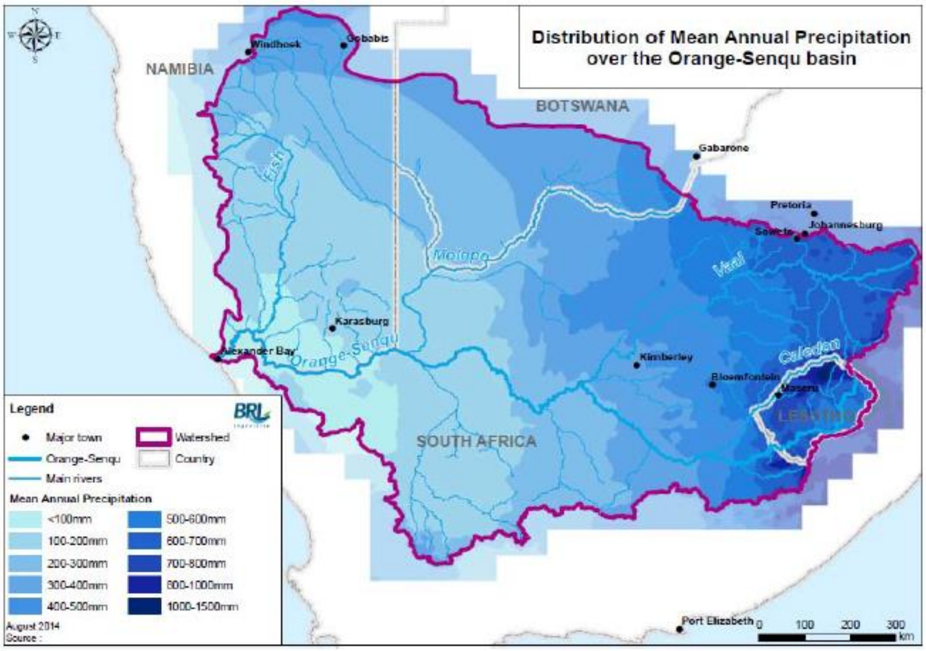

Figure 3: Distribution of Mean Annual Precipitation

In **Figure 4** it is evident that evaporation increases from south-east to north-west reaching a maximum of more than 3 000 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 accepted that Southern Africa will be highly impacted by climate change. Consequently, there are concerns around the changes in precipitation and temperature due to climate variability and climate change. Preliminary indications suggest that the Orange/Senqu River Basin will experience temperature increases due to Climate Change in future. It is also expected that the evaporation along the lower Orange River will increase due to higher temperatures and the already low rainfall will decrease. In the wetter high lying areas of Lesotho, the expectation is not clear and the various models suggest that the rainfall may remain the same or possibly experience a small decrease. The impact on runoff remains unknown and there is no clear answer to this issue. It is reasonable, however, to expect that the floods and droughts experienced in the basin will become more severe due to the greater extreme events that are expected to occur. One key element of this study is therefore to enhance investment in transboundary water security and to work towards developing resilience to future climate change within the Orange/Senqu river basin.

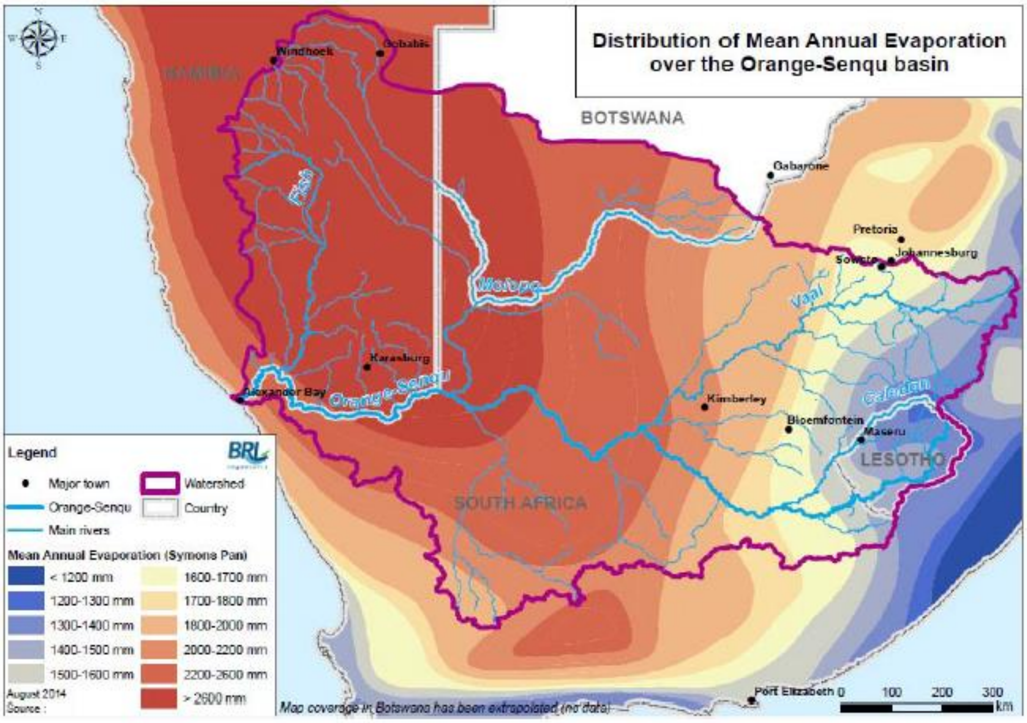

Figure 4-1: Distribution of Mean Annual Evaporation

4.3 TOR 2: Background to ORASECOM and ORASECOM Agreement

Southern Africa has fifteen (15) transboundary watercourse systems of which thirteen (13) stretch exclusively over the Southern African Development Community (SADC) Member States. The Orange–Senqu River Basin is one of these thirteen (13) transboundary water course systems. SADC member states embrace the ideals of utilising 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. SADC has therefore 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 Basin Commission (ORASECOM) was established in November 2000. It was established by the Governments of four States, namely, Botswana, Lesotho, Namibia and South Africa, for managing the transboundary water resources of the Orange-Senqu River Basin and promoting its beneficial development for the socio-economic wellbeing and safeguarding the basin environment.

The vision and objectives of ORASECOM are pursued through the implementation of an Integrated Water Resources Management Plan and Strategic Action Programme. Currently, ORASECOM is also consolidating a climate resilient investment strategy which seeks to place further critical climatic and investment lens/analysis on the basin level Integrated Water Resources Management Plan to provide for community and economic resilience to climate impacts while promoting sustainable investment in the water resources of the Orange Senqu River basin. The Strategic Action Plan forms the environmental sustainability component of ORASECOM's strategic framework.

The Integrated Water Resources Management Plan was adopted in February 2015 by the ORASECOM Member States (Report Number ORASECOM 019/2014). The Integrated Water Resources Management 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 project implementation that provides a mutually inclusive transboundary benefit. The Integrated Water Resources Management Plan recommends strategies and measures for promoting sustainable management of the water resources of the basin and 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 Strategic Action Plan is structured around the four environmental priority (root cause) areas of concern identified in the Transboundary Diagnostic Analysis: increasing water demand, declining water resources quality, changes to the hydrological regime and land degradation. The Transboundary Diagnostic Analysis was formulated in 2014 with an objective to provide structured information relating to the ecological, social, and economic status of the

Orange-Senqu River Basin, with particular focus on transboundary impacts resulting from human activities.

Since 2014, when the Transboundary Diagnostic Analysis was undertaken, a number of assessments and studies have been carried out in the basin. This warrants the review and update of the Transboundary Diagnostic Analysis to ensure the critical key information as well as any emerging issues are included and reflected in its Causal Chain Analysis as well as identifying any critical knowledge gaps that still exist and propose how the gaps would be addressed.

Background to the ORASECOM Agreement

The ORASECOM Agreement established the Council as a technical advisor to the Parties on matters relating to the development, utilisation, and conservation of the water resources in the Orange/Senqu River Basin. The objective of the Commission is to initiate, enhance and maintain greater collaboration between the Parties on matters relating but not limited to; the development and utilisation of water resources in the watercourse, the control of catchment degradation, the mitigation of the effects of environmental degradation and climate change, watercourse-wide environmental flow regimes as well as the Orange–Senqu Watercourse sources and mouth management. The Parties may also assign other functions pertaining to the development and utilization of water resources to the Commission.

In giving effect to the objectives of the Agreement, and in particular relevance to this assignment, ARTICLE 4 of the Agreement empowers the Commission to:

(a) maintain a proper balance between resource development for a higher standard of living for their people and conservation and enhancement of the environment to promote sustainable development;

(b) ensure the respect for and application of existing rules of general or customary international law relating to the utilisation and management of the resources of the watercourse and, in particular, to respect and abide by the principles of community interests in the equitable utilisation of the watercourse and related resources;

(c) establish and pursue close cooperation with regard to the study and execution of all projects likely to have an effect on the regime of the watercourse;

(d) exchange available information and data regarding the hydrological, hydrogeological, water resources quality, meteorological and ecological condition of the watercourse;

(e) utilise and develop the watercourse in an equitable manner with a view to attaining optimum utilisation thereof and obtaining benefits therefrom consistent with adequate protection of the watercourse;

(f) take appropriate measures to prevent the causing of significant harm to the watercourse within their respective and other Parties' territories;

(g) notify potentially affected Parties and competent international organisations, without delay, of any emergency originating within their respective territories;

(h) ensure that in the event that the implementation or execution of any planned measures is of the utmost urgency in order to save life, or to protect public health and safety, or other equally important interests as a result of an emergency situation, the party planning the measures may, notwithstanding the provisions of paragraph (h), immediately proceed with implementation or execution, provided that in such event a formal declaration of the urgency of the measures shall be communicated to the other Parties; and

(i) maintain and protect the watercourse and related installations, facilities and other works in order to prevent pollution or environmental degradation.

It should further be noted that the utilisation of the watercourse in an equitable manner requires taking into account all relevant factors and circumstances including but not limited to geographical, hydrographical, hydrological, climatical, ecological and other factors of a natural character; the social and economic needs of the Parties; the effects of the use of the watercourse by one Party on the other Parties; existing and potential uses of the watercourse; as well as the guidelines and agreed standards to be adopted.

The above are further buttressed by the corresponding provisions in Article 2 of the "Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region'' as ratified by all Member States.

The Agreement established the Council as a technical advisor to the Parties on matters relating to the development, utilization, and conservation of the water resources in the River System. The objective of the Commission is to initiate, enhance and maintain greater collaboration between the Parties on matters relating but not limited to; the development and utilisation of water resources in the watercourse, the control of catchment degradation, the mitigation of the effects of environmental degradation and climate change, watercourse-wide environmental flow regimes as well as the Orange–Senqu Watercourse sources and mouth management. The Parties may also assign other functions pertaining to the development and utilization of water resources to the Commission.

In giving effect to the objectives of the Agreement, and in particular relevance to this assignment, ARTICLE 4 of the Agreement empowers the Commission to:

(a) Maintain a proper balance between resource development for a higher standard of living for their people and conservation and enhancement of the environment to promote sustainable development.

(b) Establish and pursue close cooperation regarding the study and execution of all projects likely to influence the regime of the watercourse.

(c) Exchange available information and data regarding the hydrological, hydrogeological, water resources quality, meteorological and ecological condition of the watercourse.

(d) Utilise and develop the watercourse in an equitable manner with a view to attaining optimum utilisation thereof and obtaining benefits therefrom consistent with adequate protection of the watercourse.

(e) Take appropriate measures to prevent the causing of significant harm to the watercourse within their respective and other Parties' territories; Article 4 of the Agreement empower the Council to take all measures to make recommendations on inter alia; water availability in the basin, equitable and reasonable sharing of water, studies on the development of the River System, the extent to which stakeholders should be involved in management of the system, the prevention of pollution, the control of aquatic weeds, and plans for emergency situations.

(f) Take appropriate measures to prevent the causing of significant harm to the watercourse within their respective and other Parties' territories.

The above are further buttressed by the corresponding provisions in Article 2 of the "Protocol on Shared Watercourse Systems in the Southern African Development Community (SADC) Region'' as ratified by all State Parties.

4.4 TOR 4: SUPPORT AND DATA TO BE PROVIDED BY THE CLIENT

Existing relevant information, data, and documentation on topographical, geological, geotechnical, hydrogeological/geohydrological, social, environmental, hydropower, financial, economic, and other relevant aspects at the disposal of the Client's State Parties for purposes of conducting the feasibility study, will be made available to the Consultant. However, the Consultant has the ultimate responsibility to collect the required data and documentation which is not readily available under the Project. The Client will, among others, also: (i) Provide the relevant information, data and documentation from the L-BWT reconnaissance and pre-feasibility studies, as listed above under Task 1; (ii) Facilitate communication with the relevant institutions in the ORASECOM's State Parties; (iii) Liaise and assist the Consultant in obtaining any other information, data and documents required from the other government agencies in the respective countries, and those which the Client considers essential for the conducting of the assignment; (iv) Provide assistance to obtain work permits for staff of the Consultant; (v) Arrange consultative meetings and ensure linkage with relevant authorities; and (vi) Through the JSMC, provide enabling environment, including access to the study area for the Consultant to conduct the study. The Consultant will operate their own project office if need be and shall bear all accommodation, local transportation, visa permits, and other costs necessary to carry out the assignment.

4.5 TOR 5: ORGANISATION, COORDINATION AND MANAGEMENT

Implementation Arrangement

The Orange-Senqu River Commission (ORASECOM)

ORASECOM is a river basin organization established by Botswana, Lesotho, Namibia, and South Africa (State Parties) by an Agreement signed in the year 2000, and revised in the year 2018, within the framework of the SADC Revised Protocol on Shared Watercourses. ORASECOM was established to advise the State Parties on the development, utilization, and conservation of the water resources of the Orange-Senqu River Basin. The highest body of ORASECOM is the Forum of the Parties (comprising Ministers responsible for water), supported by a Council of Commissioners (designated officials). The Council is supported by various Technical Task Teams, Committees, Working Groups, and the permanent Secretariat with its head office in Centurion, South Africa.

The ORASECOM Secretariat

The ORASECOM Secretariat is responsible for programme coordination, programme development, management, and implementation of the decisions of the Forum of the Section 9. Notification of Intention to Award and Beneficial Ownership Forms 26 Parties and Council. The Secretariat is headed by an Executive Secretary who is an ex officio member of Council with responsibility for strategic programme management, direction, planning and guidance, quality assurance, resources mobilization and collaboration with partners and stakeholders. For the Lesotho-Botswana Water Transfer Project (L-BWT), the ORASECOM Secretariat is the Executing Agency, but under the oversight of the Joint Study Management Committee (JSMC) established by Botswana, Lesotho, Namibia and South Africa. The ORASECOM

Secretariat is implementing the project through a Project Implementation Unit headed by the Project Manager under the ORASECOM Secretariat.

The Joint Study Management Committee

The Joint Study Management Committee was established to coordinate and steer the undertaking of the L-BWT studies. The Joint Study Management Committee also provides progress on the implementation of the L-BWT to the Commission and the State Parties. The Joint Study Management Committee further oversees the development of agreements for the implementation of the outcomes from the studies, as well as appointments of implementing agents, as may be required from one phase of the Project, to the next.

Project Implementation Unit

The Project Implementation Unit headed by the Project Manager is established under the Executive Secretary of ORASECOM and is based in Centurion, South Africa. The main responsibility of the Project Manager is to oversee the implementation of all aspects of the Project and be fully responsible for its day-to-day management. The Project Manager also reports and oversees the activities of the consulting firms and facilitates and coordinates the support and inputs required from ORASECOM and the State Parties.

Project Management Office

To ensure more capacity for ORASECOM and the timely delivery of the studies of the LBWT, the Joint Study Management Committee recommended that a satellite Project Management Office be established within proximity of the proposed Dam on the Makhaleng River in Lesotho, where most of the field investigations will be undertaken. The Project Management Office will support the implementation of all the L-BWT studies and will report to the ORASECOM Secretariat, through the Manager of the Project Implementation Unit. The establishment and operation of the Project Management Office will be supported through funding from Botswana, Lesotho, and South Africa. The Project Management Office will be headed by a Project Coordinator.

Project Steering and Consultation

The undertaking of the water conveyance feasibility study falls under component IV of an overall Project, titled “Preparation of Climate Resilient Water Resources Investment Plan and

Lesotho-Botswana Water Transfer Multipurpose Project”. The L-BWT is covered by components III and IV. Components III and IV are therefore steered by the Joint Study Management Committee. The Joint Study Management Committee is also going to be supported and advised by a panel of experts, currently being appointed to review different technical reports and outcomes. Process to establish a broader consultation forum for the LBWT activities started in January 2019. The Consultant will be expected to utilize these stakeholder fora, where and when required. The Consultant of this assignment will also be expected to attend and present reports to the meetings of the Joint Study Management Committee, for instance presentation of an inception report, as well as interim & draft final feasibility reports. The logistical costs of the above-mentioned meetings will not be covered by the Consultant. The Consultant will liaise with the Project Implementation Unit to prepare these meetings and related power point presentations and cover its own logistical costs. In addition, the Consultant will be expected to attend the financiers’ conference which will be organized towards the end of the consultancy.

Copyright

Copyright in reports, documents or any other materials produced, prepared, or collected in direct consequence or during the execution of the studies, will be owned by the State Parties and will be administered by the ORASECOM Secretariat and the Joint Study Management Committee.

Contractual Schedule

The assignment will be implemented in an 18 months’ period from the date of the Consultancy contract’s signing.

The Main Reporting Requirements and Schedule

The main reporting requirements are summarized as follows:

(i) Inception Report: This report will review available documentation and data and propose methodology and work plan for the assignment, which includes Task 1.

(ii) Final Conveyance Route Report: This report will include the output of Task 1A. (iii)Topographical and Cadastral Report: This report will provide a usable format of all topographical data acquired in the study, covering Task 2.

(iv) Geotechnical and Materials Report: This report will include the geotechnical and geological investigations and associated simulation on the water conveyance system and its appurtenant structures, that covers Task 3.

(v) Interim Report: This report will cover Task 5 and Task 6, and the DCM, AFD drawings and Operations Philosophy from Task 4.

(vi)Draft and Final Feasibility and Preliminary Design Report: This report will present the totality of the feasibility for the water conveyance system, including the Terms of Reference for Detailed Design. It will also include Schedule of Quantities and costing (capital and O&M) and Record of Implementation Decision. The Final report will include all the comments/feedback received from the Client on the Draft Report.

(vii)The following supporting report will be required: Section 9. Notification of Intention to Award and Beneficial Ownership Forms 28 • Consultation reports presenting consultation with Authorities and owners of land and demarcation of route: servitudes, wayleave permits and land acquisitions.

Report Format

All the reports will be submitted in draft and final form. Draft reports will be submitted in soft copy only, except for the drawing and plans which will be submitted in 12 hard copies and a soft copy. Final reports will be submitted in 15 hard copies and a soft copy. Soft copies will be submitted in both native and pdf format. The Client will review each report and get back to the Consultant in no longer than 1 month for report approval. Monthly Progress notes (2 pages) will be submitted to the Client to indicate progress, planned activities for the coming quarter and draw the Client's attention on specific difficulties. These notes should not be considered as another report to be delivered by the Consultant, but as a continuous communication with the Client summarizing the situation of the project. Table 4 provides an indicative schedule for submission of the reports and deliverables. Table 2 : Indicative Schedule for Submission of the Reports and Deliverables # Deliverables Schedule (i) Inception Report M+3 (ii) Final Conveyance Route Report M+5 (iii) Progress Notes M+2,4,6,8,10,12,14,16,18 (iv) Topographical and Cadastral Report M+7 (v) Supporting Report -Land Owner Consultation Reports M+7 Geotechnical and Materials Report M+11 (vi) Interim Report (including Design Criteria Memorandum (DCM), AFD (Approved for Design) drawing templates and Operations Philosophy) M+12 (vii) Draft Feasibility and Preliminary Design Report M+15 (viii) Final Feasibility and Preliminary Design Report M+18 6.3 Composition of the Study Team.

4.6 TOR 6: Evaluation of Tenders

The contract will be awarded from the qualifying tenders as per the following criteria:

- Companies and/or individuals may only participate in one team
- The proposal must be responsive/compliant/acceptable, and
- Having received the highest score out of the pre-determined set of weighted technical and financial criteria specific to the tender proposal. In this regard, the respective weight of the proposals are as follows:
    - Technical Criteria weight is 70%
    - Financial Criteria weight is 30%

Criteria	Weight	Maximum Points
Technical	**70%**	**100**
Knowledge and Experience in Similar Projects		25
Local Knowledge and Experience in Orange/Senqu basin		25
Understanding of the Terms of Reference		30
Inclusion of Consultants from the ORASECOM region		20
Financial (Lowest Offer/Current Offer)*100	**30%**	**100**
Total Score	**Technical Score*70% + Financial Score * 30%**	

Modification of Terms

The ORASECOM Secretariat reserves the right to add, modify or omit certain portions of the tender scope at any time at its sole discretion. This includes the right to cancel this tender at any time prior to entering into a contract with the successful bidder.

Tender Award

- The contract will be awarded to a successful bidder within 60 days of closing of this tender and the successful bidder will commence work within four (4) weeks from the date of signature, by all parties.
- ORASECOM Secretariat will enter into a contract with only one successful bidder.

Confidentiality

- Tenders submitted will not be revealed to any other bidders.
- The Secretariat reserves the right to seek clarification or verification of any information contained in the tenders. iii. All information pertaining to ORASECOM obtained by the bidder as a result of participation in this tender is confidential and must not be disclosed without written authorisation from the Executive Secretary.

Ownership of Data

All tenders, including any supporting documents and/or training materials or any other documentation with reference to this tender, submitted to the ORASECOM Secretariat becomes the property of ORASECOM

4.7 TOR 7: Other Provisions

Taxes

The statutory levels of taxes – if relevant – shall be invoiced by the Consultant and reimbursed by ORASECOM in addition to the remuneration (Tax Invoice). ORASECOM shall not be liable for any taxes due to tax Authority/ies in the country of origin of the Consultant. The onus is on the Consultant to submit the tax returns and declare all income/monies received from ORASECOM to the tax Authority/ies in her own country.

Travel

The Consultant will be expected to conduct consultations with key role players in the subject matter of the assignment in the Orange-Senqu River Basin. The details of officials and institutions to be consulted will be agreed to with the Secretariat and the CTT. The list will include, but not be limited to relevant Departments and institutions in the State Parties.

4.8 TOR 8: Submission Process

The bidder should submit a separate Technical and Financial Proposals clearly detailing total number of days to complete work and daily rates inclusive of all anticipated costs in United States Dollars (USD) during the period of assignment. The term “all-inclusive” implies that all costs (professional fees, communications, consumables, VAT etc.) that could be incurred by the consultant in completing the assignment are already factored into the daily fee submitted in the proposal. Travel costs and daily allowance cost should be identified separately in line with allocated consulting days.

Electronic Technical and Financial proposals should be submitted with a subject line clearly titled: “Consultancy Services to Facilitate Water Resources Modelling and Capacity Building for ORASECOM Member States” through email to Mr A N Other (othera@orasecom.org) with a copy to:

- communication.orasecom@gmail.com and othera@gmail.com no later than 1600hrs on Friday xx of xx 2024.

Clarifications

Request for clarifications should be emailed (preferred mode of communication) to the above contacts using the following mobile +27 xx xxx xxxx, no later than 1600hrs on xxth of xxx 202x.

5 STRATEGIC ACTION 1: AGREEMENT AND IMPLEMENTATION OF ENVIRONMENTAL WATER REQUIREMENTS

5.1 Overview

The desired Environmental Water Requirements from an environmental point of view were already determined in previous studies. System analysis showed that these Environmental Water Requirements, in particular those for Augrabies and downstream, including the estuary environmental requirements, significantly reduce the yield available from the resources (Gariep and Vanderkloof dams). These Environmental Water Requirements do not represent the final Environmental Water Requirements to be implemented and adhered to, according to the RSA law. Another process still needs to be carried out to find a balance between achieving the desired ecological state and the impact on the economy of the region. This balance needs to be agreed on by all role-players. Only then can the final agreed Environmental Water Requirements be imposed on the system. These Environmental Water Requirements are then referred to as the Reserve and are published in the Government Gazette so that it can be lawfully implemented and enforced.

The reserve for the Orange River is currently unknown, and the old and outdated estuary environmental requirements determined as part of the Orange River Replanning Study (DWAF, 1996) is currently still released (287.5 million m^3/a) from Vanderkloof Dam. Based on the latest Environmental Water Requirement studies carried out, a Preliminary Reserve for the Lower Orange was determined and approved by DWS RSA (DWS, 2017). The Preliminary Reserve used the latest Environmental Water Requirements estimations but were adjusted so that it does not impact negatively on the current Orange River Project system yield.

The final agreed Reserve still needs to be determined and is expected to be somewhere between the preliminary Reserve requirements (average of ±533 million m^3/a) and those of the preferred Environmental Water Requirements (average of ± 942 million m^3/a) as defined by the environmentalists.

The impact of the desired/preferred Environmental Water Requirements (not the Reserve) on the Orange River Project yield is quite significant. The selection of the final Reserve will also 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, also to Lesotho dams such as Makhaleng Dam and other Lesotho Lowland Dams.

It is noted that ORASECOM has recently appointed a Service Provider to undertake certain work and investigations to establish the Environmental Water Requirements in the Orange/Senqu basin. It is therefore important to ensure that the proposed work envisaged for Strategic Action 1 will complement the work being undertaken currently and should not duplicate or diverge from the existing efforts. Discussions have been held with the Service Provider in order to understand the scope of the services being offered and the deliverables anticipated from the project. The proposed activities described under Strategic Action 1 are therefore structured to continue the work that is being covered under this initial project. In this regard, the current project has been split into several phases, the first of which is being undertaken by the Service Provider. The remaining phases have not yet been fully defined and no budget has been allocated to them. The proposed tasks outlined under Strategic Action 1 will therefore form the basis for the future phases of the Environment assessments being undertaken by the Service Provider and will hopefully provide the necessary funding needed to complete the work that has already been envisaged by the team.

The cost of the study to establish the final agreed EWRs or Reserve to be implemented in the Orange River System is estimated to be between \$1million and \$5 million depending upon the scope of work that is agreed upon. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalization of the TOR for the study.

(Strategic Action 3.3.3) –

5.2 Scope of Services

This assignment will be undertaken in the following Tasks:

- SA1.1: Inception Report (must include details of GAP Analysis being currently undertaken)
- SA1.2: Design an eFlow Monitoring Programme
- SA1.3: Prepare an eFlow Implementation Agreement for the Orange/Senqu basin
- SA1.4: Develop an Implementation Plan to prioritse sites for eFlows
- SA1.5: Develop a Management Plan for the Orange River Mouth

Each of the above tasks will be discussed below where it is described in the following manner:

- Objectives
- Methodology
- Deliverables

5.2.1 SA1.1: Inception Report

The purpose of an Inception Report is to capture important work that would be necessary for the successful completion of this assignment, which may for some reason or another have been overlooked in the compilation of the original Terms of Reference (ToR) or the proposal submitted by the Service Provider during tendering. Omission of this additional work is usually only detected once work on the assignment has started and most of the team members have had time to familiarise themselves with the detailed requirements of the tasks necessary to ensure the successful completion.

The Inception Report is a formal document that will cover all the aspects of the original proposal plus the additions to the scope of work, Contract Amount, Contract Arrangements and Contract Period that may be required. The Inception Report will list all tasks required, all the team members for each task and their time allocation as well as their hourly rates per task, anticipated disbursements, revised study programme, etc. The rates of all new team members need to be approved before they can be engaged. The Inception Report can therefore be considered a revised Technical and Financial Proposal which supersedes and replaces both the original Terms of Reference as well as the original Project Proposal. **All future queries relating to study progress, deliverables and/or budgets should therefore be cross-checked against the Inception Report and not the Terms of Reference or Project Proposal.**

Objectives

The objective of this task is to produce a report which will become the de-facto agreement between ORASECOM and the Project team for the successful execution of the proposed project. This report will become the basis of the proposed project and will supersede both the original TOR and the Project Proposal.

Methodology

- The appointed Service Provider shall within two (2) months of commencement / contract signing produce a detailed assignment inception report. It will be required from the appointed Service Provider to do thorough research and review all the relevant previous studies as well as all the available information relevant to this assignment. It will be necessary to update and maintain a list of such studies and their relevance to this assignment. It will be required to liaise with all relevant stakeholders in preparation for the undertaking of this assignment.
- The Service Provider shall compile an Inception Report that will consist of a detailed description of tasks, a study programme and study budget. The Inception Report will form part of the Contract and stipulate the scope of work for the study, the Contract Amount and the Contract Period which, upon signing of the Contract by both parties, allows

- The Service Provider to start with their work. In it, the Service Provider's proposal will be discussed with the Client and all aspects and uncertainties will be clarified. It will result in the final Terms of Reference for the study together with the final study cost. These will serve as a basis for all future work on the contract and will be recorded in the Agreement with the Client.

Deliverables

An Inception Report containing agreed:

- Scope of Works
- Methodology
- Deliverables
- Budget
- Programme
- Project Team members
- Involvement of ORASECOM and Basin State members
- Management Processes
- Quality Control Processes

5.2.2 SA1.2: Design an eFlow Monitoring Programme (ref 3.3.3)

Objectives

- Identify key Environmental Streamflow Requirement sites that address flows between basin states as well as all other Environmental Streamflow Requirement sites that have been identified during Phase 1 of the current GEF project being undertaken for ORASECOM.
- Investigate and establish the compliance monitoring requirements for all key Environmental Streamflow Requirement sites identified under the previous objective.
- Develop and design an eFlow Monitoring Programme

Methodology

- Through examination of the various reports together with discussions with the team members of the GEF project, a complete list of key Environmental Streamflow Requirement sites and their associated flows will be collected and collated by the Project Team.

- The key variables required to implement the proposed Environmental Streamflow Requirement's will be assessed and documented in such a manner that the necessary equipment needed to ensure and monitor compliance can be determined.
- Having assessed the monitoring needs associated with the proposed Environmental Streamflow Requirement sites, a monitoring programme will be proposed in which details of all equipment and the necessary monitoring frequencies etc will be clearly defined including likely budgets and responsibilities allocated to each basin state. Proposals on the data ownership and how the data are to be collected, collated, accessed and shared by all basin states should be included as part of the programme.

Deliverables

- A list of Environmental Water Requirement sites that address flows between the basin states together with details of the flows and flow regimes proposed in the first phase of the GEF project.
- A list of equipment needed at each site together with details of the recording frequency and data handling protocols etc
- A Programme outlining what equipment should be commissioned at each site and when it should be introduced etc as part of a comprehensive eFlow Monitoring Programme

5.2.3 SA1.3 Prepare an eFlow Implementation Agreement for the Orange/Senqu basin

Objectives

- Collect and collate all legal frameworks and agreements related to eFlows in the Orange/Senqu basin.
- Create a list all key gauges and eFlow sites that will be included in any eFlow agreements between the basin states.
- Collect and collate all hydrological and geo-hydrological data required to develop an eFlow agreement for the basin.

Methodology

- A legal specialist will provide support to the Environmental Specialist in order to identify where legal agreements involving eFlows are already in place or will be required in future. Details of all such agreements will be collected and collated so that they can be used as the basis of a future agreement that will be approved by the 4 Basin States.

- The environmental specialist will identify and list all key flow gauges as well as all additional eFlow sites within the basin as required to develop an eFlow agreement that should be approved by the 4 basin states.
- Review all appropriate reports on the Hydrology and Geo-hydrology and summarise the key information that will be required to as input to the eFlow agreement for the basin.
- Develop the eFlow agreement in partnership with the 4 Basin States through a consultative approach that may involve separate meeting with basin state members as well as a combined workshop where all 4 basin states are represented (can be virtual or physical meeting as deemed appropriate by the Project Team).

Deliverables

- Copies of all legal agreements etc that will be required to develop the eFlow Implementation Agreement that will be approved by the 4 basin States.
- A list of the key gauges and eFlow sites (already discussed under Item 2)
- A summary of the hydrological and geo-hydrological variables that will be required to develop the eFlow Implementation Agreement
- A comprehensive eFlow Implementation Agreement that has been discussed with and approved in principle by the 4 Basin States through as workshop consultative process.

5.2.4 SA1.4: Develop an Implementation Plan to prioritse sites for eFlows

Objectives

- Collect and collate information and data required to produce an eFlow Implementation Plan
- Identify agreements required between the basin states which will form the basis of the documentation needed to gazette the eFlows for the Orange – Senqu River Basin.
- Prepare documentation and facilitate agreements needed in order to proceed with the Gazetting of the eFlows in the Orange-Senqu River Basin. The actual Gazetting will not be done as part of this task.

Methodology

- The Environmental Specialist will liaise with the Legal Specialist to gather the information that will be required to develop an eFlow Implementation Plan
- Various documents and agreements will be collected that will form the basis needed to gazette the eFlows.

- Discussions with and between basin state members will be undertaken as part of the project in order to facilitate the drafting of the necessary agreements that will be required to gazette the eFlows. The actual gazetting will not be undertaken by the Project Team but all information required to do so should be prepared in a form that it can be used without further effort.

Deliverables

- The base documentation and a summary of the documents required to develop an eFlow Implementation Plan
- The documentation and agreements needed in the appropriate format to gazette the eFlows for the Orange-Senqu River Basin

5.2.5 SA1.5: Develop a Management Plan for the Orange River Mouth

Objectives

- To collect and collate all previous reports and Environmental Assessments associated with the Orange/Senqu River Mouth
- To review all issues identified in previous assessments and documented in the “Integrated Water Resources Management Plan for the Orange-Senqu River Basin of 2014
- To develop a new Management Plan for the Orange-Senqu River Mouth (Ref. 3.3.2)

Methodology

- A list of previous reports and workshop documents should be collected and collated and summarised in a short summary report.
- The review of the issues identified in the 2014 Management Plan should cover the following items as well as any additional items deemed relevant by the Environmental specialist.
    - Removal of remnant causeway
    - Control of Alien Plants
    - Removal of old earthmoving machinery
    - Implementation of dust control of mining activities
    - Undertaking a Lydar survey of the river mouth (allow a lump sum for this item)
    - Revision of existing dirt road network
- The new Environmental Management Plan for the River Mouth should be developed in co-operation with representatives from the 4 basin states through virtual meetings.

Deliverables

- A selection of reports and workshop documents which have been summarised in a short summary document explaining each document and its relevance to the proposed Environmental Management Plan.
- A short report discussing the key environmental issues that must be addressed at the Orange-Senqu River Mouth including any gaps that will have to be addressed through some additional study.
- An Environmental Management Plan for the Orange/Senqu River Mouth designed to improve the current situation at the river mouth by addressing the many issues listed in the 2014 Integrated Water Resources Management Plan.

5.3 Time-Schedule for Project 1

It is anticipated that the project will be undertaken over a 36-month period with an expected starting date of August 2024.

5.4 Team Requirements for Project 1

Eligibility

The Consultant is expected to provide in the proposal key staff, based on the needs of the assignment. When one expert has several domains of skills enabling them to occupy several positions, the corresponding Curriculum Vitae (CV) must clearly show such capabilities through education background and experiences. Each CV must be maximum 5 pages. The Consultant will determine the number and levels of professional and support staff required to complete the assignment effectively, efficiently, on-time and on-budget. The team should comprise of an international consultant with proven experience in the GEF TDA/SAP process and preferably with experience on River Basin Organisations. The team should also consist of individuals with experience in the Orange-Senqu River Basin.

Composition of the Study Team

The Consultant’s required key staff The Consultant is expected to provide in its proposal key staff, based on the needs of the assignment. When the same expert has several domains of skills enabling for occupying several positions, the corresponding Curriculum Vitae (CV) must clearly show such capabilities through education background and experience. The Consultant will determine the number and levels of professional and support staff required to complete the assignment effectively, efficiently, on-time and on-budget. An example of the descriptions of some key staff and their responsibilities under the assignment and the minimum requirements for their qualifications and experiences are provided below as examples of what should be included. It should be noted that the key specialists for each Strategic Action will have to be selected after the final Terms of Reference and Scope of Work have been finalised by ORASECOM. The specialists listed below are therefore typical example of what level of detail should be provided in the various Terms of Reference.

Team Leader/Water Engineer:

The Team Leader will be responsible for the overall planning and implementation of the consultancy services including team management and coordination; ensuring the achievement of the study objectives; and facilitating stakeholder consultation. The Team Leader will have the overall responsibility for the preparation and finalization of the various reports outlined under this assignment. He/she should have as a minimum, a Master’s Degree in Water Engineering or any related field and 25 years post qualification work experience, of which at least 15 years in the field of relevant water infrastructure (large bore pipelines and pump stations) development and feasibility studies, similar to this project, partly in Africa, related to transboundary multipurpose water transfer project preparation, and have a proven track record of leadership in managing multi-disciplinary teams. The Team Leader should be registered as a professional engineer and project manager with a recognized statutory engineering professional body (not a voluntary institution). He/she should have acted as a Team Leader for at least 5 similar projects. Previous experience and knowledge of the relevant laws and regulations related to large linear water projects in Lesotho, Botswana and RSA will be an added advantage. The Team Leader must be fluent in English and must possess excellent communication and report writing skills.

Geotechnical and Materials Engineer:

Minimum qualification of a Master’s Degree in Geotechnical Engineering or relevant fields and 15 years post qualification work experience in geotechnical studies for projects concerning large hydraulic structures, such as water supply pipelines, pump stations and canals. He/she should be registered as a professional engineer with a recognized statutory engineering professional body

Land surveyor:

Minimum qualification of a Master's Degree in relevant fields and 15 years post qualification work experience in topographical investigations for projects regarding large linear pipeline projects. He/she should be registered as a land surveyor with a recognized statutory engineering professional body.

Civil Engineer:

Minimum qualification of a Master's Degree in Civil Engineering or relevant fields and 15 years post qualification work experience in planning and development of concept and preliminary designs of large hydraulic structures, such as water supply pipelines, water abstraction works, break-pressure tanks, canals, etc. He/She should be registered as a professional engineer with a recognized statutory engineering professional body.

Hydraulic Modeller:

He/She must have a minimum of Master's degree in Civil and Structural Engineering with a major in Hydrology. He/She should have 20 years post qualification relevant work experience in the design of tunnels, canals, and inlet/outlet works as well as hydraulic analysis and structural designs for large water pipelines' projects, multipurpose water projects and strategic water assessments. Experience in Lesotho, Botswana and RSA will be an added advantage. He/She should be registered as a professional engineer with a recognized statutory engineering professional body. He/She should have acted as Hydraulic Modeller for at least 5 similar projects. He/She should have experience in hydraulic models, flow problems and procedures of various activities related to construction.

Pipeline/Piping Engineer:

Minimum qualification of a Master's degree in Mechanical Engineering or related fields, with 20 years post qualification relevant work experience in undertaking piping design and engineering, familiarity in piping materials application and stress engineering, understanding and application of codes, standards and recommended practices in in Lesotho, Botswana and RSA will be an added advantage. He/she should be registered as a professional engineer with a recognized statutory engineering professional body

Electro-Mechanical Engineer:

Minimum qualification of a Master's Degree in electro-mechanical engineering or relevant fields and 15 years post qualification work experience in planning and designing of electro-mechanical systems for large hydraulic structures and pump stations, including designing of SCADA systems for operation of electro-mechanical equipment, and electricity supply systems. He/She should be registered as a professional engineer with a recognized statutory engineering professional body.

Legal Specialist:

Minimum qualification of a Master's Degree in Law or Engineering with a specialization in Water Law and at least 10 years post qualification work experience in dealing with Water Law in the SADC area.

Economist:

Minimum qualification of a Master's Degree in Economics or related fields, and 15 years post qualification work experience in developing economic assessments and CAPEX and OPEX cost estimations in water projects in in Lesotho, Botswana and RSA will be an added advantage.

Pump Stations Design Engineer:

Minimum qualification of a Master's Degree in Mechanical engineering or a Master's Degree in Pump Stations, and 15 years post qualification experience in the design/fabrication and operation of pumps for water conveyance system projects. He/She should be registered as a professional engineer with a recognized statutory engineering professional body.

Structural Engineer:

Minimum qualification of a Master's Degree in Structural Engineering or relevant fields, and 15 years post qualification experience in the design, planning and development of reservoir and hydraulic structurers for water system projects. He/She should be registered as a professional engineer with a recognized statutory engineering professional body.

The Consultant's Non-Key Staff

The Consultant shall propose a schedule of other required non-key staff. This list may include but not limited to Financial Planner, Roads Engineer, Planning Engineer (Urban/Town), GIS Specialist, Environmentalist, etc

Qualifications/Experience

The consultants are required to have the following qualifications and expertise: -

- A relevant Master's degree, preferably Doctor of philosophy (PhD); -
- Global experience in the field of Water Resource Planning and Management -
- Previous experience with inter-governmental and multilateral cooperation initiatives, as well as with consultative process of the implementation of decisions related to the (natural) environment in general, and Orange-Senqu River Basin in particular;
- Demonstrated, successful experience in working collaboratively with a broad array of stakeholders; -
- Demonstrated ability to facilitate processes and to work with a broad array of sectors and stakeholders; -
- Well-developed analytical and reporting skills;
- Good command of spoken and written English
- The Consultant must be registered with a statutory board in any one of the ORASECOM Member States.
- Experience in Water Resources Modelling within the Southern African region;

6 STRATEGIC ACTION 2: IMPROVEMENT AND IMPLEMENTATION OF MONITORING AND INFORMATION MANAGEMENT SYSTEMS ($5 MIL+$1M /ANNUM)

6.1 Overview

Monitoring of hydrological and hydro-meteorological data is the responsibility of each country and departments already exist in the 4 basin states tasked with the collection and processing of such data and associated information. In the case of the Orange/Senqu River Basin it is important to co-ordinate the data collection and dissemination to avoid unnecessary duplication and try to ensure that the data are managed to the benefit of all basin states. While it is recognised that each country will wish to exercise its own preferences with regard to equipment and storage/processing procedures, it is important to try and develop a system whereby each country has access to all information in the Orange/Senqu River Basin. In this regard, ORASECOM can act in a facilitation role where it can direct and co-ordinate the efforts required to develop a comprehensive data-base for the basin as a whole that is freely available to the member states.

While the issue of data is extremely complicated and onerous, there are a number of key issues where a coordinated approach to data acquisition and management can be of great value, namely:

- Basin wide monitoring systems
- Monitoring and reporting on all abstractions and return flows
- Monitoring associated with Climate Change assessments
- Water Quality monitoring
- Real-time monitoring and modelling required to improve efficiency of releases from Vanderkloof Dam as well as for early warning systems for flood and drought events.

The key focus for Strategic Action 2 will concentrate on the last item mentioned above which involves setting up a Real-Time monitoring system and associated Hydraulic Model. This is considered one of the most important tasks mentioned as it can deliver very significant savings through greater release efficiency and in this manner, it has a very short “pay-back” period from a financial viewpoint.

Real time hydraulic modelling and monitoring is 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 Gariep Dam and especially from Vanderkloof Dam, in order to determine when, and to what extent releases need to be made to supply all the users downstream of Vanderkloof Dam to the river mouth, over a distance of approximately 1300 km, also taking into account possible spills from the Vaal River.

It will also be very useful to have a proper aerial survey of the Orange River, particularly from Van der Kloof Dam to the mouth. A 2-D hydraulic model will assist in disaster management during times of flooding as early warning, predicting flood levels and areas of inundation well ahead of the flood.

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 (2023/24). 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.

Real time modelling and monitoring is also a requirement to effectively supply EWRs/Reserve on Orange River and to the Estuary. The Lower Orange along the Namibia/RSA border is over the last couple of years periodically experiencing very low or zero flows in particular during summer months and too high flows in the winter months which is the exact opposite of the EWRs.

6.2 Scope of Services

This assignment will be undertaken in the following Tasks:

- SA2.1: Inception Report
- SA2.2: Status Quo Assessment (previous studies, available data sets, model calibrations, details of all measured cross sections
- SA2.3: Collection and collation of river data (cross-sections, riparian vegetation, roughness, historical floods and drought routings etc.,)
- SA2.4: Liaison with local specialists involved with flood and low flow measurements including discussions and info collection from Farmers Associations and DWS/Namibian DWA and Eskom
- SA2.5: Assessment of gauging network (real time monitoring as well as needs for new equipment and new gauging stations
- SA2.6: Establish water balance components for each river section

- SA2.7: Set up and calibrate (high and low flows) hydraulic river model using an open source model such as HEC-RAS (or similar and approved by ORASECOM) – based on the historical flow records
- SA2.8: Test new operating rules with and without the Noordoewer/Vioolsdrift Dam to improve efficiency of releases from Vanderkloof Dam and impact of changes to the Reserve at the River Mouth.
- SA2.9: Initiate discussions with DWS and DWA Namibia in order to set up a Dashboard to interact with the model using the real-time data in order to transfer ownership and operation of the model to the custodian.
- SA2.10: Improvement of monitoring networks basin-wide. (irrigation use, groundwater, water quality, surface water, Climate Mitigation Monitoring (evaporation, rainfall temp etc),

The cost of the proposed is estimated to be $5 million. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalization of the TOR for the study.

Each of the above tasks will be discussed below where it is described in the following manner:

- Objectives
- Methodology
- Deliverables

6.2.1 SA2.1: Inception Report

The purpose of an Inception Report is to capture important work that would be necessary for the successful completion of this assignment, which may for some reason or another have been overlooked in the compilation of the original Terms of Reference (ToR) or the proposal submitted by the Service Provider during tendering. Omission of this additional work is usually only detected once work on the assignment has started and most of the team members have had time to familiarise themselves with the detailed requirements of the tasks necessary to ensure the successful completion.

The Inception Report is a formal document that will cover all the aspects of the original proposal plus the additions to the scope of work, Contract Amount, Contract Arrangements and Contract Period that may be required. The Inception Report will list all tasks required, all the team members for each task and their time allocation as well as their hourly rates per task, anticipated disbursements, revised study programme, etc. The rates of all new team members need to be approved before they can be engaged. The Inception Report can therefore be considered a revised Technical and Financial Proposal which supersedes and replaces both the original Terms of Reference as well as the original Project Proposal. **All future queries relating to study progress, deliverables and/or budgets should therefore be cross-checked against the Inception Report and not the Terms of Reference or Project Proposal.**

Objectives

The objective of this task is to produce a report which will become the de-facto agreement between ORASECOM and the Project team for the successful execution of the proposed project. This report will become the basis of the proposed project and will supersede both the original TOR and the Project Proposal.

Methodology

- The appointed Service Provider shall within two (2) months of commencement / contract signing produce a detailed assignment inception report. It will be required from the appointed Service Provider to do thorough research and review all the relevant previous studies as well as all the available information relevant to this assignment. It will be necessary to update and maintain a list of such studies and their relevance to this assignment. It will be required to liaise with all relevant stakeholders in preparation for the undertaking of this assignment.
- The Service Provider shall compile an Inception Report that will consist of a detailed description of tasks, a study programme and study budget. The Inception Report will form part of the Contract and stipulate the scope of work for the study, the Contract Amount and the Contract Period which, upon signing of the Contract by both parties, allows
- the Service Provider to start with their work. In it, the Service Provider’s proposal will be discussed with the Client and all aspects and uncertainties will be clarified. It will result in the final Terms of Reference for the study together with the final study cost. These will serve as a basis for all future work on the contract and will be recorded in the Agreement with the Client.

Deliverables

An Inception Report containing agreed:

- Scope of Works
- Methodology

- Deliverables
- Budget
- Programme
- Project Team members
- Involvement of ORASECOM and Basin State members
- Management Processes
- Quality Control Processes

6.2.2 SA2.2: Status Quo Assessment (previous studies, available data sets, model calibrations, details of data sets for all measured cross sections,

Objectives

- To identify previous models and model data sets that have been developed to undertake hydraulic modelling of the Orange River downstream of Vanderkloof Dam and Bloemhof Dam on the Vaal River.
- To establish the quality of the data sets and the model calibrations in order to determine what useful information and model sets-ups are available and what will be needed to establish a reliable working hydraulic model for the Orange River downstream of Vanderkloof Dam.

Methodology

- Several studies have been undertaken over the past 20 years to undertake some form of hydraulic modelling for the Orange River downstream of Vanderkloof Dam. Reports from these studies will be obtained and studied in order to establish what was done and how useful such models and their associated data sets can be in the establishment of a new and reliable model.
- The hydraulic models and their data sets will be examined to assess the reliability of the previous work and if the models were calibrated for floods or low flow events and how well they reproduced the actual results.
- Where possible, data sets will be obtained and evaluated in order to establish gaps and inconsistencies which will have to be addressed during the development of a new model aimed at improving the efficiency of water release into the Orange River from Vanderkloof Dam.

Deliverables

- A short report providing details of the previous hydraulic models used on the Orange River and their data sets.

- Conclusions and recommendations on future dta requirements needed to complete a new and reliable hydraulic model for the Orange River downstream of Vanderkloof Dam.

6.2.3 SA2.3: Collection and collation of river data (cross-sections, riparian vegetation, roughness, historical floods and drought routings etc.,)

Objectives

- To gather useful data from previous assessments in order to create a realistic hydraulic model for the Orange River downstream of Vanderkloof Dam.
- To update all water demands along the Orange River downstream of Vanderkloof Dam which will be needed in any new hydraulic model. The demands will include but not be limited to, evaporation estimates from the water surface, evaporation estimates from the riparian vegetation, abstractions from the river for urban/industrial use as well as for irrigation, water transfers to other parts of the river basin, etc

Methodology

- The Service Provider should obtain the data available from previous hydraulic modelling studies where possible and also gather new information from various sources which were not available 20 to 30 years ago. Sources can include, aerial photographs, satellite imagery (past and present), weir design drawing from Water Affairs, flood hydrographs from the various streamflow gauges along the Orange River, low flow hydrographs from the various streamflow gauges, maximum flood peak levels from physical markings at various locations along the Orange River,
- Roughness parameters should be developed for each section of the Orange River based on physical assessments through site visits as well as from aerial photographs and satellite imagery as well as from any previous assessments.

Deliverables

- A data base of cross-sectional data for the Orange River downstream of Vanderkloof Dam suitable for using in a new hydraulic model of the river
- Water use/demand data for the Orange River downstream of Vanderkloof Dam suitable to be used in a new hydraulic model.
- Sets of flood and low-flow hydrographs for the various calibration sites along the Orange River that will be used to calibrate and verify the hydraulic model parameters.

6.2.4 SA2.4: Liaison with local specialists involved with flood and low flow measurements including discussions and info collection from Farmers Associations and DWS/Namibian DWA and Eskom

Objectives

Over the past 100 years or so there have been a number of extreme flood events which created damage as they moved downstream towards the Orange River Mouth. Many of these events are well known and, in many cases, the height of the floods, have been recorded by various organisations or farmers. Such information is invaluable in calibrating any new hydraulic model as the model must be able to replicate such floods as they moved down the river. It is important to gather relevant information on these extreme floods as it can then be used to verify and calibrate the river model.

Methodology

- Local farmers organisations and local Water Affairs representatives will be contacted in order to establish which of these have information on the flood heights achieved during previous extreme flood events.
- Site visits will be made to the various sites and/or individuals where such information is available and it will be captured through photos and/or videos. Where necessary, surveying may be used to confirm of capture such information.

Deliverables

- A summary of the flood peak information available for the Orange River at various points in the river as obtained from various organisations and/or individual farmers. This information should include photographs and GPS co-ordinates for each point where flood levels are available so that it can become a data base of such information for future use.
- Full contact details from where the information was obtained to ensure that it can be verified or checked in future should this prove necessary.

6.2.5 SA2.5: Assessment of gauging network (real time monitoring as well as needs for new equipment and new gauging stations

Objectives

- For any reliable hydraulic model, it is necessary to tie the model into the existing river gauging network so that the models are continually being updated and improved. A real-time gauging network is required for this process and in cases where there are gaps or problems, they much be identified and where possible corrected/enhanced.

- Different gauging sites may be required for low and high flow assessments as it is usually found that the gauges which are accurate at low flows may not be accurate at high flows and vice versa.

Methodology

- The various streamflow gauges along the Orange River downstream of Vanderkloof Dam will be collected and evaluated by a suitably qualified flow gauging specialist.
- The flow gauging specialist will establish the likely accuracy of each gauging site at high and low flows s well as identify one or two points where a new low or high flow gauging site is required.

Deliverables

- A report on the various gauging sites along the Orange River downstream of Vanderkloof Dam
- Details on the reliability of the flow data at each site as well as recommendations on any remedial measures required at either existing sites or where new gauging sites should be established.

6.2.6 SA2.6: Establish water balance components for each river section

Objectives

In order to develop a hydraulic model for the Orange River downstream of Vanderkloof Dam it is first necessary to develop the data sets for each section of the river including details of any abstractions or inflows that occur along the length of the section being documented.

Methodology

- The relevant abstractions and or inflows for each reach along the Orange River will be estimated and documented in a format that the data can be used to develop the final data sets to be used in the hydraulic model.
- In cases where no data are available, the specialist will create estimates of the water demands and/or return flows based on clear and concise assumptions. The riparian demands will be based on the area of vegetation along each river section and be adjusted for the vegetation type as determined from aerial photographs and site visits etc.

Deliverables

A data set of water demands and/or return flows for each river section used in the models. The data sets will be provided in a format that allows them to b included in the subsequent hydraulic model.

6.2.7 SA2.7: Set up and calibrate (high and low flows) hydraulic river model using HEC-RAS or similar and approved by ORASECOM – based on the historical flow records

Objectives

To create the first order hydraulic model using an agreed model which does not involve a large financial outlay or annual maintenance charges. The model should be reliable and widely accepted worldwide and should not involve a high initial purchase price and /or high annual running costs. A model such as HEC-Ras or similar and approved should be considered.

Methodology

- A suitable hydraulic model should be selected from the various models freely available worldwide. The selection of the model should be done in association with representatives from the four basin states and agreed upon at some meting where all 4 countries are represented.
- The selected model will be used to establish a reliable hydraulic model of the Orange River downstream of Vanderkloof Dam which can simulate both high and low flow events with reasonable accuracy.

Deliverables

- A short report on the model selection
- Details of the data sets used to create the hydraulic model of the Orange River downstream of the Vanderkloof Dam which includes the testing of the model at low and high flows.

6.2.8 SA2.8: Test new operating rules with and without the Noordoewer/Vioolsdrift Dam to improve efficiency of releases from Vanderkloof Dam and impact of changes to the Reserve at the River Mouth

Objectives

- Having set up and tested the hydraulic model of the Orange River downstream of Vanderkloof Dam the model can then be used to test different operating rules for the released from Vanderkloof Dam. Through such testing it is anticipated that significant savings can be achieved through better release strategies.
- The hydraulic model can also be used to test the impact of changes to the environmental requirements at the river mouth.

Methodology

- The calibrated hydraulic model will be used to test various different release patterns from Vanderkloof Dam.
- The calibrated hydraulic model will be used to test different environmental demands at the river mouth to assess how the different demand patterns will influence the overall demand due to the different evaporation rates and river flows during the different months.

Deliverables

- A short report on the modelling of the release patterns from Vanderkloof Dam
- A short report on the impact of the different environmental demands and demand patterns at the river mouth.
- Recommendations on the various demand patterns for releases from Vanderkloof Dam as well as the Environmental flows at the river mouth.

6.2.9 SA2.9: Initiate discussions with DWS and DWA Namibia in order to set up a Dashboard to interact with the model using the real-time data in order to transfer ownership and operation of the model to the custodian

Objectives

Having developed a hydraulic model of the Orange River it is important to try and operate and maintain the model so that it is not simply lost or discarded due to lack of budget or agreement on who will operate and maintain the model in future. It is therefore important to ensure that there is agreement between the basin states and in particular Namibia and South Africa on the operation and maintenance of the model.

Methodology

- Discussions with the 4 Basin States on the operation and maintenance of the model should be made in association or through ORASECOM. This will open discussion on how the model can be used, who has access to the model, who pays for the upkeep and maintenance of the model etc.

- A proposal on the software issues should be made by a suitably qualified software specialist which should cover all aspects of the model and its future use and maintenance.

Deliverables

- A workshop involving the 4 basin states and ORASECOM to discuss the operation and future maintenance and funding of the hydraulic model.
- A short report providing details of the agreements made at the workshop
- A short report from a software engineer providing recommendations on where the model should be hosted, how it can be accessed and how it will be operated and maintained in future to ensure that it remains operational and sustainable.

6.2.10 SA2.10: Improvement of monitoring networks basin-wide. (irrigation use, groundwater, water quality, surface water, Climate Mitigation Monitoring (evaporation, rainfall temp etc),

Objectives

- Setting up the hydraulic model of the Orange River involves collecting a wide range of data in order to create a reliable model. During this process, various problems will invariably be identified where data are either not available or are unreliable for one reason or another. It is therefore important to flag such data problems and deficiencies so that the relevant custodians of the data can be informed of the problems and how they should be addressed. This sub-task therefore aims to try and improve the data availability and quality in the Orange River basin downstream of Vanderkloof Dam for future use in the hydraulic model.
- It is proposed that the team undertaking the hydraulic modelling of the Orange River downstream of Vanderkloof Dam will also help to identify improvements to the data monitoring network that can be of specific use in “Climate Mitigation Monitoring”. Climate change is expected to increase temperature along the lower reaches of the Orange River which in turn will create higher evaporation and higher water losses from Riparian vegetation which will result in greater overall water losses between Vanderkloof Dam and the River Mouth. The hydraulic Model is ideally suited to model the impacts of such changes even if only on a scenario-based approach. For example, using the model it will be possible to quantify the increased losses due to a 2 degree

increase in temperature or perhaps a 3-degree increase. Currently, there is no model available to quantify such climate change scenarios.

Methodology

- The hydraulic modelling team will identify gaps and problems in the data collection network that should be addressed to enable the model to be used more effectively and to be used to assess future climate change scenarios.
- Various possible Climate Change scenarios will be selected from the various climate change reports and studies undertaken for the Orange River Basin. Using the hydraulic model, these scenarios will be evaluated to assess the overall impact on the water losses that occur from the Orange River downstream of Vanderkloof Dam.

Deliverables

- A report providing details of data gaps and deficiencies with recommendations on what should be done to improve the monitoring network with specific reference to the hydraulic model as well as Climate Change monitoring.
- A short report will be provided which includes the results from the hydraulic model to assess the likely future impacts of possible Climate Change scenarios on the overall water losses from the Orange River downstream of Vanderkloof Dam. For example, the analyses can provide quantitative figures for the increased river losses due to a 2 degree increase in average temperature along the lower Orange River. Once set up, the hydraulic river model can provide such estimates and will be an ideal tool for testing various scenarios and to assist in Climate Mitigation measures for the Orange River.

6.3 Time-Schedule for Strategic Action 2

It is anticipated that the project will be undertaken over a 24-month period with an expected starting date of August 2024.

6.4 Team Requirements for Strategic Action 2

- **Eligibility** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Composition of the Study Team** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Qualifications/Experience(**To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)

7 STRATEGIC ACTION 3: DEVELOPMENT AND IMPLEMENTATION OF GUIDELINES FOR SHARING OF WATER RESOURCES

7.1 Overview

Possible new dam developments have been proposed in the ORASECOM Basin Wide Investment Plan which will help to supply water to both users in the upstream areas as well as users in adjacent countries including Namibia, South Africa and Botswana. It is important to recognise that any new development in any upstream area will have some impact on the downstream users which must be taken into consideration during the planning process. When many of the previous dams were constructed in the Orange/Senqu basin, there was excess water available in the basin with the result that there was no need to mitigate for the reduced water available in the lower reaches of the Orange/Senqu river. In the past 10 to 20 years, however, the situation has changed, and any new developments can have an impact on the yields available to the downstream users. This in turn creates potential problems which must be identified and quantified to ensure that the water resources are shared in an equitable and reasonable manner.

For each possible future water resource development option, detailed analyses have been undertaken to assess both the maximum gross yield from the proposed project as well as the net yield from a systems context. It must be noted that the difference between the gross and net yields need not be released from the proposed development but must be addressed through some form of mitigation measures which can include, mitigation releases, a new dam lower in the system, the purchase of some existing water rights somewhere in the system, or the recovery of water losses etc. The solution must be carefully considered and evaluated properly in a systematic and pragmatic manner through proper debate and discussion between the four countries involved.

7.2 Scope of Services

This assignment will be undertaken in the following Tasks:

- SA3.1: Inception Report
- SA3.2: Evaluation of existing legislation, conventions and protocols on water sharing to identify those factors and circumstances that must be taken into account for the utilization of an international watercourse in an equitable and reasonable manner;
- SA3.3: Identification of relevant factors to be evaluated for each potential development option identified in the Core Scenario Basin Wide Investment Plan

- SA3.4: Workshop the various development options and key factors using a Balanced Scorecard or Multi Criteria Analysis approach or similar.
- SA3.5: Summarise the results in a final report.

The cost of the proposed is estimated to be $1 million. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalization of the Terms of Reference for the study.

Each of the above tasks will be discussed below where it is described in the following manner:

- Objectives
- Methodology
- Deliverables

7.2.1 SA3.1: Inception Report

The purpose of an Inception Report is to capture important work that would be necessary for the successful completion of this assignment, which may for some reason or another have been overlooked in the compilation of the original Terms of Reference (ToR) or the proposal submitted by the Service Provider during tendering. Omission of this additional work is usually only detected once work on the assignment has started and most of the team members have had time to familiarise themselves with the detailed requirements of the tasks necessary to ensure the successful completion.

The Inception Report is a formal document that will cover all the aspects of the original proposal plus the additions to the scope of work, Contract Amount, Contract Arrangements and Contract Period that may be required. The Inception Report will list all tasks required, all the team members for each task and their time allocation as well as their hourly rates per task, anticipated disbursements, revised study programme, etc. The rates of all new team members need to be approved before they can be engaged. The Inception Report can therefore be considered a revised Technical and Financial Proposal which supersedes and replaces both the original Terms of Reference as well as the original Project Proposal. **All future queries relating to study progress, deliverables and/or budgets should therefore be cross-checked against the Inception Report and not the Terms of Reference or Project Proposal.**

Objectives

The objective of this task is to produce a report which will become the de-facto agreement between ORASECOM and the Project team for the successful execution of the proposed project. This report will become the basis of the proposed project and will supersede both the original TOR and the Project Proposal.

Methodology

- The appointed Service Provider shall within two (2) months of commencement / contract signing produce a detailed assignment inception report. It will be required from the appointed Service Provider to do thorough research and review all the relevant previous studies as well as all the available information relevant to this assignment. It will be necessary to update and maintain a list of such studies and their relevance to this assignment. It will be required to liaise with all relevant stakeholders in preparation for the undertaking of this assignment.
- The Service Provider shall compile an Inception Report that will consist of a detailed description of tasks, a study programme and study budget. The Inception Report will form part of the Contract and stipulate the scope of work for the study, the Contract Amount and the Contract Period which, upon signing of the Contract by both parties, allows
- the Service Provider to start with their work. In it, the Service Provider’s proposal will be discussed with the Client and all aspects and uncertainties will be clarified. It will result in the final Terms of Reference for the study together with the final study cost. These will serve as a basis for all future work on the contract and will be recorded in the Agreement with the Client.

Deliverables

An Inception Report containing agreed:

- Scope of Works
- Methodology
- Deliverables
- Budget
- Programme
- Project Team members
- Involvement of ORASECOM and Basin State members
- Management Processes
- Quality Control Processes

7.2.2 SA3.2: Evaluation of Existing Legislation, Conventions and Protocols on Water Sharing

Objectives

- Identify and examine relevant protocols and agreements on water sharing in SADC and the Orange/Senqu basin.
- Identification of the key protocols and agreements that must be discussed and debated by the basin states when looking into any future water resource development options.

Methodology

- The service provider should gather copies of all existing protocols and water sharing agreements relevant to the SADC region and any specifically related to water sharing in the Orange/Senqu river basin. This should include but not be limited to
  - UN Convention on the Law of the Non-Navigation Uses of International Water Courses;
  - The Revised SADC Protocol on Shared Watercourse Systems in the SADC Community;
  - Convention on the Protection and Use of Transboundary Water Courses and International Lakes, Helsinki 1992;
  - The ORASECOM Agreement;
  - The Treaty on the Lesotho Highlands Water Project between the Government of the Republic of South Africa and the Government of the Kingdom of Lesotho
  - The Memorandum of Agreement between the Government of the Republic of Botswana and the Government of the Kingdom of Lesotho and and the Government of the Republic of South Africa on the Lesotho – Botswana Water Transfer Feasibility Study; and
  - The Ramsar Convention of Wetlands of International Importance Especially as Waterfowl Habitat
- Having collected and examined the relevant agreements, the key factors and circumstances should be established with regards to water sharing in the Orange/Senqu river basin with specific reference to the various potential future water resource development options being considered by the various basin states.

Deliverables

- A report providing a clear and concise explanation of:

- The relevant agreements and protocols that relate to water sharing in the Orange/Senqu river basin
- The key issues that must be discussed and agreed upon by the basin states when considering any future water resource development
- A recommendation of the approach and methodology to be used in future discussions by the basin states on water sharing.

7.2.3 SA3.3: Identification of relevant factors and circumstances to be evaluated for each potential development option identified in the Core Scenario Basin Wide Investment Plan

Objectives

- To evaluate each of the proposed or possible future water resource development options to determine if the proposed developments are likely to have a positive or negative impact on other basin states.
- Where potential negative impacts are identified, the proposed development option shall be analysed in detail to ensure that all factors listed in the legislation are considered.
- To establish a matrix of factors for all relevant development options which can then be discussed during a workshop.

Methodology

The various agreements and protocols will be examined in order to identify the key factors that need to be considered for each proposed future water resource development option. This will require input from both a water resource specialist as well as a water resource specialist with legal experience and expertise.

Deliverables

A report/workshop documentation providing:

- details of the various factors and circumstances that must be investigated as identified from the various Conventions, Protocols and other legal agreements.
- Details of how each of the identified factors will be impacted upon by the proposed or possible future water resource development options
- A summary matrix related to each of the proposed or possible future development options which can be used as the basis for a workshop in which representatives from the four basin states can discuss and debate each factor as it relates to each development option.

7.2.4 SA3.4: Workshop the various development options and key factors and circumstances using a Balanced Scorecard or Multi Criteria Analysis approach or similar.

Objectives

To organise and facilitate a workshop where the four basin states and ORASECOM can discuss and debate the various issues related to water sharing with regards to each of the possible or proposed future water resource development options.

Methodology

- The service provider will identify a suitable venue for a small workshop allowing for three representatives from each basin state and three from ORASECOM. It is anticipated that the workshop can be completed over a 3-day period and that the travel costs and accommodation costs will be included in the project budget plus all meals and coffee's etc.
- The service provider will provide a facilitator and scribe to manage the process and create a detailed report of the discussions and agreements/recommendations.

Deliverables

- A 3-day workshop
- A report summarising the outcomes from the workshop

7.2.5 SA3.5: Summarise the results in a final report

Objectives

A final document summarising the various guidelines for water sharing as agreed between the 4 basin states will be of great value to the future managers of the Orange/Senqu basin. This report should explain the processes involved when assessing any new water resource development option in terms of the existing water sharing legislation as well as any other agreements made between member states. The report will also provide details of the joint assessments undertaken during the workshopping process of each potential future water resource development so that the implications of each development are clearly defined and all agreements between the member countries are explained. This report will form the framework for all future co-operation between the basin states and should be written in such a manner that it can be revised in future should the need arise.

Methodology

The service provider will collect and collate all information from the previous tasks and condense the assessments into a clear and concise document that can be used to determine any actions needed with regards to compensating downstream users related to each new possible future water resource development.

Deliverables

A clear and concise report on the various issues linked to Water Sharing in the Orange-Senqu basin.

7.3 Time-Schedule for Strategic Action 3

It is anticipated that the project will be undertaken over an 18-month period with an expected starting date of August 2026.

7.4 Team Requirements for Strategic Action 3

- **Eligibility** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Composition of the Study Team** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Qualifications/Experience(**To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)

8 STRATEGIC ACTION 4: SYNCHRONISATION AND PREPARATION OF FUTURE AND PLANNED DEVELOPMENTS

8.1 Overview

Based on a number of recent studies, it is clear that there are a large number of recent and proposed future water resource developments in various parts of the Orange/Senqu River Basin. Some of these are planned many years in the future while others are planned for the near future or are already in operation or the construction phase. The proposed recent and near future developments include:

- The dam on the Makhaleng river in Lesotho and the associated transfer scheme,
- The proposed Noordoewer/Vioolsdrift Dam on the Lower Orange River.
- The Polihali Dam which is under construction in Lesotho;
- The recently completed Metolong Dam in Lesotho
- The recently completed Neckartal Dam in Namibia
- Verbeeldingskraal Dam on the upper Orange River in South Africa,
- Hlotse Dam in Lesotho,
- Ngoajane Dam in Lesotho
- as well as other possible hydro-power schemes in Lesotho.

In addition, the potential to supply water to Bloemfontein from a new dam in Lesotho appears to be a viable option that requires some additional investigation. All of these schemes are interlinked, as they are all utilising the same resource, namely the Senqu/Orange River. All of these schemes will impact on each other to some degree, with some of the impacts being significant and others relatively small. Due to the associated impacts, it will not be possible to operate these schemes as stand-alone schemes, and they must therefore be operated and managed as part of the larger system. Results from the Core Scenario analyses already highlight that the operating rules used for each scheme, as well as operating rules between the schemes, significantly impacts on the water supply to the different users, as well as to the overall optimal utilisation of the system as a whole.

It is therefore recommended that a study is commissioned to identify and harmonise the different development options to the benefit of the system as a whole. The proposed study will address the correct sizing of the dams where still required, as well as the operating rules covering the individual dams as well as the system as a whole, including any related compensation or mitigation releases. It is envisaged that the proposed study will focus on the following near future developments:

- Determine the operating rules for Makhaleng Dam users and its compensation/mitigation releases to the possible future Verbeeldingskraal Dam and existing Gariep and Vanderkloof dams, to optimise water availability from these sub-systems and to ensure an equitable utilization and benefit sharing of the resources between the different users. This will depend on the final selected size and maximum transfer volume from Makhaleng Dam, as well as whether another sub-system will be used to support Makhaleng Dam or to release compensation/mitigation requirements on behalf of Makhaleng Dam.
- Determine the required operating rules and procedures for the possible future Noordoewer/Vioolsdrift Dam in relation to Gariep and Vanderkloof dams, as well as for the Environmental Water Requirement (Reserve) releases.
- Determine operating rules for the possible future Hlotse and Ngoajane dam users and their compensation/mitigation releases to users along the Caledon/Mohokare River as well as to the possible future Verbeeldingskraal Dam or the existing Gariep and Vanderkloof dams to optimise water availability from these sub-systems and to ensure an equitable utilisation and benefit sharing of the resources between the different users. This will depend on the final selected size and yield available from the possible future Hlotse and Ngoajane dams as well as whether another sub-system will be used to support the Hlotse and/or Ngoajane dams or to release compensation/mitigation requirements on behalf of these two dams.

It should be noted that the operating rules for the soon to be completed Polihali Dam have already been analysed and are (May 2020) in the process of being finalised. The final agreed operating rules for Polihali Dam need to be confirmed and should be included in this proposed study.

(Strategic Action 1.2.1).

8.2 Scope of Services

This assignment will be undertaken in the following Tasks:

- SA4.1: Inception Report
- SA4.2: Status Quo Assessment
- SA4.3: Identification of Net and Gross Yields for each development option.
- SA4.4: An augmentation study to restore the water balance in the lower Orange River in the event of a new dam on the Makhuleng River.

- SA4.5: Identification and investigation of selected key operating rules
- SA4.6: Preliminary investigation of Legal Agreements (in conjunction with Strategic Action 3)
- SA4.7: Organise and manage workshop to discuss and refine selected key operating rules
- SA4.8: Identification of new monitoring points and gauging sites to facilitate possible new operating rules
- SA4.9: Undertake Annual Operating Analyses with representatives from the 4 Basin States (co-ordinate with possible existing study on this topic).

The cost of the proposed is estimated to be $1 million. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalization of the Terms of Reference for the study.

Each of the above tasks will be discussed below where it is described in the following manner:

- Objectives
- Methodology
- Deliverables

8.2.1 SA4.1: Inception Report

The purpose of an Inception Report is to capture important work that would be necessary for the successful completion of this assignment, which may for some reason or another have been overlooked in the compilation of the original Terms of Reference (ToR) or the proposal submitted by the Service Provider during tendering. Omission of this additional work is usually only detected once work on the assignment has started and most of the team members have had time to familiarise themselves with the detailed requirements of the tasks necessary to ensure the successful completion.

The Inception Report is a formal document that will cover all the aspects of the original proposal plus the additions to the scope of work, Contract Amount, Contract Arrangements and Contract Period that may be required. The Inception Report will list all tasks required, all the team members for each task and their time allocation as well as their hourly rates per task, anticipated disbursements, revised study programme, etc. The rates of all new team members need to be approved before they can be engaged. The Inception Report can therefore be considered a revised Technical and Financial Proposal which supersedes and replaces both the original Terms of Reference as well as the original Project Proposal. **All future queries relating to study progress, deliverables and/or budgets should therefore be cross-checked against the Inception Report and not the Terms of Reference or Project Proposal.**

Objectives

The objective of this task is to produce a report which will become the de-facto agreement between ORASECOM and the Project team for the successful execution of the proposed project. This report will become the basis of the proposed project and will supersede both the original TOR and the Project Proposal.

Methodology

- The appointed Service Provider shall within two (2) months of commencement / contract signing produce a detailed assignment inception report. It will be required from the appointed Service Provider to do thorough research and review all the relevant previous studies as well as all the available information relevant to this assignment. It will be necessary to update and maintain a list of such studies and their relevance to this assignment. It will be required to liaise with all relevant stakeholders in preparation for the undertaking of this assignment.
- The Service Provider shall compile an Inception Report that will consist of a detailed description of tasks, a study programme and study budget. The Inception Report will form part of the Contract and stipulate the scope of work for the study, the Contract Amount and the Contract Period which, upon signing of the Contract by both parties, allows
- The Service Provider to start with their work. In it, the Service Provider’s proposal will be discussed with the Client and all aspects and uncertainties will be clarified. It will result in the final Terms of Reference for the study together with the final study cost. These will serve as a basis for all future work on the contract and will be recorded in the Agreement with the Client.

Deliverables

An Inception Report containing agreed:

- Scope of Works
- Methodology
- Deliverables
- Budget

- Programme
- Project Team members
- Involvement of ORASECOM and Basin State members
- Management Processes
- Quality Control Processes

8.2.2 SA4.2: Status Quo Assessment

Objectives

To determine the latest new and possible future developments in the Orange/Senqu basin, including implementation dates.

Methodology

- Discuss with representatives of the 4 Basin States to obtain information on all new and proposed future developments. This will include details of commissioning dates, reservoir sizes and yields, any associated infrastructure or developments utilising the water, water users, water demand projections
- The agreed Core Scenario from the Climate Resilience Water Resources Strategy and Investment Plan should be used as the point of departure.

Deliverables

A Status Quo Report

8.2.3 SA4.3: Identification of Net and Gross Yields for each development option

Objectives

To collect and collate net and gross yield values for all recent and possible future development options. The agreed Core Scenario from the Climate Resilience Water Resources Strategy and Investment Plan should be used as the point of departure.

Methodology

- The existing Yield and Planning models should be used in conjunction with the agreed Core Scenario from the Climate Resilience Water Resources Strategy and Investment Plan should be used as the point of departure.
- Where necessary the models will be used to calculate and/or confirm the net and gross yield values for the various new and possible future developments.

- Discussions will be held with ORASECOM and representatives from the 4 basin states to identify any new developments that are not listed in the current Lesotho-Botswana Transfer Project assessment.

Deliverables

A summary document providing the results from the analyses of the gross and net yield results. The report must include full details of the system configurations and operating rules used in the analyses.

8.2.4 SA4.4: An augmentation study to restore the water balance in the lower Orange River in the event of a new dam on the Makhuleng River.

Objectives

To consider various options in order to restore the water balance to the Orange River Project in the event that a new dam is commissioned on the Makhuleng River in Lesotho.

Methodology

- The existing Yield and Planning models should be used in conjunction with the agreed Core Scenario from the Climate Resilience Water Resources Strategy to analyse various possible augmentation options to redress the reduction in yield experienced by the Orange River Project if a new dam is developed on the Makhuleng River in Lesotho.
- Various possible development options should be discussed with ORASECOM and the representatives from the Basin States which can be considered such as the proposed new dam at Verbeeldingskraal or at Noordoewer/Vioolsdrift etc. The possible options should be agreed before any system analyses are undertaken

Deliverables

A short report outlining the possible options and the results from the system analyses should be prepared.

8.2.5 SA4.5: Identification and investigation of selected key operating rules

Objectives

- To identify the most important operating rules that influence water allocation in the Orange-Senqu basin.
- To analyse the operating rules and suggest changes that can improve water use efficiency.

Methodology

- Discussions will be held with ORASECOM and representatives from the 4 Basin States to agree on the key operating rules and systems that are of significant in the allocation of water resources throughout the Orange-Senqu basin.
- Analyse the various operating rules previously identified to try to improve water allocation efficiency. The Yield and Planning Models should be used to analyse the various systems and operating rules. The latest existing Yield and Planning Model data sets should be obtained from ORASECOM and used in the analyses.

Deliverables

- Updated models as used in the analyses (Yield and Planning)
- A condensed summary of the results that will form a chapter (or Appendix) in the final report.

8.2.6 SA4.6: Preliminary investigation of Legal Agreements (in conjunction with Strategic Action 3)

Objectives

- To highlight key legal problem issues with water transfers in the Orange-Senqu basin
- To investigate the current legal status for the above-mentioned issues
- To suggest measures to improve the key legal problem issues with some water transfers

Methodology

With specialist support of a Legal Expert on water law:

- Identify key problem issues associated with the operating rules that exist due to current legal agreements between member states.
- Liaise and co-ordinate with the associated Strategic Action 3 on the Guidelines for Sharing of water basin-wide.
- Identify potential future problem issues associated with possible future operating rules that may occur if the future legal agreements are not correctly structured.
- Make recommendations to address the identified problem issues.

Deliverables

- Summary document highlighting possible legal problems associated with current and proposed future operating rules.
- Recommendations on how to best address the problem issues.

8.2.7 SA4.7: Organise and Manage Workshop to Discuss and Refine Selected Key Operating Rules

Objectives

To identify new operating rules for key reservoirs to optimise the use of water and assist in developing Climate Resilience.

Methodology

Organise and facilitate a workshop with ORASECOM and representatives from the 4 basin states to discuss previously identified problem issues with the existing operating rules. The service provider will identify a suitable venue for a small workshop allowing for three representatives from each basin state and three from ORASECOM. It is anticipated that the workshop can be completed over a 3-day period and that the travel costs and accommodation costs will be included in the project budget plus all meals and coffee’s etc.

Deliverables

- A 3-day workshop attended by representatives of the 4 Basin States and ORASECOM
- A guideline document from the Workshop to assist the 4 Basin States in the operation of their key reservoirs to the benefit of the whole river basin.

8.2.8 SA4.8: Identification of new monitoring points and gauging sites to facilitate possible new operating rules

Objectives

Any new dams will require some form of streamflow monitoring to measure releases from the dam. It is important to plan for such monitoring and this may require the construction of new weirs which are expensive. If weirs are not possible, then it is necessary to identify and calibrate rated river sections and the sooner this process is started the better as it can take years to build up a calibrated Discharge Table for a new river section. This requires specialist technical input from an experienced hydraulic river modeller.

Methodology

Through the use of an expert on river streamflow gauging in association with a resource system modeller, undertake investigations on possible new gauging sites required to support new and proposed future developments and related operating rules.

Deliverables

A list of recommendations for future gauging points and/or needs for new monitoring equipment.

8.2.9 SA4.9: Undertake Annual Operating Analyses with representatives from the 4 Basin States.

Objectives

- To assist members from each of the 4 Basin States to undertake the Annual Operating Analyses.
- To incorporate the new agreed operating rules into the system models to be used in the annual operating analyses.

Methodology

- Review progress on current training initiative to provide training on the Annual Operating Analyses through ORASECOM. Identify any shortcoming and problem issues to ensure that they can be addressed through subsequent training initiatives.
- Organise the venue and catering for one Annual Operating Analyses training event which will incorporate the Annual Operating Analysis undertaken by South Africa and include the latest operating rules and involve representatives from all 4 Basin States. The service provider will identify a suitable venue for the event, allowing for three representatives from each basin state and three from ORASECOM. It is anticipated that the event can be completed over a 3-day period and that the travel costs and accommodation costs will be included in the project budget plus all meals and coffee's etc. The country in which the event will be hosted will be agreed with ORASECOM during the Inception Phase of the project.
- The travel and subsistence costs for all delegates should be included in the budget as a lump sum. This project will provide the inaugural event which can later be taken over by ORASECOM to provide Annual Operating Analyses.
- Prepare feedback forms together with ORASECOM so that the event can be rated by the participants.

Deliverables

- A training workshop in June or July at end of the project.
- Completed feedback forms from all delegates on the effectiveness of the training events.

8.3 Time-Schedule for Strategic Action 4

It is anticipated that the project will be undertaken over a 36-month period with an expected starting date of August 2024.

8.4 Team Requirements for Strategic Action 4

- **Eligibility** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Composition of the Study Team** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Qualifications/Experience(**To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)

9 STRATEGIC ACTION 5: IMPLEMENTATION AND MONITORING OF WATER DEMAND MANAGEMENT ACTIVITIES

9.1 Overview

Water Conservation and Water Demand Management have been identified as important components of all future water resource assessments throughout the Orange /Senqu River Basin. The impact of Water Conservation/ Water Demand Management can be very significant in many areas where water losses are known to be high and can sometimes be in the order of 30% to 40% of the total municipal water demand. Reducing such water losses is not easy, and cannot be implemented overnight, but with proper support both financially and technically, it will be possible to achieve significant savings, which in turn will have a significant impact on the overall water balance in the Orange/Senqu River Basin.

Results from the WRPM Core Scenario analyses highlighted that failure to successfully implement the Water Conservation/ Water Demand Management interventions will result in significant deficits in water supply in the main water supply systems within the Orange/Senqu basin. This will include all users, irrigation, industry and urban.

A study is therefore recommended to set up a system to identify the key focus areas for Water Conservation/ Water Demand Management throughout the Orange/Senqu River Basin and to ensure that the related actions are implemented successfully and maintained over time.

(Strategic Action 1.2.3 & 1.2.4)

9.2 Scope of Services

This assignment will be undertaken in the following Tasks:

- SA5.1: Inception Report
- SA5.2: Status Quo Assessment (check what docs are already available in public domain)
- SA5.3: Identification and collection of data on real case studies
- SA5.4: Create a template report/framework for implementing and monitoring an agricultural Water Demand Management project
- SA5.5: Create a template report/framework for implementing and monitoring a Municipal/Industrial Water Demand Management project
- SA5.6: Develop an inventory of Water Conservation/ Water Demand Management initiatives and prioritise them for implementation basin-wide.

- SA5.7: Organise a conference in one of the basin states to discuss and disseminate info on Water Conservation/ Water Demand Management with impacts of Climate Change.
- SA5.8: Selection of 2 Agricultural (SA and Namibia) and 4 Industrial/Municipal (one in each country) case studies for future monitoring and assessment
- SA5.9: Assess impacts of Climate change on future Water Conservation/ Water Demand Management activities.
- SA5.10: Create monitoring and auditing dashboard

The cost of the proposed is estimated to be $1 million. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalisation of the Terms of Reference for the study.

Each of the above tasks will be discussed below where it is described in the following manner:

- Objectives
- Methodology
- Deliverables

9.2.1 SA5.1: Inception Report

The purpose of an Inception Report is to capture important work that would be necessary for the successful completion of this assignment, which may for some reason or another have been overlooked in the compilation of the original Terms of Reference (ToR) or the proposal submitted by the Service Provider during tendering. Omission of this additional work is usually only detected once work on the assignment has started and most of the team members have had time to familiarise themselves with the detailed requirements of the tasks necessary to ensure the successful completion.

The Inception Report is a formal document that will cover all the aspects of the original proposal plus the additions to the scope of work, Contract Amount, Contract Arrangements and Contract Period that may be required. The Inception Report will list all tasks required, all the team members for each task and their time allocation as well as their hourly rates per task, anticipated disbursements, revised study programme, etc. The rates of all new team members need to be approved before they can be engaged. The Inception Report can therefore be considered a revised Technical and Financial Proposal which supersedes and replaces both the original Terms of Reference as well as the original Project Proposal. **All future queries relating to study progress, deliverables and/or budgets should therefore be cross-checked against the Inception Report and not the Terms of Reference or Project Proposal.**

Objectives

The objective of this task is to produce a report which will become the de-facto agreement between ORASECOM and the Project team for the successful execution of the proposed project. This report will become the basis of the proposed project and will supersede both the original Terms of Reference and the Project Proposal.

Methodology

- The appointed Service Provider shall within two (2) months of commencement / contract signing produce a detailed assignment inception report. It will be required from the appointed Service Provider to do thorough research and review all the relevant previous studies as well as all the available information relevant to this assignment. It will be necessary to update and maintain a list of such studies and their relevance to this assignment. It will be required to liaise with all relevant stakeholders in preparation for the undertaking of this assignment.
- The Service Provider shall compile an Inception Report that will consist of a detailed description of tasks, a study programme and study budget. The Inception Report will form part of the Contract and stipulate the scope of work for the study, the Contract Amount and the Contract Period which, upon signing of the Contract by both parties, allows
- the Service Provider to start with their work. In it, the Service Provider's proposal will be discussed with the Client and all aspects and uncertainties will be clarified. It will result in the final Terms of Reference for the study together with the final study cost. These will serve as a basis for all future work on the contract and will be recorded in the Agreement with the Client.

Deliverables

An Inception Report containing agreed:

- Scope of Works
- Methodology
- Deliverables
- Budget

- Programme
- Project Team members
- Involvement of ORASECOM and Basin State members
- Management Processes
- Quality Control Processes

9.2.2 SA5.2: Status Quo Assessment

Objectives

- To identify the key areas where Water Demand Management interventions can have a significant impact on the water demands in each basin state and to provide an estimate of the potential savings that can be achieved based on realistic targets.
- To identify water demand management and water conservation projects that have been undertaken in the 4 basin states that can be used as case studies to demonstrate what can be achieved and how such projects can be implemented.
- To provide recommendations on where effort and resources should be directed in order to encourage future water savings projects in each basin state.
- To identify specific interventions and projects in each country which should be undertaken in future to reduce water losses or increase water use efficiency.
- To identify and highlight problem issues in each country which may be delaying or hindering the implementation of new Water Conservation/ Water Demand Management projects such as the legal frameworks, availability of funding, availability of expertise required to implement and/or audit such projects.

Methodology

- The main water demands should be summarised for each part of the Orange-Senqu basin to help identify which Water Conservation/ Water Demand Management interventions can be considered in each area. For example, industrial/domestic interventions will be most appropriate in the major urban centres while irrigation efficiency measures will be most appropriate in the huge irrigation schemes long the lower Vaal and Lower Orange areas.
- Selected Water Conservation/ Water Demand Management case studies and/or successfully implemented projects should be identified through discussions with representatives from the 4 basin states to ensure that projects in each country are considered where appropriate.

- Through examination of the various Water Conservation/ Water Demand Management projects, a list of possible interventions can be prepared which represent successful Water Conservation/ Water Demand Management measures that should be considered in future as a means of reducing water consumption and/or wastage.
- A list of proposed activities should be developed which can help to advise the 4 basin states on what they should try to implement in order to achieve water savings in each state. The recommendations should include details of the expertise and funding required for such projects as well as potential sources of funding in cases where external funding will be required. Issues such as Performance Based Contracts and Public Private Partnerships should be considered.

Deliverables

A Status Quo report summarising the various issues discussed above.

9.2.3 SA5.3: Identification and Collection of Data on Case Studies

Objectives

- To identify various Water Conservation/ Water Demand Management projects that have been undertaken in each country and summarise the projects in a simple format that provides a clear and concise overview of the project, its cost and the resulting water savings achieved. To limit the scope of this task it is proposed that 3 projects from each country will be selected. If three suitable projects cannot be found in each country then a total of 12 projects from the region should be identified and evaluated. The projects must cover the key sectors of agricultural, industrial, and commercial/municipal.
- In cases where innovative funding models have been developed, these should be identified and evaluated in order to assess the potential for replication such models in the different countries.

Methodology

- Papers and reports on Water Conservation/ Water Demand Management in each of the basin states will be sourced and evaluated to identify successful case studies that can be replicated elsewhere in the Orange-Senqu basin. The various funding models used to undertake the projects should be evaluated to provide useful reference for possible future projects.

- Discussions with representatives from the relevant government department in each of the 4 basin states will be held to establish what efforts are being undertaken or have been undertaken in the past to try and introduce Water Conservation/ Water Demand Management. Similar discussions with recognised water loss specialists in the region can help to identify suitable projects and relevant case studies that can be used to develop the proposed Water Conservation/ Water Demand Management framework.

Deliverables

- A short report providing 12 relevant case studies where some form of Water Conservation/ Water Demand Management has been implemented and has achieved some level of water savings which can be replicated in other parts of the Orange-Senqu basin.

9.2.4 SA5.4: Create Framework for Implementing and Monitoring an Agricultural Water Demand Management project

Objectives

From the evaluation of several agricultural Water Conservation/ Water Demand Management projects identified and described in the previous task, it is envisaged that a framework for implementing and funding such projects can be developed. Such a framework will include issues such as the project development, project financing and project implementation and monitoring/auditing of savings.

Methodology

- Based on the various agricultural Water Conservation/ Water Demand Management projects that were identified and examined under the previous task, a framework will be developed which is basically a standard procedures manual for the implementation of such projects in future. The framework will comprise a report that provides details of how a Water Conservation/ Water Demand Management project can be formulated and implemented in the agricultural sector. The document will provide a guide on how such a project should be managed and monitored so that it can be properly evaluated to demonstrate the actual benefits achieved from the interventions.
- One of the most important aspects of any Water Conservation/ Water Demand Management project is the monitoring and assessment of the water savings achieved as a result of the interventions implemented as part of the project. A proper monitoring and auditing system is required for such projects and this should be properly described

in the framework document. Without a proper auditing system, the results from the project may be considered unreliable or even fictitious.

Deliverables

- A document providing a framework that can be used to formulate, implement and evaluate a Water Conservation/ Water Demand Management project in the agricultural sector.
- Details of the necessary monitoring systems and auditing procedures to ensure that the water savings can be assessed effectively and accurately.

9.2.5 SA5.5: Create a Framework for Implementing and Monitoring a Municipal/Industrial WDM project

Objectives

From the evaluation of the municipal and industrial Water Conservation/ Water Demand Management projects identified and described in the previous task, it is envisaged that a framework for implementing and funding such projects can be developed. Such a framework will include issues such as the project development, project financing and project implementation and monitoring/auditing of savings.

Methodology

- Based on the various industrial and municipal Water Conservation/ Water Demand Management projects that were identified and examined under the previous task, a framework will be developed which is basically a standard procedures manual for the implementation of such projects in future. The framework will comprise a report that provides details of how a Water Conservation/ Water Demand Management project can be formulated and implemented in the industrial and municipal sectors. The document will provide a guide on how such a project should be managed and monitored so that it can be properly evaluated to demonstrate the actual benefits achieved from the interventions.
- One of the most important aspects of any Water Conservation/ Water Demand Management project is the monitoring and assessment of the water savings achieved as a result of the interventions implemented as part of the project. A proper monitoring and auditing system is required for such projects and this should be properly described in the framework document. Without a proper auditing system, the results from the project may be considered unreliable or even fictitious.

- In the case of industrial and municipal Water Conservation/ Water Demand Management interventions, there is often scope to consider some form of performance based public private partnerships. This relatively new form of project financing is becoming very popular and is being proposed as a solution to the funding problems facing so many municipalities around the world. Special attention to the funding mechanisms should be provided during this task to ensure that the issue is addressed as part of the project.

Deliverables

- A document providing a framework that can be used to formulate, implement and evaluate a Water Conservation/ Water Demand Management project in the agricultural sector.
- Details of the necessary monitoring systems and auditing procedures to ensure that the water savings can be assessed effectively and accurately.
- Details of possible funding models for the Water Conservation/ Water Demand Management activities where issues such as performance-based projects and public private partnerships are considered.

9.2.6 SA5.6: Develop an inventory of WC/WDM initiatives

Objectives

- To collate the experiences from the many case studies that have been investigated under this task and create an inventory of the most promising interventions that can be considered.
- For each initiative, the key issues, both positive and negative should be identified so that they can be considered by future water service providers who may be considering adopting them in future. Issues that can be considered may include: leak detection and repair, pipe repair or replacement, pressure management, internal plumbing repair projects, schools repair projects, education and awareness, water-wise gardening practices, continuous monitoring of water use, rising block tariffs, etc .

Methodology

- Through discussions with representative from the 4 basin states as well as with WC/WDM specialists in the study area, details from a selection of Water Conservation/ Water Demand Management projects should be collected and collated in order to provide a comprehensive list of projects which can help to motivate and direct future efforts in Water Conservation/ Water Demand Management. Details should include the costs of implementation as well as the value of the savings achieved in order to try and provide some estimate of the cost per m3 saved. In this manner the different interventions can be compared to some degree if the costs and savings are taken to a standard base year.

- Various documents and reports can be examined that summarise Water Conservation/ Water Demand Management projects that have been implemented in the basin if they provide sufficient detail to verify that they have in fact been successfully implemented and can therefore be used as case studies to motivate future Water Conservation/ Water Demand Management efforts.

Deliverables

- A summary report providing information on various Water Conservation/ Water Demand Management projects that have been successfully completed in the Orange-Senqu basin that can be used to motivate and encourage similar projects in future.
- A set of 10 "Water Conservation/ Water Demand Management" project sheets that can be branded under the ORASECOM banner and given out to member states and other organisations to help promote Water Conservation/ Water Demand Management in the basin. The sheets may be consolidated into a small "glossy" booklet that can be distributed by ORASECOM and the budget should allow for 200 copies.

9.2.7 SA5.7: Organise conference on Water Conservation/ Water Demand Management and Impacts of Climate Change

Objectives

- To organise and co-ordinate a conference on Water Conservation/ Water Demand Management in the Orange-Senqu basin which can assist in drawing together water service providers and water consumers to ensure that Water Conservation/ Water Demand Management becomes a key focus area in the basin.
- To encourage recognised water loss management specialists to participate in the event to ensure that it is both relevant and useful.

Methodology

- Identify suitable conference venues for a Water Conservation/ Water Demand Management conference to be run under the ORASECOM banner with support from the governments of the four basin states. It may be possible to co-operate with some existing event such as the recent International Water Association or South African Association of Civil Engineering American Institution of Civil Engineering or Development Bank of Southern Africa events which already have a track record and may be willing to co-operate with ORASECOM for such a joint venture.

- Agree on the programme and select the speakers to present at the conference
- The proceedings should be recorded using a suitable methodology so that each presentation can be captured for future viewing using a combination of Powerpoint presentations and some form of video system such as zoom or similar.
- The presentations should be professionally edited and prepared so that they can be distributed through ORASECOM for training purposes as well as helping to create awareness on how Water Conservation/ Water Demand Management can be improved in the Orange-Senqu basin.

Deliverables

- A 2-day conference somewhere in the Orange-Senqu basin
- A high-quality programme with some recognised water loss specialists to ensure that the presentations are relevant, and well presented on the subject of Water Conservation/ Water Demand Management
- A set of professional videos that can be viewed in future by all water service providers or water consumers in the Orange-Senqu basin.
- A conference report that can be published in a suitable journal summarising the key issues addressed during the conference. This report should be condensed into a 4-page high quality "booklet" that can be given out by ORASECOM at various events.

9.2.8 SA5.8: Selection of 2 Agricultural (SA and Namibia) and 4 Industrial/Municipal (one in each country) case studies for future monitoring and assessment

Objectives

- In order to try to encourage Water Conservation/ Water Demand Management throughout the Orange-Senqu basin, it is envisaged that the study will identify specific opportunities in the different water sectors where new Water Conservation/ Water Demand Management activities can be undertaken. While it is accepted that ORASECOM cannot take responsibility for the funding, implementation and maintenance of such projects in the basin, it can help to identify such projects and help to encourage them through a facilitation and monitoring role which may also include the auditing of the savings and dissemination of the results in the form of case study brochures.

Methodology

- It is proposed that 6 new Water Conservation/ Water Demand Management projects are identified that will be "adopted" in some manner by Orasecom. These projects will include two agricultural projects (one each in Namibia and South Africa) and four municipal or industrial projects with one in each basin state.
- Having identified the projects, the project team will help to design and implement the monitoring and auditing processes necessary to ensure that the resulting savings can be evaluated accurately and effectively over the duration of the project.
- Case study sheets should be produced for selected projects with permission of the relevant organisations (some may prefer to keep information confidential) so that successful projects can be used to encourage other similar projects elsewhere in the Orange -Senqu basin.

Deliverables

- A short summary report providing details of 6 Water Conservation/ Water Demand Management projects that will be "adopted" by ORASECOM as potential case study projects that demonstrate how Water Conservation/ Water Demand Management can be implemented in the Orange-Senqu basin in order to save water and/or improve water use efficiency.
- Recommendations on monitoring and auditing systems for selected Water Conservation/ Water Demand Management projects so that the savings can be quantified and properly verified in a clear and systematic manner that eliminates debate and confusion on what the particular project has achieved.
- Development of an agreed number of case study sheets which can be used to disseminate the information on various selected Water Conservation/ Water Demand Management projects which were successfully implemented and demonstrate how water savings can be achieved.

9.2.9 SA5.9: Assess impacts of Climate change on future WC/WDM activities

Objectives

- Global warming and Climate Change are known to be influencing the flood and drought events which occur as part of the natural water cycle in every country worldwide. While it is generally agreed that floods and droughts will become more severe in future, the actions needed to mitigate the impacts are less obvious. A key element of the proposed project is therefore to identify practical Water Conservation/ Water Demand Management measures that can be considered under the "Climate Resilience" efforts in the region. Significant financial support for Climate Resilience is available throughout Southern Africa for projects and interventions that can be presented in the appropriate format and with the appropriate motivation. The main purpose of this sub-task is therefore to identify specific issues and or projects and to package them into an appropriate format where they can be offered to the various funding organisations for consideration under the Climate Resilience "banner".

Methodology

- Identify specific WC/WDM projects that can be considered as "Climate Resilience" interventions of some nature. The contribution to Climate Resilience must be clearly defined so that the projects can be funded from available funding allocated to this key issue.
- Agree with selected organisations on the format that such Climate Resilience projects must take so that they can be packaged into the correct structure for consideration by the funding organisations.

Deliverables

- A list of possible Water Conservation/ Water Demand Management projects that can be considered for funding under the Climate Resilience "banner".
- Documentation for the selected projects in the format required by the potential funding organisations so that the projects can be submitted by ORASECOM for consideration by the funders.

9.2.10 SA5.10: Create monitoring and auditing dashboard

Objectives

A key problem with many Water Conservation/ Water Demand Management projects is the lack of reliable data concerning the implementation costs of a project as well as the short and long-term savings achieved by the project. It is therefore important to capture as much information as possible of selected Water Conservation/ Water Demand Management projects so that it can be used in future to either promote more projects of a similar nature or to highlight deficiencies in such projects so that they cn be improved or cancelled if appropriate. It is therefore considered useful to develop a proper monitoring system to capture information on the savings being achieved as well as a proper auditing system to ensure that the figures being quoted are in fact realistic and reliable.

Methodology

- ORASECOM is not a funding agency and cannot provide funding of any proposed Water Conservation/Water Demand Management activities being proposed in the Orange-Senqu basin. It can, however, provide some high-level support for such activities in the form of an independent reviewer where it collects and processes data from various Water Conservation/ Water Demand Management projects in order to monitor the success of the project and to provide an unbiased assessment of the savings.

Deliverables

A simple software application should be developed that can be used to keep track of savings achieved from different Water Conservation/ Water Demand Management interventions in the basin. It should be relatively simple in design and provide a "running-total" of savings for each project included in the data-base as well as an overall annual total for the combined projects each year.

9.3 Time-Schedule for Strategic Action 5

It is anticipated that the project will be undertaken over a 36-month period with an expected starting date of August 2025.

9.4 Team Requirements for Strategic Action 5

- **Eligibility** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Composition of the Study Team** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Qualifications/Experience(**To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)

10 STRATEGIC ACTION 6: ASSURANCE OF SUPPLY AND ECONOMIC VALUE OF WATER

10.1 Overview

In most parts of the world the water resources in a river basin are distributed by simply cutting up the available historical system yield as required, to meet the various demands. Water is often utilised by the demand centres highest up in the river basin and those lower down in the system often experience shortages during periods of drought. As the demands increase due to population growth and the droughts become more severe due to the impacts of global warming, the water supply situation in many river basins is deteriorating and will continue to do so without proper agreements and management. The issue of assurance of supply is seldom discussed and rarely, if ever, taking into account when the available water resources are allocated. The problem is compounded in many parts of the world where the available water resources were estimated using outdated techniques which leads to legal allocations that exceed the firm yields of the systems which themselves are reducing over time due to the impacts of developments and global warming.

South Africa was one of the first countries in the world to develop and use risk-based water allocations based on the “assurance of supply” concepts developed by the USA, Canada, South Africa, and the UK during the 1980’s and 1990’s. These same techniques have been adopted by many countries around the world and in particular in the SADC region of Africa where they form the backbone of water planning and water resource management in Southern Africa. The system models are used to assess and allocate the available resources to the different users based not only on the historical firm yield of each system but also on the assurance of supply which is derived from the system models and the use of stochastically generated streamflow sequences. This approach to water management has proven itself to be very robust and a valuable tool for operation and managing some of the most complicated water resource systems in the world. It has also helped to address the possible likely future impacts of global warming and is a key tool in the Climate Adaptation process where water planners must try to anticipate the impacts of climate change and how to manage their water systems during periods of extreme drought.

Despite the obvious benefits of the assurance of supply-based models available to the 4 basin states, it is currently clear that none of the basin states currently applies the assurance of supply on the same basis. Some counties only use the assurance of supply during the planning and designing stage of water supply schemes, but not at all during the management and operation of these schemes. In some cases, users, in particular irrigation, are supplied at a too high assurance. Supplying these users at a lower assurance is one of the many issues that must be investigated as it is without doubt a necessary action that will be required in future as the available water resources within the Orange/Senqu basin become stressed due to the increasing demands for water which will be exacerbated by climate change. As an example, the 95% assured yield of the Oanob Dam in Namibia is 3.6 million m^3/a and the 80% assured yield is 4.7 million. An increase of 30%. The Basin States must discuss this issue to determine what level of assurance is affordable in each case so that the available water can be used optimally to the benefit of each country. In some cases, it may be decided to accept a lower level of assurance and abstract at a higher rate which will result in greater need to manage the supply and restriction measures during dry periods.

Strategic Action 1.2.1 & 2.2.3)

When assessing the assurance of supply to the various users in the Orange/Senqu basin it is also important to recognise the “value of water” at different points in the basin. This is a highly contentious issue as value can be expressed in various terms such as monetary, social, environmental and even political. While this proposed project is not aimed at covering the social, environmental and political costs, it is considered useful to look at the monetary value of water due to the highly skewed costs that are currently applied across the basin. This information will help the decision makers to understand the different factors which lead to the skewed cost of water at different parts of the basin.

10.2 Scope of Services

Overview

This assignment will be undertaken in the following Tasks:

- SA6.1: Inception Report
- SA6.2: Status Quo Assessment
- SA6.3: Agree on a standard approach regarding assurance of supply (stand-alone schemes and integrated systems) throughout the Orange-Senqu basin
- SA6.4: Assess the economic impact of the Assurance of Supply (refer to WRC project)
- SA6.5: Provide training on the concepts of assurance of supply
- SA6.6: Agree on how restrictions will be determined and applied during drought periods throughout the Orange-Senqu basin
- SA6.7: Agree on drought emergency measures for all stand-alone schemes so that the measures tie in with those that will be applied to the overall system

The cost of the proposed is estimated to be $1 million. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalization of the TOR for the study.

Each of the above tasks will be discussed below where it is described in the following manner:

- Objectives
- Methodology
- Deliverables

10.2.1 SA6.1: Inception Report

The purpose of an Inception Report is to capture important work that would be necessary for the successful completion of this assignment, which may for some reason or another have been overlooked in the compilation of the original Terms of Reference (ToR) or the proposal submitted by the Service Provider during tendering. Omission of this additional work is usually only detected once work on the assignment has started and most of the team members have had time to familiarise themselves with the detailed requirements of the tasks necessary to ensure the successful completion.

The Inception Report is a formal document that will cover all the aspects of the original proposal plus the additions to the scope of work, Contract Amount, Contract Arrangements and Contract Period that may be required. The Inception Report will list all tasks required, all the team members for each task and their time allocation as well as their hourly rates per task, anticipated disbursements, revised study programme, etc. The rates of all new team members need to be approved before they can be engaged. The Inception Report can therefore be considered a revised Technical and Financial Proposal which supersedes and replaces both the original Terms of Reference as well as the original Project Proposal. **All future queries relating to study progress, deliverables and/or budgets should therefore be cross-checked against the Inception Report and not the Terms of Reference or Project Proposal.**

Objectives

The objective of this task is to produce a report which will become the de-facto agreement between ORASECOM and the Project team for the successful execution of the proposed project. This report will become the basis of the proposed project and will supersede both the original Terms of Reference and the Project Proposal.

Methodology

- The appointed Service Provider shall within two (2) months of commencement / contract signing produce a detailed assignment inception report. It will be required from the appointed Service Provider to do thorough research and review all the relevant previous studies as well as all the available information relevant to this assignment. It will be necessary to update and maintain a list of such studies and their relevance to this assignment. It will be required to liaise with all relevant stakeholders in preparation for the undertaking of this assignment.
- The Service Provider shall compile an Inception Report that will consist of a detailed description of tasks, a study programme and study budget. The Inception Report will form part of the Contract and stipulate the scope of work for the study, the Contract Amount and the Contract Period which, upon signing of the Contract by both parties, allows
- The Service Provider to start with their work. In it, the Service Provider’s proposal will be discussed with the Client and all aspects and uncertainties will be clarified. It will result in the final Terms of Reference for the study together with the final study cost. These will serve as a basis for all future work on the contract and will be recorded in the Agreement with the Client.

Deliverables

An Inception Report containing agreed:

- Scope of Works
- Methodology
- Deliverables
- Budget
- Programme
- Project Team members
- Involvement of ORASECOM and Basin State members
- Management Processes
- Quality Control Processes

10.2.2 SA6.2: Status Quo Assessment

Objectives

- Determine how each country allocates water to users
- Determine what tariffs are being applied by the key water service providers.

Methodology

- In order to assess how each country is allocating water to different users it will be necessary to enter into discussions with the relevant organisations in each country. This should include the national water departments as well as the main providers of potable and raw water in each country.
- The water charges being applied in each country should be collected and collated into a clear and concise report. In order to compare the costs between the different countries it will be important to differentiate between raw water and potable water as well as the sector to which the rates apply i.e. agricultural irrigation, industrial and municipal etc. Where possible the different rates should be obtained from the Government Departments, Water Boards and Municipalities since each is responsible for different elements of the supply

Deliverables

- A short report providing the processes used in each country to allocate water to the various demand centres with special attention paid to any use of the “assurance of supply” in the allocations.
- A short report outlining the average water tariffs across the different sectors of the economy (i.e. agriculture, industrial/municipal and domestic).

10.2.3 SA6.3: Agree on a standard approach regarding assurance of supply (stand-alone schemes and integrated systems) throughout the Orange-Senqu basin

Objectives

- To gain consensus from the four basin states on how the concepts of “assurance of supply” should be applied throughout the Orange/Senqu basin to avoid possible supply problems during periods of drought.
- To create a simple and user-friendly tool that can assist the basin states when allocating water to users so that there is consistency in the allocation approach across the basin.

Methodology

- A workshop will be required to bring representatives from the four countries together during which the status quo in each country with regard to water allocation will first be discussed. The concepts of risk-based water allocation can then be discussed and finally some form of agreement should be obtained regarding how water is allocated across the different sectors in the Orange/Senqu basin. The aim of this process is to avoid situations where similar users are supplied with water at different levels of assurance due to differences in allocation procedures between the countries. Ideally, a consistent approach should be developed which will avoid some problems during drought periods. ORASECOM can play an important role in this process since it is effectively a neutral partner with the sole aim of ensuring fairness and cooperation between the basin states on water matters.
- A small software model or computer APP should be developed which can assist the water suppliers when allocating water to their users so that there is a clear understanding of what is being supplied at what level of assurance. For example it is important for suppliers and users to understand that 10 million m3 of water per annum supplied to irrigation at an assurance of 80% is not the same as 10 million m3 of water supplied to an industrial user at 95% assurance. Low level assurance water will typically be supplied at a lower tariff than water at high assurance of supply. One aim of this tool will be to demonstrate to farmers that they may find it beneficial to select a higher allocation at a low level of assurance over a smaller allocation at a higher level of assurance which would be more applicable to an industrial user. Industrial users typically pay up to R100/m3 for their water while irrigators tend to operate in the R0.50/m3 price range.

Deliverables

- A document summarising an agreed approach to water allocation across the four countries in the Orange/Senqu basin.
- A small and relatively simple model or tool that will assist both water suppliers and water users to understand the balance between the quantity of water supplied and the risk of failure of the supply.

10.2.4 SA6.4: Assess the economic impact of the Assurance of Supply (refer to WRC project)

Objectives

- It is often stated that agriculture can become more efficient if it can use water saving irrigation practices. For example, drip irrigation in place of centre pivot or possibly centre pivot rather than flood irrigation. It is often suggested that large savings can be achieved if farmers can be persuaded to reduce their use. Unfortunately, the situation is rarely clear cut and along the lower Orange River, the irrigators in South Africa and Namibia are often operating under very difficult conditions and have already tailored their irrigation practices to suit local conditions. There is always scope for improvement but it is usually not cheap to implement and sometimes the more efficient practices are not viable due to soil conditions and local drainage etc. In this sub task, the emphasis is on the level of assurance of supply that is provided to the irrigators. The aim of the assessment is to determine whether or not it is feasible to reduce the assurance of supply to irrigators and in return provide higher allocations during periods when the system is full and reducing their allocations during periods of drought. The aim of the assessment is to determine if such an allocation process can help farmers to generate greater income and at the same time protecting the key industrial/municipal users during droughts.

Methodology

- The various system models are already set up to supply every user in the system at a specific level of assurance. It is therefore relatively simple and straightforward to change the assurance of supply to specific users and rerun the models to assess the likely impacts that such changes will create. In this manner it will be possible to assess the overall water supplied to the irrigators and the extent of the shortfalls experienced during the drought periods. The existing planning models used throughout the Orange-Senqu basin are designed for such assessments and it is anticipated that they can help to identify the most appropriate and financially viable blend of quantity and reliability of supply to irrigators. A recent study by the Water Research Commission on this issue can provide useful background information and some useful initial findings on this topic.

Deliverables

- A report summarising the key results from the analyses undertaken to assess the likely impacts of reducing the assurance of supply and increasing the volume supplied for certain irrigation demands.

- Summary recommendations on appropriate assurance of supply for irrigators taking into account the type of crops being irrigated and their tolerance for shortages during drought events.

10.2.5 SA6.5: Provide training on the concepts of assurance of supply

Objectives

- Understanding the "assurance of supply" and how it relates to the different user categories is a complex and often misunderstood issue. It is important that some training materials are available which can be used by representatives from the four basin states as well as other organisations which rely on water from the Orange-Senqu basin. It is therefore proposed that such training materials are developed in a format that can be used for a period of 10 years or more and presented by various specialists in each country.

Methodology

- It is proposed that five 1-hour training modules are developed by suitably qualified specialists that cover the key issues related to the assurance of supply and how it is linked to the supply of water to each user in the Orange-Senqu basin. It is proposed that the modules will be a combination of POWERPOINT slides which are captured in a ZOOM (or similar) video system so that they can be offered freely to all basin state members. These presentations should be clear, concise and "user-friendly" and should be presented by specialists who both understand the issues as well as have excellent presentation skills.

Deliverables

- A set of 5 Powerpoint presentations which cover the key issues of the Assurance of Supply as it relates to water allocation in the Orange-Senqu basin
- A set of 5 high quality video presentations where the Powerpoint presentations are presented and filmed and edited to provide a high quality 1-hour product.

10.2.6 SA6.6: Agree on how restrictions (operating rules) will be determined and applied during drought periods throughout the Orange-Senqu basin

Objectives

- One of the key uses of the "assurance of supply" based modelling approach is to try and identify droughts and to introduce appropriate water restrictions as early as possible in each new drought cycle. By introducing restrictions through agreed operating rules early in the drought cycle it is often possible to minimise the likelihood of extreme water restrictions which in turn can have very severe consequences on the water users in both rural and industrial areas. In the case of the Orange-Senqu basin there are 4 countries which use and manage the water supply in the whole basin. If each country adopts a different approach and applies different restrictions, it will create chaos and mistrust in the basin which in turn will lead to confrontation between governments. In order to ensure an orderly transition into phased water restrictions, it is therefore necessary to facilitate any restrictions in such a manner that they are accepted by all basin states and implemented as a river basin rather than 4 countries. Orasecom is obviously well placed to act as a key facilitator in this process, however, it is also important to ensure that the process to be implemented is agreed in advance so that there is no confusion or dispute when the next inevitable severe drought occurs. The key purpose of this task is therefore to prepare a Drought Plan that is known to and accepted by each basin state.

Methodology

- A workshop will be held to explain how drought operating rules are derived and can be implemented through the use of the Planning Models. The service provider will identify a suitable venue for the event, allowing for three representatives from each basin state and three from ORASECOM. It is anticipated that the event can be completed over a 3-day period and that the travel costs and accommodation costs will be included in the project budget plus all meals and coffee's etc. The country in which the event will be hosted will be agreed with ORASECOM during the Inception Phase of the project.
- It is anticipated that various operating rules which have previously been agreed will be questioned and possibly be overruled as part of the discussions from the above-mentioned workshop. These scenarios can be tested by the specialists presenting the workshop and a range of such issues will be introduced as part of the discussion process.

Deliverables

- A 3-day workshop to explain and develop operating rules.
- A series of likely scenarios that may lead to confrontation between basin members to test the various operating rules that have previously been agreed by the 4 basin states.
- A summary of the findings from the workshop and details of the agreed restrictions and processes that will be applied during the next severe drought. Where necessary,

recommendations of changes to certain operating rules may be made if such changes are considered appropriate by the basin state members

10.2.7 SA6.7: Agree on drought emergency measures for all stand-alone schemes so that the measures tie in with those that will be applied to the overall system

Objectives

- The Orange-Senqu system is one of the most integrated and complicated water resource systems in the world. It involves almost 300 reservoirs including all of the largest in Southern Africa (Gariep, Vanderkloof, Vaal, Sterkfontein, Katse, Mohale, Bloemhof etc). While much of the system is linked through river sections or pipelines, canals and tunnels, there are some parts of the system which are operated separately due to the fact that they do not act in support of any other reservoirs. During drought events, it is important to understand how such stand-alone schemes will operate and to ensure that they are also managed in a proper and responsible manner.

Methodology

- Undertake an assessment of analyses already undertaken for small stand-alone schemes in the Orange-Senqu basin.
- Undertake basic yield analyses for stand-alone schemes that operate independently from the main system that have not previously been analysed.
- Develop standard guidelines and operating rules for the small stand-alone schemes tom provide a consistent approach basin-wide.

Deliverables

- Short report on existing studies undertaken for the small stand-alone schemes
- Report on Yield analyses and operating rules for the various small stand-alone schemes that were identified and analysed.
- Provide a summary document that provides a standard guidelines and methodology for operating the small stand-alone schemes during times of severe drought.

10.3 Time-Schedule for Strategic Action 6

It is anticipated that the project will be undertaken over an 18-month period with an expected starting date of August 2023.

10.4 Team Requirements for Strategic Action 6

- **Eligibility** (To be finalised after the TOR and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Composition of the Study Team** (To be finalised after the TOR and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Qualifications/Experience(**To be finalised after the TOR and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)

11 STRATEGIC ACTION 7: WATER DISASTER MANAGEMENT AND CLIMATE ADAPTATION

11.1 Overview

In most integrated water supply systems, there are guidelines and operating rules in place to manage the overall water resource during drought events. Unfortunately, when a very severe drought does occur, it is often the case that the guidelines and operating rules are ignored as the water managers try to deal with specific problem areas and in such cases the whole allocation system can collapse with severe consequences. This issue arose recently in the Western Cape area where the City of Cape Town was within a few months of completely running out of water. Part of the problem was the fact that there were conflicting demands, between the irrigators and the municipality – both of which had their own allocations at specific levels of assurance as defined through many years of rigorous modelling. Unfortunately having two masters (The Department of Water and Sanitation and also the City of Cape Town Metropolitan Municipality) with their hands both on the tap, led to confusion and ultimately a near disaster for the whole region. The agreed operating rules were in many cases not applied, and if a retrospective analysis is undertaken, it will show that the actual levels of assurance provided to the irrigators and the municipality during the drought were not as originally agreed.

In the case of the Orange/Senqu River Basin, there are many organisations who have their hand on some tap somewhere in the system. Unless the allocation of water and the curtailment strategies are discussed and agreed properly while the system is operating under normal conditions, it may lead to a disaster in the event of a very severe drought in the region when not agreed on. It is therefore recommended that some form of mock drought disaster event is simulated involving participants from all four basin states to demonstrate exactly what will happen in the event of a severe drought. It will be less painful to identify the possible conflicts during a simulation exercise, rather than wait until the real event takes place and a new “day-zero” in the Orange/Senqu River Basin becomes a reality.

(Strategic Action 4.1.3)

11.2 Scope of Services.

This assignment will be undertaken in the following Tasks:

- SA7.1: Inception Report - Status Quo Assessment for floods and droughts
- SA7.2: Economic and social impacts of water supply failure
- SA7.3: Co-operation between basin countries during times of disaster management

- SA7.4: Compile a list of previous drought events from around the world that can be used to provide guidance to ORASECOM during the next severe drought
- SA7.5: Workshop for potential extreme drought event
- SA7.6: Develop a drought management plan for the basin

The cost of the proposed is estimated to be $2 million. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalization of the TOR for the study.

Each of the above tasks will be discussed below where it is described in the following manner:

- Objectives
- Methodology
- Deliverables

11.2.1 SA7.1: Inception Report & Status Quo Assessment for Floods and Droughts

The purpose of an Inception Report is to capture important work that would be necessary for the successful completion of this assignment, which may for some reason or another have been overlooked in the compilation of the original Terms of Reference (ToR) or the proposal submitted by the Service Provider during tendering. Omission of this additional work is usually only detected once work on the assignment has started and most of the team members have had time to familiarise themselves with the detailed requirements of the tasks necessary to ensure the successful completion.

The Inception Report is a formal document that will cover all the aspects of the original proposal plus the additions to the scope of work, Contract Amount, Contract Arrangements and Contract Period that may be required. The Inception Report will list all tasks required, all the team members for each task and their time allocation as well as their hourly rates per task, anticipated disbursements, revised study programme, etc. The rates of all new team members need to be approved before they can be engaged. The Inception Report can therefore be considered a revised Technical and Financial Proposal which supersedes and replaces both the original Terms of Reference as well as the original Project Proposal. **All future queries relating to study progress, deliverables and/or budgets should therefore be cross-checked against the Inception Report and not the Terms of Reference or Project Proposal.**

Objectives

The objective of this task is to produce a report which will become the de-facto agreement between ORASECOM and the Project team for the successful execution of the proposed project. This report will become the basis of the proposed project and will supersede both the original Terms of Reference and the Project Proposal. In this Strategic Action it is also proposed that much of the base data required for the project will be collected and collated during the Inception Phase as this will help to clarify the final scope of the project. The data collection will form an integral part of the Inception Phase and will allow the Inception Report to clearly define what flood and drought events will be assessed during the mock disaster management event.

Methodology

- The appointed Service Provider shall within two (2) months of commencement / contract signing produce a detailed assignment inception report. It will be required from the appointed Service Provider to do thorough research and review all the relevant previous studies as well as all the available information relevant to this assignment. It will be necessary to update and maintain a list of such studies and their relevance to this assignment. It will be required to liaise with all relevant stakeholders in preparation for the undertaking of this assignment.
- The Service Provider shall compile an Inception Report that will consist of a detailed description of tasks, a study programme and study budget. The Inception Report will form part of the Contract and stipulate the scope of work for the study, the Contract Amount and the Contract Period which, upon signing of the Contract by both parties, allows
- The Service Provider to start with their work. In it, the Service Provider's proposal will be discussed with the Client and all aspects and uncertainties will be clarified. It will result in the final Terms of Reference for the study together with the final study cost. These will serve as a basis for all future work on the contract and will be recorded in the Agreement with the Client.
- The Service Provider will examine the naturalised flow sequences to identify the most severe drought and flood events that have occurred over the past 100 years. Two drought events and two flood events will be selected to be used in the mock disaster assessments and if necessary, they may be adjusted to provide more severe events reflective of what can be expected in future due to the impacts of global warming and the subsequent climate change.

Deliverables

- An Inception Report containing agreed:
    - Scope of Works
    - Methodology
    - Deliverables
    - Budget
    - Programme
    - Project Team members
    - Involvement of ORASECOM and Basin State members
    - Management Processes
    - Quality Control Processes
- A summary report (or chapter in the Inception Report) providing details of the selected drought and flood events that will be used in the mock disaster management assessments.

11.2.2 SA7.2: Economic and Social Impacts of Water Supply Failure

Objectives

- In cases of floods and droughts, the impacts on local communities and the greater regional economy can be significant and, in some cases, catastrophic. As it is expected that such events will become more frequent and more severe due to global warming, it is important to assess the likely implications of future floods and droughts in order to try and develop action plans that can provide some level of Climate Resilience.
- The economic and social impacts of water supply failure should be assessed where possible to identify the likely problem areas where actions will be required to mitigate the impacts of future floods and/or droughts. It should be noted that in some areas the impacts of severe floods can result in total failure of the water infrastructure due to damage to pipelines or silting up of canals etc. The recent floods in the KwaZulu /Natal area demonstrate the long-term damage that can be caused by such events and they are often as disruptive and destructive as the drought events.

Methodology

- The project team will consider previous flood events to identify areas which were severely impacted and assess the possible consequences of even larger floods in future. Broad based assessments of the costs to the local economies as well as the larger regional costs should be investigated.

- The project team will consider previous drought events to identify areas which were severely impacted and assess the possible consequences of more prolonged and more severe droughts in future. Broad based assessments of the costs to the local economies as well as the larger regional costs should be investigated.

Deliverables

- A short report providing details of the various possible economic and social impacts from a severe drought event in the Orange-Senqu basin.

11.2.3 SA7.3: Co-operation between Basin Countries Regarding Disaster Management

Objectives

- To review current policies and procedures related to water sharing where available for co-operation between the various basin states.
- To review current policies and procedures related to disaster management between the various basin states where any such arrangements are in place.
- To highlight where co-operative agreements are already in place and to identify gaps and shortfalls which should be addressed to avoid a future water related disaster.

Methodology

- The relevant government water agencies in each basin state will be contacted and discussions held to identify where co-operative agreements and procedures are in place to deal with flood and drought events as well as other water supply agreements.
- Through the discussions, the gaps and shortfalls in the agreements should be identified so that they can be tabled at a joint meeting/workshop where measures to address the problem areas can be discussed and if possible agreed upon.

Deliverables

- A report summarising the current agreements between the basin states involving water supply as well as drought and flood disaster management.
- A short report providing recommendations on how the agreements and procedures can be improved to ensure that there is a proper plan in place to deal with severe droughts and floods in the Orange-Senqu basin.

11.2.4 SA7.4: Compile a list of previous drought events from around the world that can be used to provide guidance to ORASECOM during the next severe drought

Objectives

Severe droughts are not unique to any specific country and are becoming more common in more cities around the world. Many large cities have come close to total failure due to extreme droughts and in some cases the water supply systems have completely failed. It is important to understand what happened in such events and what lessons can be learned from such experiences, both positive and negative. It is therefore proposed to examine between 4 and 8 case studies of previous large-scale droughts which caused significant water supply problems to large cities and/or irrigation schemes.

Methodology

- A list of severe drought events will be selected which are known to have caused significant water supply problems to either large urban populations and/or irrigation schemes. Details of each drought event will be examined from published articles and papers which can be used to provide a summary overview of each event.
- The actions taken by the relevant water suppliers to address the effects of the drought will be examined and summarised to highlight the key elements of the actions taken. Where possible, the lessons learned should be identified and documented in order to assist water service providers to tackle future drought events.

Deliverables

- A list of severe drought events and the key features of each event in a summary report.
- A list of recommendations on how to deal with such drought events which can help water service providers to “mitigate” against the effects of future climate change.

11.2.5 SA7.5: Carry out Mock Severe Drought Event

Objectives

- One of the key uses of the “assurance of supply” based modelling approach is to try and identify droughts and to introduce appropriate water restrictions as early as possible in each new drought cycle. By introducing restrictions early in the drought cycle it is often possible to minimise the likelihood of extreme water restrictions which in turn can have very severe consequences on the water users in both rural and industrial areas. In the case of the Orange-Senqu basin there are 4 countries which use and manage the water supply in the whole basin. If each country adopts a different approach and applies different restrictions, it will create chaos and mistrust in the basin which in turn will lead to confrontation between governments. In order to ensure an orderly transition into phased water restrictions, it is therefore necessary to facilitate any restrictions in such a manner that they are accepted by all basin states and implemented as a river basin rather than 4 countries. ORASECOM is obviously well placed to act as a key facilitator in this process, however, it is also important to ensure that the process to be implemented is agreed in advance so that there is no confusion or dispute when the next inevitable severe drought occurs. The key purpose of this task is therefore to prepare a Drought Plan that is known to and accepted by each basin state.

Methodology

- A workshop will be held to undertake a mock severe drought and present the phased restrictions that should be implemented so that each representative from the basin states can understand and agree on how the water allocations are made. The mock drought event will be sufficiently severe that some very difficult and potentially controversial restrictions will be made so that the actions taken can be discussed between the members.
- It is anticipated that various operating rules which have previously been agreed will be questioned and possibly be overruled as part of the discussions from the above-mentioned workshop. These scenarios can be tested by the specialists presenting the workshop and a range of such issues will be introduced as part of the discussion process.

Deliverables

- A 3-day workshop to present a mock severe drought event.
- A series of likely scenarios that may lead to confrontation between basin members to test the various operating rules that have previously been agreed by the 4 basin states.
- A summary of the findings from the workshop and details of the agreed restrictions and processes that will be applied during the next severe drought. Where necessary, recommendations of changes to certain operating rules may be made if such changes are considered appropriate by the basin state members

11.2.6 SA7.6: Development of a Drought Management Plans

Objectives

Drought Management Plans should be drawn up to deal with future severe droughts that may occur in the Orange-Senqu basin. It is important that such plans provide clear and concise actions to be taken as a drought event impacts on the basin. Such plans should include actions to be taken by each basin state and the actions taken should be agreed by all basin states and have been properly discussed before the drought event.

Methodology

- Based on the results of the mock drought event and other agreements that may be in place, a plan of action will be developed which will provide an action plan that should be implemented when a new drought event is identified in the Orange-Senqu basin
- The proposed action plan should be discussed and debated with members from the basin states as it must be approved and agreed upon by all basin states.

Deliverables

- A Drought Management Plan that covers the Orange-Senqu basin and has the support of the four basin states.

11.3 Time-Schedule for Strategic Action 7

It is anticipated that the project will be undertaken over an 18-month period with an expected starting date of August 2026.

11.4 Team Requirements for Strategic Action 7

- **Eligibility** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Composition of the Study Team** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Qualifications/Experience(**To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)

12 STRATEGIC ACTION 8: CAPACITY BUILDING

12.1 Overview

In order to ensure transparency and to facilitate future co-operation between the four basin states, it is recommended that an annual meeting should take place in which the different countries can each provide any updated information as well as any new or adjusted plans/strategies. The proposed project will help to:

- Monitor progress with the implementation of the activities defined for the Integrated Water Resources Management Plan and relating to the water balance of the Core Scenario:
- Facilitate the sharing of information that is required to ensure the Integrated Water Resources Management Plan remains relevant;
- Evaluate the implication of new initiatives or plans and revised information (pertaining to the water balance) have on the Core Scenario and recommend reviews or updates of the Integrated Water Resources Management Plan;
- Discuss the implications of these changes and updates, the progress or lack in progress of individual system strategy implementation programmes, as well as that of the ORASECOM Integrated Water Resources Management Plan implementation programme, on the entire Orange-Senqu River System, as indicated or supported by Water Resources Planning Model scenario analyses (when required). It might be that in some cases only simple water balance graph adjustments would be required;
- Provide recommendations on possible adjustments to the Core Scenario and Integrated Water Resources Management Plan, as well as whether specific components/issues or problem areas require more in-depth investigation/study by specialised task groups;
- Keep the model up to date with the latest information, plans and implementation progress of existing strategies and or water resource plans, from all the basin states as well as the status regarding the ORASECOM Integrated Water Resources Management Plan implementation;
- Determine or table specific training/capacity building requirements; and
- Discuss and evaluate existing monitoring activities, to recommend additional monitoring sites or components with focus on Integrated Water Resources Management Plan implementation monitoring.

The anticipated costs for Strategic Action 8 are estimated as follows:

- Water Resources Planning Model updates relating to updated water requirements, infrastructure changes and possible changes to the Core Scenario and possible scenario analysis. Study costs = Euro 75 000
- Capacity Building on Annual Operating Analyses – Study costs = Euro 25 000
- Annual updating, meeting and analysis and training – Costs = Euro 50 000

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the Terms of Reference for the study

Managing the water allocation in a river basin of more than 1 million km^2 is not a trivial issue and involves significant support to establish a realistic hydrological data base. In addition, the planning and allocation tools (computer support models) must be continually improved and the demand data updated each year to ensure that the results and proposed water allocations are realistic.

To date, the Orange/Senqu River Basin has not experienced major water shortages resulting in potential disputes between the four basin states and is often used by international organisations as an example where proper planning and discussion can mitigate such problems. While serious conflicts are now emerging in many parts of the world over the issue of water allocations, the Orange/Senqu River Basin remains operational and generally free from serious disagreements.

In order to ensure that the current status quo of friendly co-operation between the four countries through the ORASECOM membership, it is recommended that there is regular training and discussion on the basic hydrological data used to model the basin, as well as training on the yield and allocation models where each country will have access to the same data and same models. It is only through such training that there can be future agreement and co-operation on the water allocations in the Orange/Senqu River Basin, as the resources near the point of full utilisation.

In view of the recent developments in video-conferencing and video-training it is envisaged that a series of Video Training Modules will be developed which can then be used by each of the Basin countries (and others worldwide ?) to understand the concepts of the various processes that are part of the overall water resource management practices in the Orange Senqu Basin. In this regard the following training modules are suggested:

- Overview of the Orange Senqu Basin
- Overview of the Water Resource Modelling Techniques used to Manage the Orange/Senqu basin

- General overview of Rainfall Runoff Modelling
- Practical issues for Rainfall-Runoff Modelling
- Patching and Extension of Rainfall Data
- Naturalisation and Patching of Streamflow data
- General Concepts for Stochastic Streamflow Generation
- Verification tests of Stochastic Streamflow Sequences
- Concepts of Reservoir Yield and Assurance of Supply
- Overview of the Water Resource Yield Model
- Setting up and Testing of Penalty Structures
- The Water Resources Planning Model
- Annual Operating Analyses
- Understanding Box Plots and Stochastic Results

(Strategic Actions 6.1.1, 6.1.3, 7.1.1, 7.1.2 & 9.1.1).

12.2 Scope of Services.

This assignment will be undertaken in the following Tasks:

- SA8.1: Inception Report and Agreement on Training Modules to be Developed
- SA8.2: Design of Standard Video Training Module
- SA8.3: Discussion and Refinement of Video Training Module Structure
- SA8.4: Development of Remaining Video Training Modules
- SA8.5: Development of Web site to host Training Modules
- SA8.6: Development of supporting documentation to Support Video Training Modules

The cost of the proposed is estimated to be $2 million. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalization of the Terms of Reference for the study.

Each of the above tasks will be discussed below where it is described in the following manner:

- Objectives
- Methodology
- Deliverables

12.2.1 SA8.1: Inception Report and Agreement on Training Modules to be Developed

The purpose of an Inception Report is to capture important work that would be necessary for the successful completion of this assignment, which may for some reason or another have been overlooked in the compilation of the original Terms of Reference (ToR) or the proposal submitted by the Service Provider during tendering. Omission of this additional work is usually only detected once work on the assignment has started and most of the team members have had time to familiarise themselves with the detailed requirements of the tasks necessary to ensure the successful completion.

The Inception Report is a formal document that will cover all the aspects of the original proposal plus the additions to the scope of work, Contract Amount, Contract Arrangements and Contract Period that may be required. The Inception Report will list all tasks required, all the team members for each task and their time allocation as well as their hourly rates per task, anticipated disbursements, revised study programme, etc. The rates of all new team members need to be approved before they can be engaged. The Inception Report can therefore be considered a revised Technical and Financial Proposal which supersedes and replaces both the original Terms of Reference as well as the original Project Proposal. **All future queries relating to study progress, deliverables and/or budgets should therefore be cross-checked against the Inception Report and not the Terms of Reference or Project Proposal.**

Objectives

The objective of this task is to produce a report which will become the de-facto agreement between ORASECOM and the Project team for the successful execution of the proposed project. This report will become the basis of the proposed project and will supersede both the original Terms of Reference and the Project Proposal.

Methodology

- The appointed Service Provider shall within two (2) months of commencement / contract signing produce a detailed assignment inception report. It will be required from the appointed Service Provider to do thorough research and review all the relevant previous studies as well as all the available information relevant to this assignment. It will be necessary to update and maintain a list of such studies and their relevance to this assignment. It will be required to liaise with all relevant stakeholders in preparation for the undertaking of this assignment.

- The Service Provider shall compile an Inception Report that will consist of a detailed description of tasks, a study programme and study budget. The Inception Report will form part of the Contract and stipulate the scope of work for the study, the Contract Amount and the Contract Period which, upon signing of the Contract by both parties, allows
- The Service Provider to start with their work. In it, the Service Provider's proposal will be discussed with the Client and all aspects and uncertainties will be clarified. It will result in the final Terms of Reference for the study together with the final study cost. These will serve as a basis for all future work on the contract and will be recorded in the Agreement with the Client.

Deliverables

An Inception Report containing agreed:

- Scope of Works
- Methodology
- Deliverables
- Budget
- Programme
- Project Team members
- Involvement of ORASECOM and Basin State members
- Management Processes
- Quality Control Processes

12.2.2 SA8.2: Design of Standard Video Training Module

Objectives

- In order to provide high quality training materials it is first necessary to establish a template that can then be used for all training modules. It is proposed that the training modules will each be 1-hour in length which will comprise a 40minute to 45 minute presentation by a recognised expert/specialist in the field being presented plus a further 15 to 20 minutes of pre-determined questions which will be discussed after the presentation in an informal discussion. The format of the presentation and the discussion session must be carefully selected to provide high quality presentation materials as well as high quality video materials that can then be combined by an editing company into a professional 1-hour module. The structure and layout of the video should be carefully designed to ensure it can be easily replicated and it allows for sponsorship opportunities where appropriate.

Methodology

- A suitable topic should be selected for the first pilot training video as agreed between Orasecom and the service provider
- A 40-minute Powerpoint presentation should be developed together with a selection of questions that can be discussed after the presentation during the 20 minute question and answer session.
- The presentation should be undertaken using Powerpoint and videoed using a suitable video platform with at least two separate feeds so that there is sufficient material to edit into a professional looking product.
- The 20-minute question and answer session should be undertaken and videoed also using at least two video feeds to provide materials for editing into a professional product.
- The two components should be edited by a professional editor or editing company to produce a single 1-hour training video which includes the 40 minute presentation and the 20 minute question and answer session.

Deliverables

- The various video and powerpoint materials required to produce the training video
- A high-quality professional training video of 1-hour which provides a template for future training videos on other topics.

12.2.3 SA8.3: Discussion and Refinement of Video Training Module Structure

Objectives

- Following the develop of the first training module which is designed to provide the template for the subsequent modules, it is anticipated that some changes and improvements will be required. This sub-task allows for such changes in order to establish the final approved template that has been agreed by ORASECOM and the 4 basin states.

Methodology

- The pilot training video must be presented to ORASECOM and representatives from the 4 Basin States in order to allow for feedback before the final format of the materials can be established. It is anticipated that this will be achieved through a virtual workshop and need not involve a physical event in the interests of economy.

- Following the discussions and comments from ORASECOM and the representatives from the 4 basin states, the pilot training video will be refined where necessary to create a final pilot video that will become the template for future training materials.

Deliverables

- A virtual workshop to present the pilot training video and agree on any necessary changes as agreed by ORASECOM and the representatives from the 4 basin states.
- A final pilot training video in a format agreed by ORASECOM and representatives from the 4 basin states.

12.2.4 SA8.4: Development of Remaining Video Training Modules

Objectives

- Having established a pilot training video, the other training modules can then be developed using a similar format to cover the remaining topics as agreed with ORASECOM and the representatives from the 4 Basin States.

Methodology

- The topics to be covered in the subsequent training videos must be discussed and agreed with ORASECOM and representative from the 4 Basin States.
- The 1-hour training videos can them be developed using the same format as the pilot training video so that all training videos are similar in their structure and duration.

Deliverables

- A list of training topics as agreed with ORASECOM and representatives from the 4 Sasin States.
- 1-hour training videos for each topic as agreed with ORASECOM and representatives from the 4 Basin States.

12.2.5 SA8.5: Development of Web site to host Training Modules

Objectives

- Having identified and developed the training modules needed by ORASECOM and the 4 Basin States, it will be necessary to provide a mechanism to disseminate the training materials to provide easy access as and when required by representatives from the 4 basin states. In this regard, it is clear that access through the internet is the obvious and most appropriate route to follow. This sub-task will therefore provide a suitable web-based solution for dissemination of the training materials.

Methodology

- Discussions should be held with ORASECOM and representatives from the 4 basin states to gain their views on how best to provide access to the training materials. This can be achieved through a virtual discussion from which the key issues to be addressed by the web service can be finalised.
- A web site will be developed to offer access to the various training modules. It is envisaged that this will be incorporated into existing web sites such as the current ORASECOM site or hosted on a suitable site in each basin state.

Deliverables

- A virtual discussion with ORASECOM and representatives from the 4 basin states to agree on the approach for disseminating the training videos .
- Development of the web site to incorporate the training videos and testing thereof.

12.2.6 SA8.6: Development of supporting documentation to Support Video Training Modules

Objectives

- In order to support each training video, it is proposed that a short document will be prepared which can then be used by anyone wishing to view the training videos. These documents should be written in summary form which are clear and concise so that each slide in the presentation component of the training video is explained – preferably in bullet form without unnecessary text.

Methodology

- The developer and/or presenter of each training video will provide a summary explanation text to accompany each slide in the presentation.
- The training documentation should be included in the web site so that it can be downloaded by anyone wanting to view the training materials.

Deliverables

- A set of training notes to accompany each training video which can be added to the web site and downloaded by those viewing the training materials.

12.3 Time-Schedule for Strategic Action 8

It is anticipated that the project will be undertaken over an 18-month period with an expected starting date of August 2025.

12.4 Team Requirements for Strategic Action 8

- **Eligibility** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Composition of the Study Team** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Qualifications/Experience(**To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)

13 STRATEGIC ACTION 9: HYDROLOGY UPDATE AND CALIBRATION OF WATER QUALITY MODEL

13.1 Overview

The current naturalised historic hydrology based on observed flows within the Orange Senqu basin covers the period 1920/21 to 2004/05 hydrological years. This means that the current natural hydrology can be extent by about 16 years to 2020. Normal practice is to update the hydrology after 15 to 20 years or shortly after a severe drought has passed. During this 16-year period quite a number of severe dry years occurred over most parts of the basin. For climate change purposes it is of high importance to capture the latest characteristics of flows and rainfall influenced by climate change. These characteristics will then also be captured in the generation of the generated stochastic flows used for modelling and planning purposes. Work carried out as part of the climate change task of the current study showed that the stochastic flow band with was in general wide enough to capture the spread of expected flows and yield results obtained from the different climate change models. Capturing the latest rainfall and rainfall runoff characteristics will only further enhance the capability of the stochastic model for future planning and operating analysis to account for possible changes due to climate change. Due to climate change impacts, it is advised to rather carry out hydrology updates on shorter intervals than that indicated by previous guidelines.

Department of Water and Sanitation RSA already picked up that the existing Water Resource Planning Model outputs with respect to water quality along the Vaal River downstream of Vaal Dam do not agree well with reality. Department of Water and Sanitation RSA is thus already planning a study to improve the water quality calibrations as well as the hydrology in the affected area. The update of the hydrology and improvement of water quality calibrations for the remainder of the Orange/Senqu River Basin can be carried out in addition to the Department of Water and Sanitation RSA work. It is, however, important to select areas where the updating of the water quality component of the WRPM is really required, as it might not be worthwhile for all the areas in the basin.

The anticipated costs for Strategic Action 15 are estimated as follows:

- Hydrology update and calibration of water quality model – Study costs = Euro 1.0 mil

It should be noted that the cost estimate is very preliminary at this stage and will be reviewed and refined during the development of the Terms of Reference for the study

(Strategic Action 1.1.1 & 3.1.2):

13.2 Scope of Services.

This assignment will be undertaken in the following Tasks:

- SA9.1: Inception Report and Status Quo Assessment of Hydrology, Water Quality, and Groundwater interaction (where appropriate).
- SA9.2: Update of Lesotho and Caledon Hydrology
- SA9.3: Update Upper and Middle Orange Hydrology plus Riet and Modder
- SA9.4: Update Lower Orange plus Namibia plus River Losses from Vanderkloof Dam, including water quality and groundwater interaction.
- SA9.5: Update of Vaal, Usutu, Komati and Tugela Hydrology, including water quality and groundwater interaction.
- SA9.6: Assessment of Eastern Cape System
- SA9.7: Validation and Verification of Hydrology using Stochastic Modelling.
- SA9.8: Assess possible inclusion of El Nino and La Nina in the stochastic projections to improve Climate Change modelling.
- SA9.9: Assessment of Climate Change models to investigate potential downscaling problems
- SA9.10: Assessment of Eutrophication and Salinity problems in Lower Vaal and Orange rivers.

The cost of the proposed is estimated to be $5 million. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalization of the TOR for the study.

Each of the above tasks will be discussed below where it is described in the following manner:

- Objectives
- Methodology
- Deliverables

13.2.1 SA9.1: Inception Report and Status Quo Assessment

The purpose of an Inception Report is to capture important work that would be necessary for the successful completion of this assignment, which may for some reason or another have been overlooked in the compilation of the original Terms of Reference (ToR) or the proposal submitted by the Service Provider during tendering. Omission of this additional work is usually only detected once work on the assignment has started and most of the team members have had time to familiarise themselves with the detailed requirements of the tasks necessary to ensure the successful completion.

The Inception Report is a formal document that will cover all the aspects of the original proposal plus the additions to the scope of work, Contract Amount, Contract Arrangements and Contract Period that may be required. The Inception Report will list all tasks required, all the team members for each task and their time allocation as well as their hourly rates per task, anticipated disbursements, revised study programme, etc. The rates of all new team members need to be approved before they can be engaged. The Inception Report can therefore be considered a revised Technical and Financial Proposal which supersedes and replaces both the original Terms of Reference as well as the original Project Proposal. **All future queries relating to study progress, deliverables and/or budgets should therefore be cross-checked against the Inception Report and not the Terms of Reference or Project Proposal.**

Objectives

The objective of this task is to produce a report which will become the de-facto agreement between ORASECOM and the Project team for the successful execution of the proposed project. This report will become the basis of the proposed project and will supersede both the original TOR and the Project Proposal.

Methodology

- The appointed Service Provider shall within two (2) months of commencement / contract signing produce a detailed assignment inception report. It will be required from the appointed Service Provider to do thorough research and review all the relevant previous studies as well as all the available information relevant to this assignment. It will be necessary to update and maintain a list of such studies and their relevance to this assignment. It will be required to liaise with all relevant stakeholders in preparation for the undertaking of this assignment.
- The Service Provider shall compile an Inception Report that will consist of a detailed description of tasks, a study programme and study budget. The Inception Report will form part of the Contract and stipulate the scope of work for the study, the Contract Amount and the Contract Period which, upon signing of the Contract by both parties, allows
- The Service Provider to start with their work. In it, the Service Provider's proposal will be discussed with the Client and all aspects and uncertainties will be clarified. It will

result in the final Terms of Reference for the study together with the final study cost. These will serve as a basis for all future work on the contract and will be recorded in the Agreement with the Client.

Deliverables

An Inception Report containing agreed:

- Scope of Works
- Methodology
- Deliverables
- Budget
- Programme
- Project Team members
- Involvement of ORASECOM and Basin State members
- Management Processes
- Quality Control Processes

13.2.2 SA9.2: Update of Lesotho and Caledon Hydrology

Objectives

- The hydrology for Lesotho as part of the Orange-Senqu River Basin is usually combined with the hydrology for the Caledon River since the two are linked due to the fact that the Caledon River is supplied on the west from South Africa and on the East from Lesotho. It is also helpful to utilise rain gauges from both Lesotho and South Africa when trying to infill and extend the rainfall records in either country. For these reasons, the hydrology of both Lesotho and the Caledon are usually undertaken together and it is proposed that this approach be continued in the proposed project.

Methodology

- Based on the status quo evaluation undertaken under sub-task 1 the scope of the hydrology update for the Lesotho-Caledon systems will be defined. This will normally involve either a simple extension of the hydrology using previously calibrated rainfall-runoff models or it may involve the re-calibration of the rainfall-runoff models which in turn is a more comprehensive and time-consuming update. For the purposes of this project it should be assumed that a detailed re-calibration is included since the hydrology has not been updated for more than 20 years.
- A complete revision of the Lesotho -Caledon hydrology will be undertaken using the standard Pitman Rainfall-runoff model which has previously been used to develop the

naturalised streamflow sequences used in the water resource planning models. This will involve the following:

- Updating the raw monthly rainfall records
- Infilling and extending (if required) the monthly rainfall records using the CLASSR and PATCHR models or similar and approved by ORASECOM
- Updating of all land use practices which will influence the naturalisation of the streamflow records
- Collection and infilling of the recorded streamflow records using the Pitman Model or similar and approved by ORASECOM
- Extension and naturalisation of the streamflow records using the Pitman Model or similar and approved to produce naturalised streamflow records of the length defined in Sub-task 1 during the Status-quo assessment.
- Finalisation of the hydrological update to provide the various time series files required for use in the system models. These files include:
    - Rainfall records which have been infilled and extended where necessary to be used in the subsequent rainfall runoff modelling
    - Catchment rainfall files to be used in the rainfall runoff modelling
    - Point rainfall files to be used at each reservoir site used in the subsequent system modelling
    - Monthly evaporation figures to be used for each reservoir site and any other demand centre where evaporation data are required.
    - Infilled streamflow records at each gauging site used in the analyses.
    - Naturalised and extended streamflow files at each gauge included in the analysis
    - Naturalised extended streamflow records for each node used in the subsequent system modelling analyses
- A preliminary stochastic streamflow assessment to ensure that the various naturalised streamflow records are realistic and pass the basic tests for serial and cross correlation. It is assumed that the GENTST model will be used for this assessment or a model similar and approved by ORASECOM.

Deliverables

- A set of hydrological time series files that have been checked and verified using the various testing packages to provide the various time series files required in the subsequent yield and planning analyses.

13.2.3 SA9.3: Update Upper and Middle Orange Hydrology plus Riet and Modder

Objectives

The hydrologies for the Upper and Middle Orange are usually analysed together with the hydrology for the Riet and Modder since they are linked by various transfer schemes and canals etc. For these reasons, the hydrology of the Upper and Middle Orange plus the Riet and Modder are usually undertaken together and it is proposed that this approach be continued in the proposed project.

Methodology

- Based on the status quo evaluation undertaken under sub-task 1 the scope of the hydrology update for the Upper and Middle Orange plus the Riet and Modder will be defined. This will normally involve either a simple extension of the hydrology using previously calibrated rainfall-runoff models or it may involve the re-calibration of the rainfall-runoff models which in turn is a more comprehensive and time-consuming update. For the purposes of this project it should be assumed that a detailed re-calibration is included since the hydrology has not been updated for more than 20 years.
- A complete revision of the Upper and Middle Orange plus the Riet and Modder hydrology will be undertaken using the standard Pitman Rainfall-runoff model which has previously been used to develop the naturalised streamflow sequences used in the water resource planning models. This will involve the following:
    - Updating the raw monthly rainfall records
    - Infilling and extending (if required) the monthly rainfall records using the CLASSR and PATCHR models or similar and approved by ORASECOM
    - Updating of all land use practices which will influence the naturalisation of the streamflow records
    - Collection and infilling of the recorded streamflow records using the Pitman Model or similar and approved by ORASECOM
    - Extension and naturalisation of the streamflow records using the Pitman Model or similar and approved to produce naturalised streamflow records of the length defined in Sub-task 1 during the Status-quo assessment.
    - Finalisation of the hydrological update to provide the various time series files required for use in the system models. These files include:
        - Rainfall records which have been infilled and extended where necessary to be used in the subsequent rainfall runoff modelling
        - Catchment rainfall files to be used in the rainfall runoff modelling

    - Point rainfall files to be used at each reservoir site used in the subsequent system modelling
    - Monthly evaporation figures to be used for each reservoir site and any other demand centre where evaporation data are required.
    - Infilled streamflow records at each gauging site used in the analyses.
    - Naturalised and extended streamflow files at each gauge included in the analysis
    - Naturalised extended streamflow records for each node used in the subsequent system modelling analyses
  - A preliminary stochastic streamflow assessment to ensure that the various naturalised streamflow records are realistic and pass the basic tests for serial and cross correlation. It is assumed that the GENTST model will be used for this assessment or a model similar and approved by ORASECOM.

Deliverables

- A set of hydrological time series files that have been checked and verified using the various testing packages to provide the various time series files required in the subsequent yield and planning analyses.

13.2.4 SA9.4: Update Lower Orange plus Namibia and Botswana in the Orange Senqu basin plus River Losses from Vanderkloof Dam

Objectives

The hydrologies for the Lower Orange plus the portion of Namibia and Botswana in the Orange -Senqu basin plus the River Losses from Vanderkloof Dam are usually analysed together as they are all linked in some respect.

Methodology

- Based on the status quo evaluation undertaken under sub-task 1 the scope of the hydrology update for the Lower Orange plus the portion of Namibia and Botswana in the Orange -Senqu basin plus the River Losses from Vanderkloof Dam will be defined. This will normally involve either a simple extension of the hydrology using previously calibrated rainfall-runoff models or it may involve the re-calibration of the rainfall-runoff models which in turn is a more comprehensive and time-consuming update. For the purposes of this project it should be assumed that a detailed re-calibration is included since the hydrology has not been updated for more than 20 years.

- A complete revision of the Lower Orange plus the portion of Namibia and Botswana in the Orange -Senqu basin plus the River Losses from Vanderkloof Dam hydrology will be undertaken using the standard Pitman Rainfall-runoff model which has previously been used to develop the naturalised streamflow sequences used in the water resource planning models. This will involve the following:
  - Updating the raw monthly rainfall records
  - Infilling and extending (if required) the monthly rainfall records using the CLASSR and PATCHR models or similar and approved by ORASECOM
  - Updating of all land use practices which will influence the naturalisation of the streamflow records
  - Collection and infilling of the recorded streamflow records using the Pitman Model or similar and approved by ORASECOM
  - Extension and naturalisation of the streamflow records using the Pitman Model or similar and approved to produce naturalised streamflow records of the length defined in Sub-task 1 during the Status-quo assessment.
  - Finalisation of the hydrological update to provide the various time series files required for use in the system models. These files include:
    - Rainfall records which have been infilled and extended where necessary to be used in the subsequent rainfall runoff modelling
    - Catchment rainfall files to be used in the rainfall runoff modelling
    - Point rainfall files to be used at each reservoir site used in the subsequent system modelling
    - Monthly evaporation figures to be used for each reservoir site and any other demand centre where evaporation data are required.
    - Infilled streamflow records at each gauging site used in the analyses.
    - Naturalised and extended streamflow files at each gauge included in the analysis
    - Naturalised extended streamflow records for each node used in the subsequent system modelling analyses
  - A preliminary stochastic streamflow assessment to ensure that the various naturalised streamflow records are realistic and pass the basic tests for serial and cross correlation. It is assumed that the GENTST model will be used for this assessment or a model similar and approved by ORASECOM.

Deliverables

- A set of hydrological time series files that have been checked and verified using the various testing packages to provide the various time series files required in the subsequent yield and planning analyses.

13.2.5 SA9.5: Update of Vaal, Usutu, Komati and Tugela Hydrology, including water quality and groundwater interaction

Objectives

The hydrologies for the Vaal, Usutu, Komati and Tugela, including water quality and groundwater interaction are usually analysed together as they are all linked in some respect.

Methodology

- Based on the status quo evaluation undertaken under sub-task 1 the scope of the hydrology update for the Vaal, Usutu, Komati and Tugela Hydrology, including water quality and groundwater interaction will be defined. This will normally involve either a simple extension of the hydrology using previously calibrated rainfall-runoff models or it may involve the re-calibration of the rainfall-runoff models which in turn is a more comprehensive and time-consuming update. For the purposes of this project, it should be assumed that a detailed re-calibration is included since the hydrology has not been updated for more than 20 years.
- A complete revision of the Vaal, Usutu, Komati and Tugela Hydrology, including water quality and groundwater interaction will be undertaken using the standard Pitman Rainfall-runoff model and the Water Quality Model which have previously been used to develop the naturalised streamflow sequences used in the water resource planning models. This will involve the following:
    - Updating the raw monthly rainfall records
    - Infilling and extending (if required) the monthly rainfall records using the CLASSR and PATCHR models or similar and approved by ORASECOM
    - Updating of all land use practices which will influence the naturalisation of the streamflow records
    - Collection and infilling of the recorded streamflow records using the Pitman Model or similar and approved by ORASECOM

- Extension and naturalisation of the streamflow records using the Pitman Model or similar and approved to produce naturalised streamflow records of the length defined in Sub-task 1 during the Status-quo assessment.
- Finalisation of the hydrological update to provide the various time series files required for use in the system models. These files include:
  - Rainfall records which have been infilled and extended where necessary to be used in the subsequent rainfall runoff modelling
  - Catchment rainfall files to be used in the rainfall runoff modelling
  - Point rainfall files to be used at each reservoir site used in the subsequent system modelling
  - Monthly evaporation figures to be used for each reservoir site and any other demand centre where evaporation data are required.
  - Infilled streamflow records at each gauging site used in the analyses.
  - Naturalised and extended streamflow files at each gauge included in the analysis
  - Naturalised extended streamflow records for each node used in the subsequent system modelling analyses
- A preliminary stochastic streamflow assessment to ensure that the various naturalised streamflow records are realistic and pass the basic tests for serial and cross correlation. It is assumed that the GENTST model will be used for this assessment or a model similar and approved by ORASECOM.

Deliverables

A set of hydrological time series files that have been checked and verified using the various testing packages to provide the various time series files required in the subsequent yield and planning analyses.

13.2.6 SA9.6: Assessment of the Eastern Cape System

Objectives

- The hydrology for the Eastern Cape System should be updated as it is an integral part of the Orange-Senqu system since it receives significant water through the 80km long Orange-Fish Tunnel. The Eastern Cape system has also experienced a very severe drought over the past decade and it is important to update the streamflow sequences so that the stochastically generated sequences can be based on the most severe drought that has been experienced by the area.

Methodology

- Based on the status quo evaluation undertaken under sub-task 1 the scope of the hydrology update for the Eastern Cape System will be defined. This will normally involve either a simple extension of the hydrology using previously calibrated rainfall-runoff models or it may involve the re-calibration of the rainfall-runoff models which in turn is a more comprehensive and time-consuming update. For the purposes of this project, it should be assumed that a detailed re-calibration is included since the hydrology has not been updated for more than 20 years.
- A complete revision of the Lesotho -Caledon hydrology will be undertaken using the standard Pitman Rainfall-runoff model which has previously been used to develop the naturalised streamflow sequences used in the water resource planning models. This will involve the following:
    - Updating the raw monthly rainfall records
    - Infilling and extending (if required) the monthly rainfall records using the CLASSR and PATCHR models or similar and approved by ORASECOM
    - Updating of all land use practices which will influence the naturalisation of the streamflow records
    - Collection and infilling of the recorded streamflow records using the Pitman Model or similar and approved by ORASECOM
    - Extension and naturalisation of the streamflow records using the Pitman Model or similar and approved to produce naturalised streamflow records of the length defined in Sub-task 1 during the Status-quo assessment.
    - Finalisation of the hydrological update to provide the various time series files required for use in the system models. These files include:
        - Rainfall records which have been infilled and extended where necessary to be used in the subsequent rainfall runoff modelling
        - Catchment rainfall files to be used in the rainfall runoff modelling
        - Point rainfall files to be used at each reservoir site used in the subsequent system modelling
        - Monthly evaporation figures to be used for each reservoir site and any other demand centre where evaporation data are required.
        - Infilled streamflow records at each gauging site used in the analyses.
        - Naturalised and extended streamflow files at each gauge included in the analysis
        - Naturalised extended streamflow records for each node used in the subsequent system modelling analyses

- A preliminary stochastic streamflow assessment to ensure that the various naturalised streamflow records are realistic and pass the basic tests for serial and cross correlation. It is assumed that the GENTST model will be used for this assessment or a model similar and approved by ORASECOM.

Deliverables

- A set of hydrological time series files for the Eastern Cape System that have been checked and verified using the various testing packages to provide the various time series files required in the subsequent yield and planning analyses.

13.2.7 SA9.7: Validation and Verification of Hydrology using Stochastic Modelling

Objectives

Having revised the hydrologies in the different sub-systems, it is necessary to undertake various checks and balances to ensure that the stochastically generated streamflow sequences to be used in the system models are realistic and can be used with confidence. This is achieved through the use of a suite of statistical checks which look at both the annual serial correlations as well as the cross correlations between each sequence. If either are not modelled correctly, the resulting yield results may be unreliable. For this reason a detailed validation and verification process is required which can be undertaken using the GENTST suite.

Methodology

- The various naturalised streamflow records at each node used in the system models should be collected and collated into a single data set of almost 300 naturalised streamflow sequences.
- The naturalised streamflow sequences will be used to create the PARAM.DAT file which incorporates all of the statistical characteristics of each record.
- The PARAM.DAT file will be used with GENTST to undertake the various statistical checks and balances to ensure that the generated stochastic sequences are realistic and have similar statistical characteristics as the original naturalised sequence.

Deliverables

- A full set of naturalised and extended streamflow sequences for the various nodes in the Orange-Senqu basin plus the various adjacent basins which are included in the system model.

- The new PARAM.DAT file containing the statistical variables for all naturalised streamflow files.
- The results from the GENTST analysis showing the results from each statistical check

13.2.8 SA9.8: Assess possible inclusion of El Nino and La Nina in the stochastic projections to improve Climate Change modelling.

Objectives

The current stochastic streamflow generation models are based on complicated and robust statistical algorithms which involve utilising the various statistical properties of the naturalised streamflow sequences to generate numerous possible future stochastic streamflow sequences at each node or reservoir in the system. These synthetic streamflow sequences can then be analysed using the Yield and Planning models to create projections of the likely future water situation at each reservoir and demand centre in the system together with estimates of the probability of failure. The stochastically generated sequences are tested to ensure that they are realistic and exhibit similar characteristics to the recorded and naturalised streamflow sequences which are generated by the hydrologists at the start of any new resource assessment.

In recent years the whole issue of the ocean temperature has become very topical as it can be used as a predictor for above average and below average rainfalls and subsequent runoffs. Knowing the status of the ocean temperatures (El Nino and La Nina) can assist in the prediction of future sequences.

Methodology

- It is therefore proposed to examine the various El Nino and La Nina events to assess the strength of the correlation between the temperature and the subsequent rainfall values to determine if the temperature can be used to improve the stochastic streamflow sequences that are being generated by the statistical models.
- In the event that there is sufficient statistical evidence to support the use of the ocean temperature as a predictor for the future flows, it is proposed that the stochastic streamflow generator is modified to improve the prediction. Great care must be taken to ensure that the stochastic sequences remain realistic and contain the same statistical characteristics as the original recorded and naturalised flow sequences. It is therefore suggested that the adjustments are relatively minor and ensure that the generated sequences remain plausible.

Deliverables

- An assessment of the ocean temperatures against the resulting annual rainfall totals to quantify if there is clear evidence at some level of statistical certainty to verify that the ocean temperature can be used as a predictor for the subsequent rainfall and runoff.
- A modification to the stochastic streamflow generator which incorporates the latest ocean temperature so that the first year (or two) of the stochastic streamflow sequences will be above or below average.
- Testing and verification of the new model to demonstrate that the stochastically generated streamflow sequences remain realistic and preserve the key statistical properties of the original recorded streamflow sequences.

13.2.9 SA9.9: Assessment of Climate Change Models to Identify Downscaling Problems

Objectives

In previous Climate Change assessments, the expected rainfall and runoff in the Orange/Senqu basin was estimated from numerous global Climate Models which are used around the world for such assessments. The models use a simple downscaling approach to create the expected rainfall on a catchment level from the overall global model. In the case of the Orange/Senqu basin it is expected that the catchment will become warmer due to global warming and that this will result in a slight decrease in rainfall over much of the basin. There is, however, no clear indication regarding the rainfall over Lesotho which may increase or decrease. This in turn creates some doubt over the expected future streamflows which may increase or decrease depending upon the rainfall over the Lesotho Highlands which provide almost 40% of the total runoff for the Orange/Senqu basin.

It is generally accepted worldwide, that the rainfall will become more intense and variable due to global warming and Climate Change. This suggests that even if the average Mean Annual Precipitation does not change, the variability (measured by the Coefficient of Variability = Standard Deviation/mean) will increase.

In the most recent assessments of the Climate Change models undertaken for the Orange/Senqu basin, it was found that the various globally accepted Climate Change Models provided rainfall estimates that were generally slightly lower than the current values but they also lost some variability during the downscaling process. This seemingly trivial observation is in fact critical to any future planning as the lower variability of the rainfall results in synthetic streamflow records that have significantly lower variability which in turn results in higher yields. In other words, despite the global models predicting lower rainfall over the Orange/Senqu basin, the resulting streamflows tend to be higher which is the opposite of what would be expected by any competent hydrology specialist. This is a very important issue as it can completely discredit the results from any Climate Change assessment undertaken in the Orange/Senqu basin and it is therefore important that it is investigated and addressed as a matter of urgency.

Methodology

- The predicted rainfall records from a selection of generally accepted Climate Change Models will be assessed for the Orange/Senqu basin to check the predicted change in Mean Annual Precipitation as well as the variability as measured by the Coefficient of Variability.
- The rainfall records predicted from the Climate Change Models will be run through a standard Rainfall-Runoff Model to assess the impact on the streamflow sequences for both the Mean Annual Runoffs as well as the annual variability of the streamflows measured by the Coefficient of Variability
- The simulated streamflow sequences will be run through a yield model to assess the impact of the changes to the yields from the system at various points.
- The process will be repeated using rainfall sequences which have been manipulated to give the same Mean Annual Precipitation as suggested from the Climate Change Models but adjusted to ensure that they have the same variability as the original rainfall sequences.

Deliverables

- A report on the results from the analyses will be provided
- A summary “paper” on the results will be provided which can be offered to the various Climate Change organisations to highlight the potential problem issue with the down-scaling process.

13.2.10 SA9.10: Assessment of Eutrophication and Salinity problems in Lower Vaal and Orange rivers

Objectives

Eutrophication and salinity are becoming important issues in certain parts of the Orange-Senqu basin. The middle and lower Vaal River as well as the Orange River downstream of the Orange-Vaal confluence are at risk due to the levels of phosphates entering the Vaal River from Gauteng and also from the many irrigation schemes downstream of Vaal Dam and along most of the Orange River downstream of its confluence with the Vaal River. It is important that the key problem areas are identified and remedial measures proposed. The key objectives of this task are therefore to identify and quantify the key problem areas affected by high salinity and eutrophication after which remedial measures can be developed.

Methodology

- Areas within the Orange Senqu basin affected by high salinity and eutrophication will be identified through discussions with representatives from the 4 Basin States.
- Having identified the key problem areas, the relevant data should be collected and examined in order to try and quantify the relevant water quality parameters such as, but not limited to TDS and phosphate/nitrate levels.
- Recommendations on remedial measures needed to address the problems should be suggested based on current best practice.

Deliverables

- A report providing details of the key problem areas supported by relevant data to quantify the salinity and eutrophication problems. The report should conclude with practical recommendations on how the problem issues can be addressed in order to lower salinity and phosphate/nitrate levels to normally acceptable levels.

13.3 Time-Schedule for Strategic Action 9

It is anticipated that the project will be undertaken over a 60-month period with an expected starting date of August 2024.

13.4 Team Requirements for Strategic Action 9

- **Eligibility** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Composition of the Study Team** (To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)
- **Qualifications/Experience(**To be finalised after the Terms of Reference and Scope of Work have been agreed by ORASECOM – See **Section 5.4** for example layout)

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

COMPONENTS I AND II

ROADMAP SUPPORTING REPORT

APPENDIX B

STRATEGIC ACTIONS : CONCEPT NOTES

Orange-Senqu River Commission (ORASECOM)

Von Willich LN, C nr Von Willich LN & Lenchen Avenue, Corporate 66 Office Park, Block A

Prepared by

in association with

ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER

Strategic Actions

Summary of Proposed Key Strategic Actions

Proposed Key Strategic Actions

As part of the final deliverable from Component ll of this study a report has been written which describes a number of Key Strategic Actions and possible Road-Map for their implementation. The report provides details of potential Strategic Actions which support the road map and operational plan for ORASECOM to rollout the implementation thereof, over the coming years for activities under its direct operational responsibility. Following the completion of the first phase of the project, 17 possible strategic actions were identified by the project team which it considered could be included in future projects to be undertaken through ORASECOM.
The 17 Strategic Actions which were initially identified were discussed and through a lengthy selection process which is fully described in the relevant report a short-list of 9 key Strategic Actions were finally selected. identified and are discussed in detail in Sections 5 to 13 of the report. The 9 key Strategic Actions are listed below together with a preliminary estimate of the budget that will be required to complete the work. Each Strategic Action is presented individually in the form of a 2-page summary in the remainder of this spreadsheet in a format designed to allow funding partners to understand the scope of work and likely budget so that they can evaluate the potential for either normal loan funding or alternatively grant funding or even some combination of the two.

Key Strategic Actions Discussed in this Spreadsheet

SA1 Agreement and Implementation of Environmental Water Requirements. ($1m to $5m plus $1m per annum)
SA2 Improvement and Implementation of Monitoring and Information Management + Hydraulic Model ($5m +$1m per annum)
SA3 Development and Implementation of Guidelines for sharing. ($1m)
SA4 Synchronisation and Preparation of Future and Planned Developments ($1m)
SA5 Implementation and monitoring of WDM Activities ($1m)
SA6 Assurance of Supply and Economic Value of Water ($1m)
SA7 Water Disaster Management and Climate Adaptation ($2m to $3mil)
SA8 Capacity Building (3 year programme) ($2m + $2m every 3 years)
SA9 Hydrology Update and WQ Model Calibration ($5m)

ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 1

Agreement and Implementation of Environmental Water Requirements

Project Description

The preliminary desired Environmental Water Requirements from an environmental point of view have already been determined in various previous studies undertaken over the past 30 years. System analyses showed that these Environmental Water Requirements, in particular those for Augrabies and downstream, including the Orange River estuary environmental requirements, significantly reduce the yield available from the resources (Gariep and Vanderkloof dams). These Environmental Water Requirements do not represent the final Environmental Water Requirements to be implemented and adhered to, according to the South African legislation. Another process must first be completed to find a balance between achieving the desired ecological state and the impact on the economy of the region. This balance needs to be agreed on by all role-players. Only then, can the final agreed Environmental Water Requirements be imposed on the system. These Environmental Water Requirements are then referred to as the Reserve and are published in the Government Gazette so that it can be lawfully implemented and enforced.

The reserve for the Orange River is currently unknown, and the old and outdated estuary environmental requirements determined as part of the Orange River Replanning Study (DWAF, 1996) is currently still released (287.5 million m3/a) from Vanderkloof Dam. Based on the latest Environmental Water Requirement studies carried out, a Preliminary Reserve for the Lower Orange was determined and approved by DWS RSA (DWS, 2017). The Preliminary Reserve used the latest Environmental Water Requirement estimations but were adjusted so that they do not impact negatively on the current Orange River Project (Gariep and Vanderkloof Dams) system yield.

The final agreed Reserve still needs to be determined and is expected to be somewhere between the preliminary Reserve requirements (average of ±533 million m3/a) and those of the preferred Environmental Water Requirement (average of ± 942 million m3/a) as defined by the environmentalists.

It is noted that ORASECOM has recently appointed a Service Provider to undertake certain work and investigations to establish the Environmental Water Requirements in the Orange/Senqu basin. It is therefore important to ensure that the proposed work envisaged for Strategic Action 1 will compliment the work being undertaken currently and should not duplicate or diverge from the existing efforts. In this regard, the current project has been split into several phases, the first of which is being undertaken by the Service Provider. The remaining phases have not yet been fully defined and no budget has been allocated to them.

The proposed tasks outlined under Strategic Action 1 will therefore form the basis for the future phases of the Environment assessments being undertaken by the Service Provider and will hopefully provide the necessary funding needed to complete the work that has already been envisaged by the team.

This assignment will be undertaken in the following Tasks:

- SA1.1: Inception Report (must include details of GAP Analysis being currently undertaken)
- SA1.2: Design an eFlow Monitoring Programme
- SA1.3: Prepare an eFlow Implementation Agreement for the Orange/Senqu basin
- SA1.4: Develop an Implementation Plan to prioritse sites for eFlows
- SA1.5: Develop a Management Plan for the Orange River Mouth

The cost of the study to establish the final agreed Environmental Water Requirements or Reserve to be implemented in the Orange River System is estimated to be between $1million and $5 million depending upon the scope of work that is agreed upon.

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	Namibia
Supporting 2	Lesotho
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	X
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 1

Agreement and Implementation of Environmental Water Requirements

1: Involvement of ORASECOM		**2: Countries involved**	
High	X	Botswana	
Significant		Lesotho	X
Medium		Namibia	X
Limited		South Africa	X

3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	
Low Priority		Low to None	X

5:Funding Required		**6: Likley Loan Period**	
Normal Loan		1 to 5 Years	X
Loan and Donor		6 to 20 Years	
Donor Only	X	More than 20 Years	

7: Type of Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	X
Only during construction		Neutral	
None	X	Negative	

9: Socio economic influence		**10: Influence on local communities**	
High	X	Positive	X
Medium		Neutral	
Low		Negative	

11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution		Moderate contribution	
Little or no contribution	X	Little or no contribution	X

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 2

Improvement and Implementation of Monitoring and Information Management Systems

Project Description

Monitoring of hydrological and hydro-meteorological data is the responsibility of each country and departments already exist in the 4 basin states tasked with the collection and processing of such data and associated information. In the case of the Orange/Senqu River Basin it is important to co-ordinate the data collection and dissemination to avoid unnecessary duplication and try to ensure that the data are managed to the benefit of all basin states. While it is recognised that each country will wish to exercise its own preferences with regard to equipment and storage/processing procedures, it is important to try and develop a system whereby each country has access to all information in the Orange/Senqu River Basin. In this regard, ORASECOM can act in a facilitation role where it can direct and co-ordinate the efforts required to develop a comprehensive data-base for the basin as a whole that is freely available to the member states.

The key focus for Strategic Action 2 will concentrate on the Real-Time monitoring system and associated Hydraulic Model. This is considered one of the most important tasks mentioned as it can deliver very significant savings with a very short “pay-back” period from a financial viewpoint.

It will also be very useful to have a proper aerial survey of the Orange River, particularly from Van der Kloof Dam to the mouth. A 2-D hydraulic model will assist in disaster management during times of flooding as early warning, predicting flood levels and areas of inundation well ahead of the flood.

This assignment will be undertaken in the following Tasks:

•SA2.1: Inception Report

•SA2.2: Status Quo Assessment (previous studies, available data sets, model calibrations, details of all measured cross sections

•SA2.3: Collection and collation of river data (cross-sections, riparian vegetation, roughness, historical floods and drought routings etc.,)

•SA2.4: Liaison with local specialists involved with flood and low flow measurements including discussions and info collection from Farmers Associations and DWS/Namibian DWA and Eskom

•SA2.5: Assessment of gauging network (real time monitoring as well as needs for new equipment and new gauging stations

•SA2.6: Establish water balance components for each river section

•SA2.7: Set up and calibrate (high and low flows) hydraulic river model using an open source model such as HEC-RAS (or similar and approved by ORASECOM) – based on the historical flow records

•Task 8: Test new operating rules with and without the Noordoewer/Vioolsdrift Dam to improve efficiency of releases from Vanderkloof Dam and impact of changes to the Reserve at the River Mouth.

•Task 9: Initiate discussions with DWS and DWA Namibia in order to set up a Dashboard to interact with the model using the real-time data in order to transfer ownership and operation of the model to the custodian.

•Task 10: Improvement of monitoring networks basin-wide. (irrigation use, groundwater, water quality, surface water, Climate Mitigation Monitoring (evaporation, rainfall temp etc),

The cost of the proposed is estimated to be $5 million. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalization of the TOR for the study.

ies

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	Namibia
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	X
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 2

Improvement and Implementation of Monitoring and Information Management Systems

1: Involvement of ORASECOM		**2: Countries involved**	
High	X	Botswana	X
Significant		Lesotho	X
Medium		Namibia	X
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Low to None	
5:Funding Required		**6: Likley Loan Period**	
Normal Loan		1 to 5 Years	
Loan and Donor	X	6 to 20 Years	X
Donor Only		More than 20 Years	
7: Type of Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	X
Only during construction		Neutral	
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	X
Medium		Neutral	
Low	X	Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	X
Moderate contribution	X	Moderate contribution	X
Little or no contribution		Little or no contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 3

Development and Implementation of Guidelines for Sharing of water resources

Project Description

Possible new dam developments have been proposed in the ORASECOM Basin Wide Investment Plan which will help to supply water to both users in the upstream areas as well as users in adjacent countries including Namibia, South Africa and Botswana. In view of the fact that the available yield from the Orange-Senqu basin is currently fully utilized, any new development abstracting or diverting water from the upper reaches of the basin will result in shortages lower down in the system. To address such shortages, any new development must therefore be accompanied by some form of augmentation development to restore the water balance and to protect all downstream users. When many of the previous dams were constructed in the Orange/Senqu basin, there was excess water available in the basin with the result that there was no need to mitigate for the reduced water available in the lower reaches of the Orange/Senqu river. In the past 10 to 20 years, however, the situation has changed, and any new developments must be identified and quantified to ensure that the water resources are shared in an equitable and reasonable manner.

For each possible future water resource development option, detailed analyses have been undertaken to assess both the maximum gross yield from the proposed project as well as the net yield from a systems context. It must be noted that the difference between the gross and net yields need not be released from the proposed development but must be addressed through some form of mitigation measures which can include, mitigation releases, a new dam lower in the system, the purchase of some existing water rights somewhere in the system, or the recovery of water losses etc. The solution must be carefully considered and evaluated properly in a systematic and pragmatic manner through proper debate and discussion between the four countries involved.

This assignment will be undertaken in the following Tasks:

- SA3.1: Inception Report
- SA3.2: Evaluation of existing legislation, conventions and protocols on water sharing to identify those factors and circumstances that must be taken into account for the utilization of an international watercourse in an equitable and reasonable manner;
- SA3.3: Identification of relevant factors to be evaluated for each potential development option identified in the Core Scenario Basin Wide Investment Plan
- SA3.4: Workshop the various development options and key factors using a Balanced Scorecard or Multi Criteria Analysis approach or similar.
- SA3.5: Summarise the results in a final report.

The cost of the proposed is estimated to be $1 million. It should be noted that this is a preliminary estimate at this stage which will be reviewed and refined during the finalization of the TOR for the study.

ies

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	
Supporting 1	Botswana
Supporting 2	Lesotho
Supporting 3	Namibia
Supporting 4	South Africa

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	
Less than 1 million USD	X

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 3

Development and Implementation of Guidelines for Sharing of water resources

1: Involvement of ORASECOM		**2: Countries involved**	
High	X	Botswana	X
Significant		Lesotho	X
Medium		Namibia	X
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Low to None	
5:Funding Required		**6: Likley Loan Period**	
Normal Loan		1 to 5 Years	X
Loan and Donor		6 to 20 Years	
Donor Only	X	More than 20 Years	
7: Type of Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	X
Only during construction		Neutral	
None	X	Negative	
9: Socio economic influence		**10: Influence on local communities**	
High	X	Positive	X
Medium		Neutral	
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	X
Moderate contribution		Moderate contribution	
Little or no contribution	X	Little or no contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 4

Synchronisation and Preparation of Future and Planned Developments

Project Description

Based on a number of recent studies, it is clear that there are a large number of new and proposed future water resource developments in various parts of the Orange/Senqu River Basin. The proposed recent and near future developments include:

- A dam on the Makhaleng river in Lesotho and associated transfer scheme,
- A dam on the Lower Orange River at Noordoewer/Vioolsdrift.
- The Polihali Dam which is under construction in Lesotho;
- The recently completed Metolong Dam in Lesotho
- The recently completed Neckartal Dam in Namibia
- A dam on the upper Orange River in South Africa at Verbeeldingskraal
- The Hlotse Dam in Lesotho,
- The Ngoajane Dam in Lesotho
- Several possible hydro-power schemes in Lesotho.

In addition, the potential to supply water to Bloemfontein from a new dam in Lesotho appears to be a viable option that requires additional investigation. In the event that a new dam is commissioned on the Makhuleng River it will be necessary to complete a study to assess possible augmentation options to restore the yield to the Orange River Project.

All of these schemes are interlinked, as they are all utilising the same resource, namely the Senqu/Orange River. All of these schemes will therefore impact on each other to some degree, with some of the impacts being significant and others relatively small. Due to the associated impacts, it will not be possible to operate these schemes as stand-alone schemes, and they must therefore be operated and managed as part of the larger system. Results from the Core Scenario analyses already highlight that the operating rules used for each scheme, as well as operating rules between the schemes, significantly impact on the water supply to the different users, as well as to the overall optimal utilisation of the system as a whole.

It is therefore recommended that a study is commissioned to identify and harmonise the different development options to the benefit of the system as a whole.

This assignment will be undertaken in the following Tasks:

- SA4.1: Inception Report
- SA4.2: Status Quo Assessment
- SA4.3: Identification of Net and Gross Yields for each development option.
- SA4.4: An augmentation study to restore the water balance in the lower Orange River in the event of a new dam on the Makhuleng River.
- SA4.5: Identification and investigation of selected key operating rules
- SA4.6: Preliminary investigation of Legal Agreements (in conjunction with Strategic Action 3)
- SA4.7: Organise and manage workshop to discuss and refine selected key operating rules
- SA4.8: Identification of new monitoring points and gauging sites to facilitate possible new operating rules
- SA4.9: Undertake Annual Operating Analyses with representatives from the 4 Basin States (co-ordinate with possible existing study on this topic).

ies

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	
Supporting 1	Botswana
Supporting 2	Lesotho
Supporting 3	Namibia
Supporting 4	South Africa

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	
Less than 1 million USD	X

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 4

Synchronisation and Preparation of Future and Planned Developments

1: Involvement of ORASECOM		**2: Countries involved**	
High	X	Botswana	X
Significant		Lesotho	X
Medium		Namibia	X
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Low to None	
5:Funding Required		**6: Likley Loan Period**	
Normal Loan		1 to 5 Years	X
Loan and Donor		6 to 20 Years	
Donor Only	X	More than 20 Years	
7: Type of Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	X
Only during construction		Neutral	
None	X	Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	X
Medium	X	Neutral	
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Little or no contribution	X	Little or no contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 5

Implementation and monitoring of WDM Activities

Project Description

Water Conservation and Water Demand Management have been identified as important components of all future water resource assessments throughout the Orange /Senqu River Basin. The impact of WC/WDM can be very significant in many areas where water losses are known to be high and can sometimes be in the order of 30% to 50% of the total municipal water demand. Reducing such water losses is not easy and cannot be implemented overnight, but with proper support both financially and technically, it will be possible to achieve significant savings, which in turn will have a significant impact on the overall water balance in the Orange/Senqu River Basin. It has been shown in many cases that the cheapest solution to provision of "new" water resources is to identify and reduce existing water losses in large urban water supply systems. In many planning studies and reports, the reduction in water losses has already been factored into the future projected water demands. Results from the WRPM Core Scenario analyses have already highlighted that failure to successfully implement the anticipated WC/WDM interventions will result in significant deficits in water supply in the main water supply systems within the Orange/Senqu basin. This will include all users, irrigation, industry and urban.
A study is therefore recommended to set up a system to identify the key focus areas for WC/WDM throughout the Orange/Senqu River Basin and to ensure that the related actions are implemented successfully and maintained over time.

This assignment will be undertaken in the following Tasks:

- SA5.1: Inception Report
- SA5.2: Status Quo Assessment (check what docs are already available in public domain)
- SA5.3: Identification and collection of data on real case studies
- SA5.4: Create a template report/framework for implementing and monitoring an agricultural WDM project
- SA5.5: Create a template report/framework for implementing and monitoring a Municipal/Industrial WDM project
- SA5.6: Develop an inventory of WC/WDM initiatives and prioritise them for implementation basinwide.
- SA5.7: Organise a conference in one of the basin states to discuss and disseminate info on WC/WDM with impacts of Climate Change.
- SA5.8: Selection of 2 Agricultural (SA and Namibia) and 4 Industrial/Municipal (one in each country) case studies for future monitoring and assessment
- SA5.9: Assess impacts of Climate change on future WC/WDM activities.
- SA5.10: Create monitoring and auditing dashboard

ies

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	
Supporting 1	Botswana
Supporting 2	Lesotho
Supporting 3	Namibia
Supporting 4	South Africa

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	
Less than 1 million USD	X

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 5

Implementation and monitoring of WDM Activities

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	X
Significant	X	Lesotho	X
Medium		Namibia	X
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority		High	
Medium Priority	X	Medium	X
Low Priority		Low to None	
5:Funding Required		**6: Likley Loan Period**	
Normal Loan		1 to 5 Years	X
Loan and Donor		6 to 20 Years	
Donor Only	X	More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	X
Only during construction		Neutral	
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	X
Medium	X	Neutral	
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	X
Moderate contribution	X	Moderate contribution	
Little or no contribution		Little or no contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 6

Assurance of Supply and Economic Value of Water

Project Description

In most parts of the world the water resources in a river basin are distributed by simply allocation the available historical system yield to meet the various demands. Water is often utilised by the demand centres highest up in the river basin and those lower down in the system experience shortages during periods of drought. As the demands increase due to population growth the droughts become more severe exacerbated by the impacts of global warming and Claimet Change. The water supply situation in many river basins throughout the World is deteriorating and will continue to do so without proper agreements and management. The issue of assurance of supply is seldom discussed and rarely, if ever, taking into account when the available water resources are allocated. The problem is compounded in many parts of the world where the available water resources were estimated using outdated techniques which often leads to legal allocations that exceed the firm yields of the systems.

South Africa was one of the first countries in the world to develop and use risk-based water allocations based on the "assurance of supply" concepts developed by the USA, Canada, South Africa, and the UK during the 1980's and 1990's. These same techniques have been adopted by many countries around the world and in particular in the SADC region of Africa where they form the backbone of water planning and water resource management in Southern Africa. The system models are used to assess and allocate the available resources to the different users based not only on the historical firm yield of each system but also on the assurance of supply which is derived from the system models and the use of stochastically generated streamflow sequences. This approach to water management has proven itself to be very robust and a valuable tool for operation and managing some of the most complicated water resource systems in the world.

Despite the obvious benefits of the assurance of supply-based models available to the 4 basin states, it is currently clear that none of the basin states currently applies the assurance of supply on the same basis. The Basin States must therefore discuss this issue and agree on how the risk of failure of the water supply should be managed in a concise and pragmatic manner and to determine what level of assurance is affordable in each case so that the available water can be used optimally to the benefit of each country.

This assignment will be undertaken in the following Tasks:

- **SA6.1: Inception Report**
- **SA6.2: Status Quo Assessment**
- **SA6.3: Agree on a standard approach regarding assurance of supply (stand-alone schemes and integrated systems) throughout the Orange-Senqu basin**
- **SA6.4: Assess the economic impact of the Assurance of Supply (refer to WRC project)**
- **SA6.5: Provide training on the concepts of assurance of supply**
- **SA6.6: Agree on how restrictions will be determined and applied during drought periods**

ies

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	
Supporting 1	Botswana
Supporting 2	Lesotho
Supporting 3	Namibia
Supporting 4	South Africa

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	
Less than 1 million USD	X

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 6

Assurance of Supply and Economic Value of Water

1: Involvement of ORASECOM		**2: Countries involved**	
High	X	Botswana	X
Significant		Lesotho	X
Medium		Namibia	X
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	X
Medium Priority		Medium	
Low Priority		Low to None	
5:Funding Required		**6: Likley Loan Period**	
Normal Loan		1 to 5 Years	X
Loan and Donor		6 to 20 Years	
Donor Only	X	More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	X
Only during construction		Neutral	
None	X	Negative	
9: Socio economic influence		**10: Influence on local communities**	
High	X	Positive	
Medium		Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution	X	Significant contribution	X
Moderate contribution		Moderate contribution	
Little or no contribution		Little or no contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 7

Water Disaster Management and Climate Adaptation

Project Description

In most integrated water supply systems, there are guidelines and operating rules in place to manage the overall water resource during drought events. Unfortunately, when a very severe drought does occur, it is often the case that the guidelines and operating rules are ignored as the water managers try to deal with specific problem areas and in such cases the whole allocation system can collapse with severe consequences. This issue arose recently in the Western Cape area where the City of Cape Town was within a few months of completely running out of water. Part of the problem was the fact that there were conflicting demands, between the irrigators and the municipality – both of which had their own allocations at specific levels of assurance as defined through many years of rigorous modelling. The agreed operating rules were in many cases not applied, and if a retrospective analysis is undertaken, it will show that the actual levels of assurance provided to the irrigators and the municipality during the drought were not as originally agreed.
It is therefore recommended that some form of mock drought disaster event is simulated involving participants from all four basin states to demonstrate exactly what will happen in the event of a severe drought. It will be less painful to identify the possible conflicts during a simulation exercise, rather than wait until the real event takes place and a new "day-zero" in the Orange/Senqu River Basin becomes a reality

This assignment will be undertaken in the following Tasks:
SA7.1: Inception Report - Status Quo Assessment for floods and droughts
SA7.2: Economic and social impacts of water supply failure
SA7.3: Co-operation between basin countries during times of disaster management
SA7.4: Compile a list of previous drought events from around the world that can be used to provide guidance to ORASECOM during the next severe drought
SA7.5: Workshop for potential extreme drought event
SA7.6: Develop a drought management plan for the basin

ies

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	Botswana
Supporting 2	Lesotho
Supporting 3	Namibia
Supporting 4	South Africa

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	X
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 7

Water Disaster Management and Climate Adaptation

1: Involvement of ORASECOM		2: Countries involved	
High	X	Botswana	X
Significant		Lesotho	X
Medium		Namibia	X
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	X
Medium Priority		Medium	
Low Priority		Low to None	
5:Funding Required		**6: Likley Loan Period**	
Normal Loan		1 to 5 Years	X
Loan and Donor		6 to 20 Years	
Donor Only	X	More than 20 Years	
7: Type of Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	X
Only during construction		Neutral	
None	X	Negative	
9: Socio economic influence		**10: Influence on local communities**	
High	X	Positive	X
Medium		Neutral	
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Little or no contribution		Little or no contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 8

Capacity Building

Project Description

In order to ensure transparency and to facilitate future co-operation between the four basin states, it is recommended that an annual meeting should take place to share the basic hydrological and water demand data and to discuss the training needs of each country with regard to the overall operation of the Orange-Senqu water resource system. The proposed project will help to:

- **Facilitate the sharing of information required to ensure the Integrated Water Resource Management Plan remains relevant;**
- **Evaluate the implication of new initiatives or plans and revised information (pertaining to the water balance) have on the Core Scenario and recommend reviews or updates of the Integrated Water Resource Management Plan;**
- **Discuss the implications of these changes and updates, the progress or lack in progress of individual system strategy implementation programmes, as well as that of the ORASECOM Integrated Water Resource Management Plan implementation programme, on the entire Orange-Senqu River System, as indicated or supported by Water Resources Planning Model scenario analyses (when required)**
- **Provide recommendations on possible adjustments to the Core Scenario and Integrated Water Resource Management Plan, as well as whether specific components/issues or problem areas require more in-depth investigation/study by specialised task groups;**
- **Keep the model up to date with the latest information, plans and implementation progress of existing strategies and or water resource plans, from all the basin states as well as the status regarding the ORASECOM Integrated Water Resource Management Plan implementation;**
- **Determine or table specific training/capacity building requirements.**

This assignment will be undertaken in the following Tasks:

SA8.1: Inception Report and Agreement on Training Modules to be developed
SA8.2: Design of Standard Video Training Module
SA8.3: Discussion and Refinement of Video Training Module Structure
SA8.4: Development of Remaining Video Training Modules
SA8.5: Development of Web site to host Training Modules
SA8.6: Development of supporting documentation to Support Video Training Modules

ies

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	
Supporting 1	Botswana
Supporting 2	Lesotho
Supporting 3	Namibia
Supporting 4	South Africa

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	X
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 8

Capacity Building

1: Involvement of ORASECOM		2: Countries involved	
High	X	Botswana	X
Significant		Lesotho	X
Medium		Namibia	X
Limited		South Africa	X

3: Priority		4: Impact on Climate Resilience	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Low to None	

5:Funding Required		6: Likley Loan Period	
Normal Loan		1 to 5 Years	X
Loan and Donor		6 to 20 Years	
Donor Only	X	More than 20 Years	

7: Type of Job Creation		8: Impact on possible Conflicts Between Basin States	
Long term jobs	X	Positive	X
Only during construction		Neutral	
None		Negative	

9: Socio economic influence		10: Influence on local communities	
High		Positive	
Medium	X	Neutral	X
Low	X	Negative	

11: Yield contribution		12: Contribution to alleviating water scarcity	
Significant contribution		Significant contribution	
Moderate contribution		Moderate contribution	X
Little or no contribution	X	Little or no contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 9

Hydrology Update and Calibration of Water Quality Model

Project Description

The hydrological data sets used to manage the Orange-Senqu basin are currently based on observed flows covering the period 1920/21 to 2004/05 which provides 85 years of data. The hydrological data sets were last updated over 15 years ago and they can now be improved by adding the last 15 years of recorded rainfall and streamflow data. It is normal practice is to update the hydrology after 15 to 20 years or shortly after a severe drought has passed. During the last 16-year period some severe dry years have occurred over most parts of the basin and it is important to include such information to improve the accuracy of the water resource assessments. In addition it is very important to include all recent rainfall and streamflow data to ensure that trends and changes resulting from possible Climate Change can be identified as soon as possible. The updated hydrological records will then also be able to generate more realistic stochastic sequences which are used for modelling and planning purposes.

Work carried out as part of the climate change task of the current study suggests that the stochastic flow band was, in general, wide enough to capture the spread of expected flows and yield results obtained from the different climate change models. Capturing the latest rainfall and rainfall runoff characteristics will improve the capability of the stochastic models to provide realistic future streamflow and rainfall predictions used for future planning and operating analyses to account for possible changes due to climate change.

This assignment will be undertaken in the following Tasks:

- SA9.1: Inception Report and Status Quo Assessment of Hydrology, Water Quality, and Groundwater interaction (where appropriate).
- SA9.2: Update of Lesotho and Caledon Hydrology
- SA9.3: Update Upper and Middle Orange Hydrology plus Riet and Modder
- SA9.4: Update Lower Orange plus Namibia plus River Losses from Vanderkloof Dam, including water quality and groundwater interaction.
- SA9.5: Update of Vaal, Usutu, Komati and Tugela Hydrology, including water quality and groundwater interaction.
- SA9.6: Assessment of Eastern Cape System
- SA9.7: Validation and Verification of Hydrology using Stochastic Modelling.
- SA9.8: Assess possible inclusion of El Nino and La Nina in the stochastic projections to improve Climate Change modelling.
- SA9.9: Assessment of Climate Change models to investigate potential downscaling problems
- SA9.10: Assessment of Eutrophication and Salinity problems in Lower Vaal and Orange rivers.

ies

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	
Supporting 1	Botswana
Supporting 2	Lesotho
Supporting 3	Namibia
Supporting 4	South Africa

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	X
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Strategic Action 9

Hydrology Update and Calibration of Water Quality Model

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	X
Significant		Lesotho	X
Medium	X	Namibia	X
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority		High	
Medium Priority	X	Medium	X
Low Priority		Low to None	
5:Funding Required		**6: Likley Loan Period**	
Normal Loan		1 to 5 Years	X
Loan and Donor		6 to 20 Years	
Donor Only	X	More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	X
Only during construction		Neutral	
None	X	Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium		Neutral	X
Low	X	Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution		Moderate contribution	X
Little or no contribution	X	Little or no contribution	

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

COMPONENTS I AND II

ROADMAP SUPPORTING REPORT

APPENDIX C

CORE SCENARIO : CONCEPT NOTES

Orange-Senqu River Commission (ORASECOM)

Von Willich LN, C nr Von Willich LN & Lenchen Avenue, Corporate 66 Office Park, Block A

Prepared by

in association with

ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT	Cluster	1

Orange River Project + Noordoewer/Vioolsdrift Dam Cluster related development Projects

Development Options Core Scenario

The Basin Wide Investment Plan and the Core Scenatio development options comprises projects that had already been identified by the basin states, and which had been subject to various levels of planning. The projects were grouped into clusters based on the larger schemes or sub-systems of which they formed one of the key components. The following Clusters were concidered:

1) Orange River Project (ORP) + Noordoewer/Vioolsdrift Dam future improvements.
2)Lesotho Botswana Water Transfer Scheme.
3)Lesotho Lowlands Water Project
4)Integrated Vaal River System Intervention Options.
5)Caledon to Greater Bloemfontein transfer.
6)Greater Bloemfontein internal resource improvements
7)Gariep to Greater Bloemfontein Transfer.
8)Neckartal Dam Scheme
9)Integrated Water management actions.

Projects forming part of the Orange River Project Cluster.

1a) Utilise 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 m3. 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. 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. RSA DWS will most probably install this option once Polihali Dam started to inundate water and the ORP system is moving into a dry cycle.

1b)Real-time monitoring and modelling Orange River:
This option already forms part of one of key strategiec action 2. Thus no need to provide details here.

1c) 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 and just upstream of the Aliwal North Town. The initial planning is to construct a 67m high dam (FSL) with a 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 impacteddue to 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 construction cost of the dam is estimated at R4.0 billion and the annual operating cost at R12 million at 2018 prices.

1**d) Orange River agreed EWRs (Ecological Reserve)**
This project was selected as one of the Strategic actions (Strategic Action 1) and will not be discussed here.

1e)Noordoewer-Vioolsdrift Dam
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. A feasibility study has already been completed and at the time of writing this report the decision on confirming the dam size had yet to be taken (between 400 and 2800 mil m3) . A bridging study will soon start with the main aim to determine and agree on the size of the dam, bearing in mind the EWR impacts.

1f) Development of 12 000 ha for resource-poor farmers in the RSA from the ORP
These developments are almost completed and is driven by DWS RSA.

1 g) Polihali Dam (Lesotho Highlands Water Project (LHWP) Phase ll and connecting tunnel to Katse Dam; using new operating rule
The construction of this scheme started in 2023

ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Project 1a

Utilize the lower-level storage in Vanderkloof Dam

Project Description

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 m3 to 3 023 million m^3, with the gross storage of the dam being 3 188 million m^3.

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 **$9.47 million** and the cost of operating the dam is estimated to increase by about **$0.53 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.

This is a quick win project in that construction can commence almost immediately. 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 inundation and construction of Polihali Dam.

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	Namibia
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	X
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Project 1a

Utilize the lower-level storage in Vanderkloof Dam

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	
Medium		Namibia	X
Limited	X	South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Small	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor		6 to 20 Years	X
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	X
During construction	X	Neutral	
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	X
Medium		Neutral	
Low	X	Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Small contribution		Low contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Project 1c

Building of the Verbeeldingskraal Dam upstream of the Gariep Dam

Project Description

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. There is a high possibility that Lesotho, Botswana and RSA will look at an intervention option to re-balance the ORP after the construction of Makhaleng Dam. Verbeeldingskraal Dam might then be a good option to conder to re-balance the ORP due to the impacts of both Polihali and Makhaleng dams.

The dam site is located in the Orange River just upstream of the Aliwal North Town. Only a low level reconaicance level study was carried out untilnow. Pre-feasibility and feasibility studies still need to take place. This should include to also look at possible other dam sites as well as the raising of Gariep Dam.

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 this dam is estimated at **$210.5 million** and the annual operating cost at **$0.63 million/a** at 2018 prices.

STRATEGIC ACTION

Strategic action being supported	Specific action
Valuable input from SA3 & SA4	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	Namibia
Supporting 2	Possibly Lesotho
Supporting 3	Possibly Botswana
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	X
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER

Project 1c

Building of the Verbeeldingskraal Dam upstream of the Gariep Dam

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	X
Significant		Lesotho	X
Medium	x	Namibia	X
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	X
Medium Priority		Medium	
Low Priority		Small	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	X
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	X
During construction	X	Neutral	
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution	X	Significant contribution	X
Moderate contribution	X	Moderate contribution	X
Small contribution		Small contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Project 1e

Noordoewer-Vioolsdrift Dam

Project Description

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 final dam size is still to be determined and will be between 400 mil m3 and 2800mil m3.
A feasibility study was already completed. Due to EWR impacts agreement on the size of the dam could not be obtained. A bridging study will soon start with the main aim to determine and agree on the size of the dam, bearing in mind the EWR ipmacts. 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.
It is expected that the Noordoewer/Vioolsdrift Dam yield may 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.
1) 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.
2) 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 $231.6 million and the annual operating cost at $0.68 million/a although the costs will change and depend upon the final size of dam selected.

STRATEGIC ACTION

Strategic action being supported	Specific action
Valuable input from SA3 & SA4	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	Namibia
Supporting 1	RSA
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	X
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER

Project 1e

Noordoewer-Vioolsdrift Dam

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	
Medium	x	Namibia	X
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Small	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	X
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	X
During construction	X	Neutral	
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	X
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Small contribution		Small contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Cluster **2**

Lesotho Botswana Water Transfer Scheme

Development Options Core Scenario

The Basin Wide Investment Plan and the Core Scenatio development options comprises projects that had already been identified by the basin states, and which had been subject to various levels of planning. The projects were grouped into clusters based on the larger schemes or sub-systems of which they formed one of the key components. The following Clusters were conciderred:

1) Orange River Project (ORP) Scheme future improvements.

2)Lesotho Botswana Water Transfer Scheme.

3)Lesotho Lowlands Water Project

4)Integrated Vaal River System Intervention Options.

5)Caledon to Greater Bloemfontein transfer.

6)Greater Bloemfontein internal resource improvements

7)Gariep to Greater Bloemfontein Transfer.

8)Neckartal Dam Scheme

9)Integrated Water management actions.

Projects forming part of the Lesotho Botswana Water Transfer Scheme

2a) Future Dam on the Makhaleng River in Lesotho :

Based on the results from the Phase ll Pre-feasibility Study (Feasibility study is already in process) 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. The capital cost of the dam is estimated at R4.1 billion for the Arch dam option.

2b) L-BWTS Conveyance System

The recommended pipeline route is the Central Route and was proposed to be a fully piped option that will transport raw water from a proposed weir located just downstream of the proposed dam site on the Makhaleng River in Lesotho, to a proposed outfall upstream of Nnywane Dam in Botswana over 688 km away. Following pre-feasibility level hydraulic analysis, steel pipe with diameters ranging from 2 200 mm to 1 100 mm are required. 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.

ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Project 2a

Proposed Future Dam on the Makhaleng River

Project Description

Based on the results from the Phase ll Pre-feasibility Study (Feasibility study is already in process) the dam will have a wall height of about 126 m at full supply level and storage of 1 133 million m3 (3 MAR dam). The gross yield from a 3 MAR Makhaleng Dam at the N1A site was determined as 334 million m3/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 **$216 million** and the annual operating cost at **$1.1 million/a** for the Arch dam option.

STRATEGIC ACTION

Strategic action being supported	Specific action
SA3 & SA 4 will provide important inputs	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	Lesotho
Supporting 1	Botswana
Supporting 2	RSA
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	X
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT	Project	2a

Proposed Future Dam on the Makhaleng River

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	X
Significant		Lesotho	X
Medium	X	Namibia	X
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Small	
5: Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	X
7: Type of Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	
During construction	X	Neutral	
None		Negative	X
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Small contribution		Small contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Project 2b

LBWT Conveyance System

Project Description

The recommended pipeline route is the Central Route and was proposed to be a fully piped option that will transport raw water from a proposed weir located just downstream of the proposed dam site on the Makhaleng River in Lesotho, to a proposed outfall upstream of Nnywane Dam in Botswana over 688 km away. Following pre-feasibility level hydraulic analysis, steel pipe with diameters ranging from 2 200 mm to 1 100 mm are required to deliver the required design flows ranging from 8 731 l/s to 2 735 l/s resulting in pipe velocities between 1.3 m/s and 2.9 m/s. As a result of the total dynamic head requirement at the discharge in Botswana, a combination of high lift pump stations, booster pump stations and break-pressure tanks will be required. The capital cost of the pipeline is estimated at **$2.53 billion** and the annual operating and pumping cost at the full supply capacity of the transfer system at **$44.1 million/a**. 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. Lesotho urban ±22 million m^3/a Botswana urban 156 million m^3/a.

STRATEGIC ACTION

Strategic action being supported	Specific action
SA3 & SA 4 will provide important inputs	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	Lesotho
Supporting 1	Botswana
Supporting 2	RSA
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	X
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER

Project 2b

LBWT Conveyance System

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	X
Significant		Lesotho	X
Medium	x	Namibia	
Limited		South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	X
Medium Priority		Medium	X
Low Priority		Small	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	X
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	
During construction	X	Neutral	X
None		Negative	X
9: Socio economic influence		**10: Influence on local communities**	
High	X	Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	X
Moderate contribution	X	Moderate contribution	X
Small contribution		Small contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT	Cluster	3

Lesotho Lowlands Water Project

Development Options Core Scenario

The Basin Wide Investment Plan and the Core Scenatio development options comprises projects that had already been identified by the basin states, and which had been subject to various levels of planning. The projects were grouped into clusters based on the larger schemes or sub-systems of which they formed one of the key components. The following Clusters were conciderred:

1) Orange River Project (ORP) Scheme future improvements.
2)Lesotho Botswana Water Transfer Scheme.
3)Lesotho Lowlands Water Project
4)Integrated Vaal River System Intervention Options.
5)Caledon to Greater Bloemfontein transfer.
6)Greater Bloemfontein internal resource improvements
7)Gariep to Greater Bloemfontein Transfer.
8)Neckartal Dam Scheme
9)Integrated Water management actions.

Projects forming part of the Lesotho Lowlands Water Supply Schemes

3a) Future Hlotse Dam in Lesotho :

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. This demand includes the urban/rural (about 30%) and irrigation developments (about 70%).

3b) Future Ngoajane Dam in Lesotho

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.

ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Project 3a

Proposed Future Dam on the Hlotse River

Project Description

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 **$50 million** and the operating annual cost at **$0.16 million/a** at 2018 development level costs.

STRATEGIC ACTION

Strategic action being supported	Specific action
SA3 & SA4 will provide important input	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	Lesotho
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	X
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Project 3a

Proposed Future Dam on the Hlotse River

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	X
Medium		Namibia	X
Limited	X	South Africa	X
3: Priority		**4: Impact on Climate Resiliance**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Small	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	X
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	
During construction	X	Neutral	X
None		Negative	X
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Little or no contribution		Little or no contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT	Project	3b

Proposed Future Ngoajane Dam on the Hololo River

Project Description

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 **$26.2 million** and the annual operating cost at **$0.16 million/a**

STRATEGIC ACTION

Strategic action being supported	Specific action
SA3 & SA4 will provide important input	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	Lesotho
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	X
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER	Project	3b

Proposed Future Ngoajane Dam on the Hololo River

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	X
Medium		Namibia	X
Limited	X	South Africa	X
3: Priority		**4: Inpact on Climate Resiliance**	
High Priority		High	
Medium Priority	X	Medium	
Low Priority		Smal	X
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	X
Donor Only		More than 20 Years	
7: Type of Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	
During construction	X	Neutral	X
None		Negative	X
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution		Moderate contribution	
Small contribution	X	Small	X

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT	Cluster	4

Integrated Vaal River System Intervention Options

Development Options Core Scenario

The Basin Wide Investment Plan and the Core Scenatio development options comprises projects that had already been identified by the basin states, and which had been subject to various levels of planning. The projects were grouped into clusters based on the larger schemes or sub-systems of which they formed one of the key components. The following Clusters were conciderred:

1) Orange River Project (ORP) Scheme future improvements.
2)Lesotho Botswana Water Transfer Scheme.
3)Lesotho Lowlands Water Project
4)Integrated Vaal River System Intervention Options.
5)Caledon to Greater Bloemfontein transfer.
6)Greater Bloemfontein internal resource improvements
7)Gariep to Greater Bloemfontein Transfer.
8)Neckartal Dam Scheme
9)Integrated Water management actions.

Projects forming part of the Integrated Vaal River System Intervention Options.

4a) Utilise Crocoldile 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. By re-using these return flows, the demand of the Northern Gauteng area, of which most is supplied from the IVRS, will be reduced.

4b)The proposed further phases of the 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.

4c) The desalination and re-use of acid mine drainage 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. 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.

ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Project 4a

Utilise Crocoldile River Return flows

Project Description

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. 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 **$77.6 million**, at the 2018 price level;
- The annual operation costs are estimated to be **$6.68 million/a** (2018); and
- This intervention option is expected to be in place by 2025

STRATEGIC ACTION

Strategic action being supported	Specific action
SA2 Can provide usefull input	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	X
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT	Project	4a

Utilise Crocoldile River Return flows

1: Involvement of ORASECOM		2: Countries involved	
High		Botswana	
Significant		Lesotho	
Medium		Namibia	
Limited	X	South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Low	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	X
During construction	X	Neutral	
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	X
Medium		Neutral	
Low	X	Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Low contribution		Low contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT	Project 4b

The proposed further phases of the Thukela River Water Transfer.

Project Description

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 m3/a. This represents the net yield from the two dams after provisions were made for required yield loss mitigation releases for existing downstream users.
Key information on this water transfer scheme includes:

•The Jana Dam with the net yield of 396 million m3/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 **$1 184 million** and the annual operations cost at **$9.1 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

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	X
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER	**Project 4b**

The proposed further phases of the Thukela River Water Transfer.

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	
Medium		Namibia	
Limited	X	South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority		High	X
Medium Priority	X	Medium	
Low Priority		Low	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	
During construction	X	Neutral	X
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution	X	Significant contribution	X
Moderate contribution		Moderate contribution	
Low contribution		Low contribution	

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ORASECOM:CLIMATE RESILIENT WATER RESOURCES INVESTMENT PLAN & LESOTHO TO BOTSWANA WATER TRANSFER PROJECT

Project 4c

The desalination and re-use of acid mine drainage

Project Description

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. 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.

Initial estimations indicated a positive quantity contribution to the IVRS of 500 million m3/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 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 which has not yet started.

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. This is an expensive intervention option with total capital expenditure at 2018 price levels estimated at **$0.463 billion** and operational costs at **$68 million/a**

STRATEGIC ACTION

Strategic action being supported	Specific action
SA 2 will provide usefull input	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	X
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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Project 4c

The desalination and re-use of acid mine drainage

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	
Medium		Namibia	
Limited	X	South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Low	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs	X	Positive	X
During construction	X	Neutral	
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	X
Medium		Neutral	X
Low	X	Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution	X	Significant contribution	X
Moderate contribution		Moderate contribution	
Low contribution		Low contribution	

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Cluster 5

Caledon to Greater Bloemfontein transfer Cluster

Development Options Core Scenario

The Basin Wide Investment Plan and the Core Scenatio development options comprises projects that had already been identified by the basin states, and which had been subject to various levels of planning. The projects were grouped into clusters based on the larger schemes or sub-systems of which they formed one of the key components. The following Clusters were conciderred:

1) Orange River Project (ORP) Scheme future improvements.
2)Lesotho Botswana Water Transfer Scheme.
3)Lesotho Lowlands Water Project
4)Integrated Vaal River System Intervention Options.
5)Caledon to Greater Bloemfontein transfer.
6)Greater Bloemfontein internal resource improvements
7)Gariep to Greater Bloemfontein Transfer.
8)Neckartal Dam Scheme
9)Integrated Water management actions.

Projects forming part of the Caledon to Bloemfontein transfers

5a) Increase Tienfontein Pumping capacity to 3.87 m^3/s :

This was already completed .

5b) Tienfontein pump station capacity increase to 7 m^3/s

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 Tienfontein infrastructure belongs to DWS RSA. There is some possibility of future links with Lesotho via compensation releases from Lesotho Lowland dams and or support from the LHWP.

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Project 5b

Tienfontein pump station capacity increase to 7 m^3/s

Project Description

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 Tienfontein infrastructure belongs to DWS RSA. There is some possibility of future links with Lesotho via compensation releases from Lesotho Lowland dams and or support from the LHWP.

oThis option is expected to increase the system yield by 13.7 million m^3/a;
oThe capital cost for this option is estimated at **$ 9.5 million** (2018)
oThe operational cost is estimated at **$0.37 million/a** (2018)

STRATEGIC ACTION

Strategic action being supported	Specific action
SA3 possible inputs	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	X
Less than 1 million USD	

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Project 5b

Tienfontein pump station capacity increase to 7 m^3/s

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	X
Medium		Namibia	
Limited	X	South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority		High	
Medium Priority	X	Medium	X
Low Priority		Low	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	
During construction	X	Neutral	X
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Low contribution		Low contribution	

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Cluster	6

Greater Bloemfontein Internal Resource Improvements

Development Options Core Scenario

The Basin Wide Investment Plan and the Core Scenatio development options comprises projects that had already been identified by the basin states, and which had been subject to various levels of planning. The projects were grouped into clusters based on the larger schemes or sub-systems of which they formed one of the key components. The following Clusters were conciderred:

1) Orange River Project (ORP) Scheme future improvements.
2)Lesotho Botswana Water Transfer Scheme.
3)Lesotho Lowlands Water Project
4)Integrated Vaal River System Intervention Options.
5)Caledon to Greater Bloemfontein transfer.
6)Greater Bloemfontein internal resource improvements
7)Gariep to Greater Bloemfontein Transfer.
8)Neckartal Dam Scheme
9)Integrated Water management actions.

Projects forming part of the Greater Bloemfontein Internal Resource Improvements

6a)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.

6b)Increase the Maselspoort WTW capacity :

Maselspoort WTW capacity increase 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 .

6c)Indirect re-use of 16 million m^3/a from the Bloemspruit WWTW to be captured in Mockes Dam.

6d) 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

Comined System:

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 **$ 86.2 million**
The combined operational cost for all components was estimated at **$ 9.2 million/a**

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Project 6a

Raise Mockes Dam

Project Description

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.

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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Project 6a

Raise Mockes Dam

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	
Medium		Namibia	
Limited	X	South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Low	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	
During construction	X	Neutral	X
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	
Low contribution		Low contribution	X

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Project 6b

Increase the Maselspoort WTW capacity :

Project Description

Maselspoort WTW capacity increase 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 .

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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Project 6b

Increase the Maselspoort WTW capacity :

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	
Medium		Namibia	
Limited	X	South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Low	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	
During construction	X	Neutral	X
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Low contribution		Low contribution	

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Project 6c

Indirect re-use

Project Description

Indirect re-use of 16 million m^3/a from the Bloemspruit WWTW to be captured in Mockes Dam.

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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Project 6c

Indirect re-use

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	
Medium		Namibia	
Limited	X	South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Low	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	
During construction	X	Neutral	X
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Low contribution		Low contribution	

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Project 6d

Direct re-use

Project Description

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

STRATEGIC ACTION

Strategic action being supported	Specific action

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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Project 6d

Direct re-use

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	
Medium		Namibia	
Limited	X	South Africa	X
3: Priority		**4: Impact on Climate Resilience**	
High Priority		High	
Medium Priority	X	Medium	X
Low Priority		Low	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	
During construction	X	Neutral	X
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Low contribution		Low contribution	

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Cluster 7

Gariep to Greater Bloemfontein Transfer

Development Options Core Scenario

The Basin Wide Investment Plan and the Core Scenatio development options comprises projects that had already been identified by the basin states, and which had been subject to various levels of planning. The projects were grouped into clusters based on the larger schemes or sub-systems of which they formed one of the key components. The following Clusters were conciderred:

1) Orange River Project (ORP) Scheme future improvements.
2)Lesotho Botswana Water Transfer Scheme.
3)Lesotho Lowlands Water Project
4)Integrated Vaal River System Intervention Options.
5)Caledon to Greater Bloemfontein transfer.
6)Greater Bloemfontein internal resource improvements
7)Gariep to Greater Bloemfontein Transfer.
8)Neckartal Dam Scheme
9)Integrated Water management actions.

Projects forming part of the Gariep to Greater Bloemfontein Transfer

7a)Gariep to Greater Bloemfontein Transfer :

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 currently in process through DWS RSA.

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Project 7a

Gariep to Greater Bloemfontein Transfer

Project Description

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 currently in process through DWS RSA.

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.

Phase 1 capital cost estimated at **$ 200 million.**

Phase 1 operational cost estimated at **$ 9 million/a**

Phase 2 capital cost estimated at **$ 26.3 million**

Phase 2 operational expenditure estimated at **$ 3.1 million/a**

STRATEGIC ACTION

Strategic action being supported	Specific action
Valuable input from SA 3	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	RSA
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	X
Between 1 million USD and 50 million USD	
Less than 1 million USD	

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Project 7a

Gariep to Greater Bloemfontein Transfer

1: Involvement of ORASECOM		2: Countries involved	
High		Botswana	
Significant		Lesotho	X
Medium		Namibia	
Limited	X	South Africa	X

3: Priority		4: Impact on Climate Resilience	
High Priority	X	High	
Medium Priority		Medium	X
Low Priority		Low	

5:Type of Funding Required		6: Likley Loan Period	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	

7: Job Creation		8: Impact on possible Conflicts Between Basin States	
Long term jobs		Positive	
During construction	X	Neutral	X
None		Negative	

9: Socio economic influence		10: Influence on local communities	
High		Positive	
Medium	X	Neutral	X
Low		Negative	

11: Yield contribution		12: Contribution to alleviating water scarcity	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Low contribution		Low contribution	

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Neckartal Water Supply Scheme

Development Options Core Scenario

The Basin Wide Investment Plan and the Core Scenatio development options comprises projects that had already been identified by the basin states, and which had been subject to various levels of planning. The projects were grouped into clusters based on the larger schemes or sub-systems of which they formed one of the key components. The following Clusters were conciderred:

1) Orange River Project (ORP) Scheme future improvements.
2)Lesotho Botswana Water Transfer Scheme.
3)Lesotho Lowlands Water Project
4)Integrated Vaal River System Intervention Options.
5)Caledon to Greater Bloemfontein transfer.
6)Greater Bloemfontein internal resource improvements
7)Gariep to Greater Bloemfontein Transfer.
8)Neckartal Dam Scheme
9)Integrated Water management actions.

Projects forming part of the Neckartal Water Supply Scheme

8a)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. The main purpose of this dam is to supply water to a new irrigation development.

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Project 8a

Neckartal Water Supply Scheme

Project Description

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. 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 behind schedule, and at the time of writing this report (June 2024) it was confirmed that the Namibian Government had aquired 4 farms measuring 19 137 Ha. 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.

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 planned irrigation scheme to cover approximately 5 000 ha
The capital cost for the irrigation scheme was estimated at $ 26.3 million (2018);
The operational costs for the irrigation scheme were estimated at $ 0.79 /a (2018)

STRATEGIC ACTION

Strategic action being supported	Specific action
SA 1 might provide usefull input on EWRs	

LEAD AND SUPPORTING ORGANISATIONS OR COUNTRIES

LEAD	Namibia
Supporting 1	
Supporting 2	
Supporting 3	
Supporting 4	

BUDGET REQUIREMENTS

More than 1 billion USD	
Between 50 million USD and 1 billion USD	
Between 1 million USD and 50 million USD	X
Less than 1 million USD	

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Project 8a

Neckartal Water Supply Scheme

1: Involvement of ORASECOM		**2: Countries involved**	
High		Botswana	
Significant		Lesotho	
Medium		Namibia	X
Limited	X	South Africa	
3: Priority		**4: Impact on Climate Resilience**	
High Priority		High	
Medium Priority	X	Medium	X
Low Priority		Low	
5:Type of Funding Required		**6: Likley Loan Period**	
Normal Loan	X	1 to 5 Years	
Loan and Donor	X	6 to 20 Years	
Donor Only		More than 20 Years	
7: Job Creation		**8: Impact on possible Conflicts Between Basin States**	
Long term jobs		Positive	
During construction	X	Neutral	X
None		Negative	
9: Socio economic influence		**10: Influence on local communities**	
High		Positive	
Medium	X	Neutral	X
Low		Negative	
11: Yield contribution		**12: Contribution to alleviating water scarcity**	
Significant contribution		Significant contribution	
Moderate contribution	X	Moderate contribution	X
Low contribution		Low contribution	

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