REPUBLIC OF NAMIBIA

MINISTRY OF AGRICULTURE, WATER AND LAND REFORM

SWAKOP UPPER-OMATAKO BASIN INTEGRATED WATER RESOURCES MANAGEMENT PLAN

SC/DP/DWRM/20-02/2019/2020

SCE CONSULTING ENGINEERS

BIGEN KUUMBA

ABBREVIATIONS

AADD	Average Annual Daily Demand
ASR	Aquifer Storage and Recovery
BMC	Basin Management Committee
BWD	Brackish Water Desalination
CAN	Central Area of Namibia (this area refers to the water supply system and does not related to an administrative entity)
CoW	City of Windhoek
CWRF	City Water Resilience Framework
DPR	Direct Potable Reuse
ECB	Electricity Control Board
GRP	Global Resilience Partnership
IPR	Indirect Potable Reuse
IUSDF	Integrated Urban Spatial Development Framework
IWA	International Water Association
IWRM	Integrated Water Resources Management
IWRMP	Integrated Water Resources Management Plan(ning)
IRBM	Integrated River Basin Management
MAR	Mean Annual Rainfall
MAWLR	Ministry of Agriculture, Water and Land Reform
NamWater	Namibia Water Corporation Ltd
NGWRP	New Goreangab Water Reclamation Plant
OECD	Organisation for Economic Co-operation and Development
PSC	Project Steering Committee
PPP	Public-Private Partnership
SAP	Strategic Action Plan

SDG	Sustainable Development Goal
SUO	Swakop Upper-Omatako (Basin)
TCE	Technical Committee of Experts
WDM	Water Demand Management
WMARS	Windhoek Managed Aquifer Recharge System, used interchangeably with Windhoek Managed Aquifer recharge
WRMA	Water Resources Management Act 11 of 2013

TABLE OF CONTENTS

INTRODUCTORY BASIN NARRATIVE

The Swakop Upper-Omatako Basin is located in the central area of Namibia and defines arguably the most economically important national water supply area. The Basin is in a water scarce subregion (see Fig.1 below) and its major urban center. The capital Windhoek's water demand exceeds its spatial water source footprint already for more than the past half a century. Economic activity in this crucial region depends on water and security of supply influences investment decisions affecting the national economy.

Waste water runoff in the Basin (domestic and industrial waste water) crucially represents one of the most pronounced risks to the supply system – systemic pollution of water sources.

Whereas climate modelling remains inclusive regarding the long-term effect of global warning on Namibia in general, indications are that larger frequency of greater drought severity and flood occurrences events can be expected.[1] A global mega trend report by PWC[2] furthermore projected that Namibia is likely to experience chronic economic water scarcity from 2025.

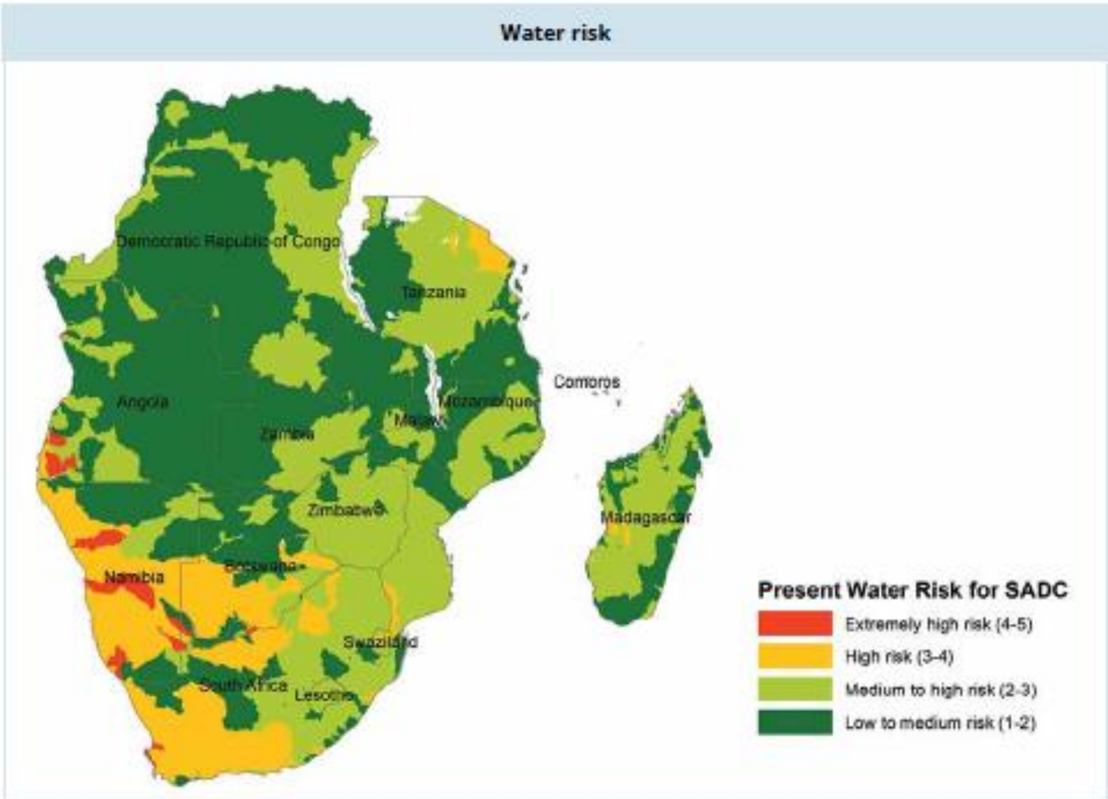

Figure 1: Current situation of water scarcity in southern Africa: (source Climate Change Risk and Vulnerability Handbook for Southern Africa, quoting the International Water Management Institute (IWMI), Web:www.immi.org

[1] Davis-Reddy, C.L. and Vincent, K. 2017:36
[2] PWC: 2016

Despite water scarcity, the urban population in the Basin keeps growing at a rapid rate[3]. Over the decades a complex water supply system has been developed that requires careful and ongoing optimization to ensure the supply system continues to meet water demand of a growing population and expanding economy. Water supply is anchored in the three-dam system, comprising the Von Bach, Swakoppoort and Omatako Dams. These three dams are interlinked with transfer systems that allow conjunctive use. The three-dam supply system is augmented from the Karst borehole scheme close to Grootfontein and linked into the supply system with canal and piped transfer schemes. However, the supply system is augmented with several critical augmentation infrastructure that consists of some pioneering, innovative and world class water reuse, managed aquifer recharge, semi-purified reuse, and demand management solutions.

Figure 2: The effect of urbanisation: Informal water supply and lack of sanitation in new informal settlements in outskirts of Windhoek

A recent severe drought episode has however placed the water supply system in the Basin under pressure to provide water security under extended drought conditions. Water restrictions and disrupted supply were only narrowly averted through the implementation of emergency measures. This 2017/18 drought event raised acute awareness in water stakeholders to the water supply system's lack of resilience and contributed to uncertainty regarding future water security.

A platform for stakeholder engagement has been created through the establishment of a Basin Management Committee (BMC) under the auspices of the Ministry of Agriculture, Water and Land Reform (MWALR). The BMC comprises representatives of the bulk users, water suppliers, water sector experts and representatives from line department(s). The BMC is a dialogical forum intended to provide an information conduit to channel stakeholder concerns to authorities and allow participation in the development and execution of water related programmes and interventions.

Namibia subscribes to international best practice developed under the Dublin Principles and the National Water White Paper is aligned with the UN adopted Sustainable Development Goals. It follows that Namibia applies Integrated Water Resources Management (IWRMP) practices that guides its approach to the planning in the

[3] Historical data suggests Windhoek maintains a growth rate that is approximately double that of the Namibian population growth rate.

water sector. An IWRMP process was launched for the Swakop Upper-Omatako Basin towards developing a 10-year plan under the BMC as its stakeholder participation platform.

This draft consultative document reflects the input for stakeholder engagement and technical document reviews in order to frame the content of a 10-year IWRMP for the Swakop Upper Omatako basin that articulates a water security, water stewardship and water resilience agenda.

1. BACKGROUND

Seelenbinder Consulting Engineers (SCE) and BigenKuumba Infrastructure Services have been appointed, following a procurement process concluded in 2019, under Contract SC/DP/DWRM/20-02/2019/2020 by the Ministry of Agriculture, Water and Land Reform's Department of Water Affairs: Directorate of Water Resource Management (Client) for the preparation of an Integrated Water Resources Management Plan for the Swakop Upper-Omatako Basin.

The Terms of Reference (Procurement No SC/RP/DWRM/20-01/2019/2020) for the Project is defined as:

a) To facilitate and guide the development of a 10-year IWRM Plan using a participatory approach to seek consensus among basin stakeholders on the long-term goals of water resources management of the Swakop Upper-Omatako Basin;
b) To develop a detailed Strategic Action Plan (SAP) for the Upper-Swakop part of the basin with clear timelines and responsible institutions and estimated cost;
c) The deliverables for the assignment (Part 5 of the ToR) (be completed through a public participatory approach of at least 3 workshops) are defined as:
    - An Inception Report with a methodology to be taken; breakdown of financial implications for this study and its deliverables. The deliverables are to include a clear timetable/work plan indicating the various activities to be undertaken;
    - An updated overview of the Swakop Upper-Omatako Basin thematic situation analysis;
    - A Vision, Mission and Goals development workshop with relevant basin stakeholders; and
    - A 10-year Basin Integrated Water Resources Management Plan (IWRMP) and detailed Strategic Action Plan (SAP) for the Swakop Upper-Omatako part of the basin with clear timelines, responsible institutions and estimated cost.

The Project execution period unfortunately coincided with a period of restrictions imposed under lockdown rules pertaining to the Covid-19 pandemic. Whereas a series of consultative interviews with selected stakeholders and one consultative workshop was completed, further planned workshops are faced with ongoing delays. Uncertainty to the duration of lockdown delays necessitated a change to the consultative process whereby stakeholders were presented with a consultative draft IWRMP for input in lieu of participative plan development process.

2. SETTING THE SCENE

2.1 INTRODUCTION

The guiding policy framework against which Integrated Water Resources Management Plans (IWRMPs are developed, is the National Water Policy White Paper of August 2000. The White Paper in turn explicitly aligns the Namibian policy framework with international principles and approaches pertaining to water sector planning such as:

a) United Nations Conference on the Environment and Development (UNCED), popularly known as the Earth Summit, held in Rio de Janeiro in 1992. The White Paper specifically aligns water sector policy in Namibia to Chapter 18 of Agenda 21, the key document of the Earth Summit, which called for an approach to water resources management based on respect for the value of water, and on principles of sustainability, social equity, and environmental integrity;

b) International Conference on Water and the Environment held in Dublin in January 1992. The Dublin Principles were formulated as follows:

- *"Fresh water is a finite and vulnerable resource, essential to sustain life, development and the environment;*
- *Water resources development and management should be based on a participatory approach, involving users, planners and policymakers at all levels;*
- *Women play a central part in the provision, management and safeguarding of water; and*
- *Water has an economic value in all its competing uses and should be recognised as an economic good."*

> **Key guiding principles for water sector planning:**
>
> - Water is a finite and valuable resource
> - Water resource development and management should be based on a participatory process
> - Women play a central part in the water value chain
> - Water has an economic value in its competing uses and is an economic good

Since the 2000 adoption of the National Water Policy White Paper, Namibia has committed itself to the Sustainable Development Goals (SDGs) adopted by the United Nations Conference on Sustainable Development in Rio de Janeiro in 2012. The objective was to produce a set of universal goals that meet the urgent environmental, political and economic challenges facing the world. The SDGs replaced the Millennium Development Goals (MDGs), which started a global effort in 2000 to tackle the indignity of poverty. The SDGs frame a common vision for a better future – the 2030 Agenda for Sustainable Development and the Paris Agreement on Climate Change. The Sustainable Development Goals (SDGs) are the UN's blueprint for a more sustainable future for all. Their adoption put environmental degradation, sustainability, climate change, and water security under the international spotlight. Whereas all the SDGs are of importance, the SDG goals of particular relevance are:

a) Goal 6: Ensure access to water and sanitation for all;

b) Goal 9: Build resilient infrastructure, promote sustainable industrialization and foster innovation; and

c) Goal 11: Make cities inclusive, safe, resilient and sustainable.

Namibia has thus adopted the Dublin Principles for its own national water policy framework and this approach remains the basis for all water sector planning and policy development. Utilizing an integrated approach to resource development underpins the White Paper and has resulted in the adoption of and subsequent legislative provisions for an Integrated Water Resources Management in the Namibian water sector. Namibia started an Integrated Water Resources Management Planning (IWRMP) approach since the 1990's, defined catchment basins and piloted the BMC approach in 2001. Due to the economic significance of the central region, a decision has been made to prepare an IWRMP for the Swakop Upper-Omatako Basin for the purpose of reviewing previous activities of the BMC and developing an IWRMP for a 10-year planning and review cycle.

Pertinent Question:

What optimal role can Water Sector play in addressing Namibia's Triple Challenge?

Namibia is facing three major long-term objectives *(World Bank 2019):*

- the combatting of inequality,
- unemployment, and
- poverty within the Nation

2.2 ENABLING LEGISLATION: NAMIBIAN WATER SECTOR LEGAL FRAMEWORK INFORMING AN IWRM APPROACH

Despite the de facto adoption of an IWRM approach in Namibia, it is important to note that no formal legal framework exists regulating the preparation, execution, funding and monitoring of such plans. The current applicable water act in Namibia remains the Water Act 54 of 1956. Some 22 Gazetted Regulations are listed under Act 54 of 1956. Following the Water Act of 54 of 1956, two additional water resource management acts have been prepared. These are the Water Resources Management Act 24 of 2004 and the Water Resource Management Act 11 of 2013. While the expectation is to repeal the 1956 and 2004 Acts with Act 11 of 2013 – this legislation has not yet been enacted.

> **Pertinent Question:**
>
> What is the optimal institutional role of the Basin Management Committee in water resource planning in the Swakop Upper-Omatako Basin?

The concept of an IWRMP; taking cognizance of the legal requirements to implement the IWRM in a manner that ensures Namibia's water resources are managed, developed, protected, conserved and used in ways which ***facilitate equitable access to water resources by every citizen, in support of a healthy and productive life***, has been introduced in the WRMA (2004) and continues into the WRMA (2013). The WRMA (2004) provides for integrated planning and management of surface and underground water resources, in ways which incorporate the planning process, economic, environmental and social dimensions as needed. In prescribing procedures as to how to develop and adopt efficient water management practices, the WRMA (2004) highlights efficiency in improved water technology. The WRMA (2004) was, however, found inadequate in clarifying the responsibilities for implementation of the legislative goals and IWRMPs and was replaced by the WRMA (2013).

The Water Resource Management Act 11 of 2013 provides for the management, protection, development, use and conservation of water resources, to provide for the regulation and monitoring of water services and for incidental matters. A fundamental principle of the WRMA (2013) is the promotion of the ***sustainable development of water resources based on an integrated water resources management plan which incorporates social, technical, economic, and environmental issues.*** The responsibility for ensuring the sustainable development and use of water resources are delegated to the regional/basin level to involve people at local level in basin management and planning. The WRMA (2013) thus made important institutional provisions, such:

- Basin Management Committees (BMC);
- Water Advisory Council; and
- Water Regulator and Water Tribunal.

BMCs have been appointed despite the non-promulgation of the WRMA (2013). It follows that the BMC is the *de facto* institution under whose auspices IWRMPs are to be prepared and executed.

The central role the WRMA (2013) allocates to the BMC is that of ***involving people at the local level in watershed management and planning***. Section 23 of the WRMA (2013) ascribes the BMC functions as, inter alia, to:

- Advise the Minister;
- Promote community participation;
- Prepare an Integrated Water Resources Management plan for its water resources management area;
- Monitor and report on the effectiveness of policies and measures in water management.

Basin Management Committee Role Keywords

- Advise
- Stakeholder participation
- Coordination
- Promote Integrated Water Resource Management
- Monitor and Report

Importantly, the defined role of a BMC does not include an executive role in water supply, infrastructure management, project execution or resource allocation/prioritization. These functions remain firmly with the bulk water supplier (NamWater) and water distributers/bulk users (Municipalities). It follows that the interaction of the BMC with water services providers, the regulatory and planning authorities is coordinating in nature. Section 25 of the WRMA (2013) is therefore pertinent in ascribing an explicit ***coordination with planning authorities*** function to the BMC.

It is, however, also not the legislator's intent to allow the BMC to usurp the planning function of water services providers (NamWater) and bulk users (i.e. Municipalities). The BMC may however provide input into the content of water sector plans. By developing an IWRMP, a BMC, through a stakeholder consultative process, can contribute to the content of bulk water supplier and municipal water sector planning.

2.3 A BEST PRACTICE FRAMEWORK FOR AN INTEGRATED WATER RESOURCES MANAGEMENT APPROACH

The need for an integrated approach to water resource management stems from inter-alia[4]:

a) freshwater resources are limited;

b) those limited freshwater resources are becoming more and more polluted, rendering them unfit for human consumption and unfit to sustain the ecosystem;

c) those limited freshwater resources must be divided amongst the competing needs and demands in a society

d) many citizens do not yet have access to sufficient and safe freshwater resources

e) structures to control water (such as dams and open canals) may often have undesirable consequences on the environment

f) there is an intimate relationship between groundwater and surface water, between coastal water and fresh water, etc. Regulating one system and not the others may not achieve the desired results.

An appropriate and efficient Integrated Water Resources Management Plan thus has to function within the constraints of the entire water cycle with all its natural aspects, as well as the interests of the water users in the different sectors of a community (i.e. those living within a basin that is depended on its natural resources). Decision-making would involve the integration of the different objectives where possible, and a trade-off or priority-setting between these objectives where necessary, by carefully weighing these in an informed and transparent manner, according to societal objectives and constraints.

An IWRMP thus seeks to integrate and reflect an efficient effective and equitable balance between engineering,

Integrated Water Resource Management drivers

It is recognized that:

- Freshwater resources are limited
- Freshwater resources are increasingly becoming polluted
- Unequal access to sufficient and safe freshwater resources persist

Therefore

- Efficient use of existing water resources and optimization of future infrastructure paramount
- Limited freshwater resources must be fairly divided between competing needs and demands
- All water resources; surface water, groundwater, water reuse etc. forms an integrated system and needs to be managed accordingly

[4] Van der Zaap & Savenije (2014)

economic, social, ecological and legal aspects of water supply and demand. An IWRMP should moreover address the 'management cycle' (planning, monitoring, operation and maintenance, etc.) needs to be consistent.

3. GUIDING THE WAY: A CHANGE NARRATIVE BASED ON WATER SECURITY, RESILIENCE AND STEWARDSHIP

Water management systems will continue to evolve due to the world-wide trends pertaining to urbanisation and economic concentration. Water supply systems unable to plan and adapt to the changing needs of people and contribute towards improving their livelihoods, will become resource constrained, socially unstable and stagnate economically. Also, water supply systems that are unable to manage waste water become an environmental and social liability.

Better Integrated Water Resources Management practices stem from the realization that the separation of functions in terms of resource development, water treatment, distribution and wastewater treatment are not optimal. There is an increased recognition that institutional interfaces are becoming blurred when water is considered a circular resource, i.e. it can be recycled and reused. It implies that all water practitioners are involved in Integrated Water Resources Management systems. Integrated Water Resources Management does not only involve the management and integration of different water sources, but multiple aspects encountered on a basin scale such as stakeholders, water quality, licensing, environmental impact etc.

Three key inter-related water concepts require amplification in informing a change of emphasis in the way water systems management can be improved:

a) ***Water Security:*** The UN[5]-Water definition attached to this concept is: *"The capacity of a population to safeguard sustainable access to adequate quantities of acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability."*

b) ***Water Resilience:*** The OECD's[6] definition of (urban) resilience states: "*Resilient cities are cities that have the ability to absorb, recover and prepare for future shocks (economic, environmental, social & institutional).*" Resilient cities promote sustainable development, well-being and inclusive growth. The International Water Association (IWA) has published principles for Water-Wise Cities that offers a holistic approach in improving resilience. The Global Resilience Partnership (GRP) has also developed guidelines towards improving resilience. These two organisations jointly published a City Water Resilience Framework (CWRF). The Rockefeller Foundation's 100 Resilient Cities program similarly developed a useful resilience framework between 2013 until its discontinuation in 2019. A City Resiliency

[5] United Nations

[6] Organisation for Economic Co-operation and Development

Framework, including twelve "drivers" in four major areas helps cities to focus on its chronic resiliency challenges, and to set the stage for a nimble response if an acute shock occurs.

c) ***Water Stewardship:*** UNIDO's [7] definition of Water Stewardship is: *"the responsible planning and management of resources. Water stewardship is using water in a way that is socially equitable, environmentally sustainable and economically beneficial. This is achieved through a stakeholder inclusive process that involves site and catchment-based actions*." An International Water Stewardship Standard, that drives, recognizes and rewards good water stewardship performance has been established to benchmark performance.

It is thus recognised that in ensuring water resilience, a multi-disciplinary approach is required that considers economic, financial, social, environmental, technical, institutional and legal aspects to address a range of continuously emerging water resource challenges. Once the various stakeholders in a water constrained environment are consulted, it is soon realised that the scale and complexity of the challenges that need to be addressed increases exponentially. Water management has during recent times seen significant changes due to increased economic activity and associated population growth in areas where insufficient fresh water supply was available. This has led to the realisation that economies and societies will eventually become water constrained if water security cannot be ensured.

Pertinent Question:

What changes are needed to current water resource management policy and planning?

What to Keep, Adapt or Amend

Current water management planning has produced foundational water supply and wastewater infrastructure, as well as stormwater protection in build-up areas. Pollution management and optimization of infrastructure utilization and measures such as demand management, innovative water reuse strategies and managed aquifer utilization have followed. Whereas these current measures remain appropriate and needs ongoing strengthening, there is arguably a need to improve water security, prepare a more resilient water supply system and improve stewardship of water resources.

[7] United Nations Industrial Development Organisation

4. UNDERSTANDING THE SWAKOP UPPER-OMATAKO WATER SYSTEM

4.1 THE BASIN(S) DEFINED

The broad determination of Basin Boundaries for the purpose of integrated water and land use management was done in terms of the Demarcation of Water Basins on a National Level Report[8]. In this report, the Swakop Upper-Omatako Basin, as a subset of the Swakop-Omaruru basin, has been identified as the most economically significant river basin in Namibia.

The precise boundaries of the Swakop-Upper-Omatako, in terms of Section 20.4(a)(iii) of the Water Resources Management Act 11 of 2013 are not formally demarcated and proclaimed. The Act (section 20.3) however allows for several principles to be considered in determining the jurisdiction of a BMC:

- shared water supply infrastructure;
- an area comprising adjacent geographic entities with joint water resources management features;
- an area defined for common management of water resources.

There are several practical approaches towards study boundary determination:

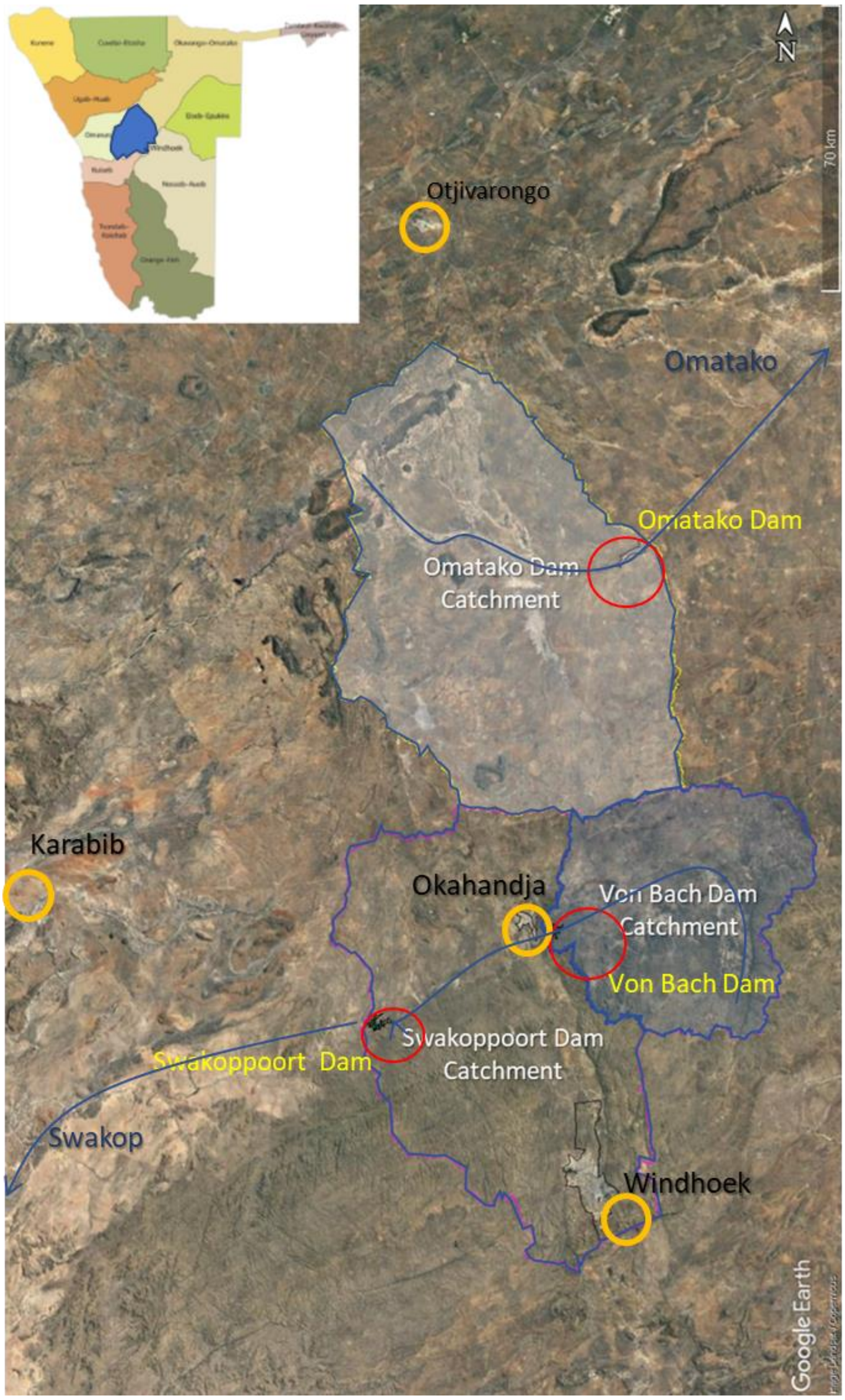

Figure 3: Swakop Upper-Omatako Orientation: Key Features

[8] Bittner:2004

a) Determining the catchment areas of the three-dam system that form the backbone of the water supply systems for the central area of Namibia (see Fig. 3);

b) Using the inter-basin transfer areas of the three-dam system, which include these dams' catchments but including the Omatako River catchment up to the Dolomite Karst Aquifer in the Grootfontein Area;

c) Determining the functional water supply area downstream of the three-dam system. Utilising this approach will incorporate Karibib and the supply area to the east of Windhoek up to the Hosea Kutako International Airport with the three-dam system's catchment; and

d) A combination of the above.

A functional definition of the Swakop Upper-Omatako Basin for the purposes of clarifying the jurisdiction of the BMC's planning would suggest incorporating the bulk water supply infrastructure for the Central Area of Namibia (CAN) with a core focus on the three-dam catchment and supply areas.

During the consultative process questions were raised regarding the appropriateness of the Basin's name. In effect the Basin covers both the upper part of the Swakop, as well as the upper part of the Omatako river basins. By referring to the Swakop Upper-Omatako Basin could thus be misconstrued as an aera that covers the whole Swakop River basin. Renaming of the Basin for purposes of avoiding ambiguity could thus be considered as part of the BMC's agenda.

Boundaries, Borders and Jurisdiction in relation to water services delivery

A central institutional issue is the fact that the water system serving the CAN and therefore the SUO Basin, does not neatly coincide with the boundaries of government structures. It follows that the water supply systems cross over between predominantly urban settlement pattern in Khomas and Erongo regions and the more rural settlement Otjozondjupa Region. Networked water supply and sanitation services are however limited to urban settlements in demarcated municipal areas. These municipalities are legally defined as Part I and Part II municipalities, town councils and village councils with non-contiguous boundaries. Windhoek is the only Part I municipality in the area, with Karibib and Okahandja being Part II municipalities.

WATER SERVICES: A VERTICALLY DIVIDED SUPPLY MODEL

NamWater, in terms of the Namibia water Corporation Act 12 of 1997 has the power and duty as bulk water supplier.

Municipalities' powers, duties and functions pertaining to water supply and sanitation services relate to distribution networks but may also provide bulk supply systems. Importantly, municipalities are solely responsible for sewerage networks in practice. Only Windhoek currently re-use wastewater, operate municipal augmentation infrastructure and apply demand management.

Regional Councils may, by delegation, provide services to sub-municipal entities (i.e. town councils, village councils, settlement areas and communal land areas). Generally, Regional Councils do not provide services directly. It follows that NamWater also provides water distribution in non-municipal jurisdictions linked to water supply schemes in a vertically integrated manner. Regional Councils do however have an important regional planning responsibility.

4.2 WHERE ARE WE COMING FROM: WATER SYSTEMS DEVELOPMENT TRAJECTORY: THE WATER SUPPLY SYSTEM DEVELOPMENT NARRATIVE: FRAMING THE CHALLENGE

The evolving supply system in the Swakop Upper-Omatako Basin has been defined by growing urban water demand accompanying Windhoek's development. Windhoek was famous for its warm water springs, which was historically exploited to supply water. By 1954 it was however apparent that the natural/ spatial water supply footprint would no longer be sufficient. Construction of the three-dam system subsequently commenced by the end of that decade and was completed by 1981. The various transfer schemes linking the dams were completed by 1993, joining the three-dam supply system to form an integrated bulk water supply system. This infrastructure system remains largely the core of the existing bulk water supply system in the Basin.

Various augmentation projects have evolved over the years – much of it innovative and visionary. The reclamation of wastewater was first introduced in 1968 and has since evolved through several upgrades to form an essential and integral element of the supply system. As early pioneer and adopter of direct potable reuse, the CoW has expanded the reuse with the New Goreangab Water Reclamation Plant in 2002 and is in the process of launching an additional plant (Gammams Advanced Reclamation Plant).

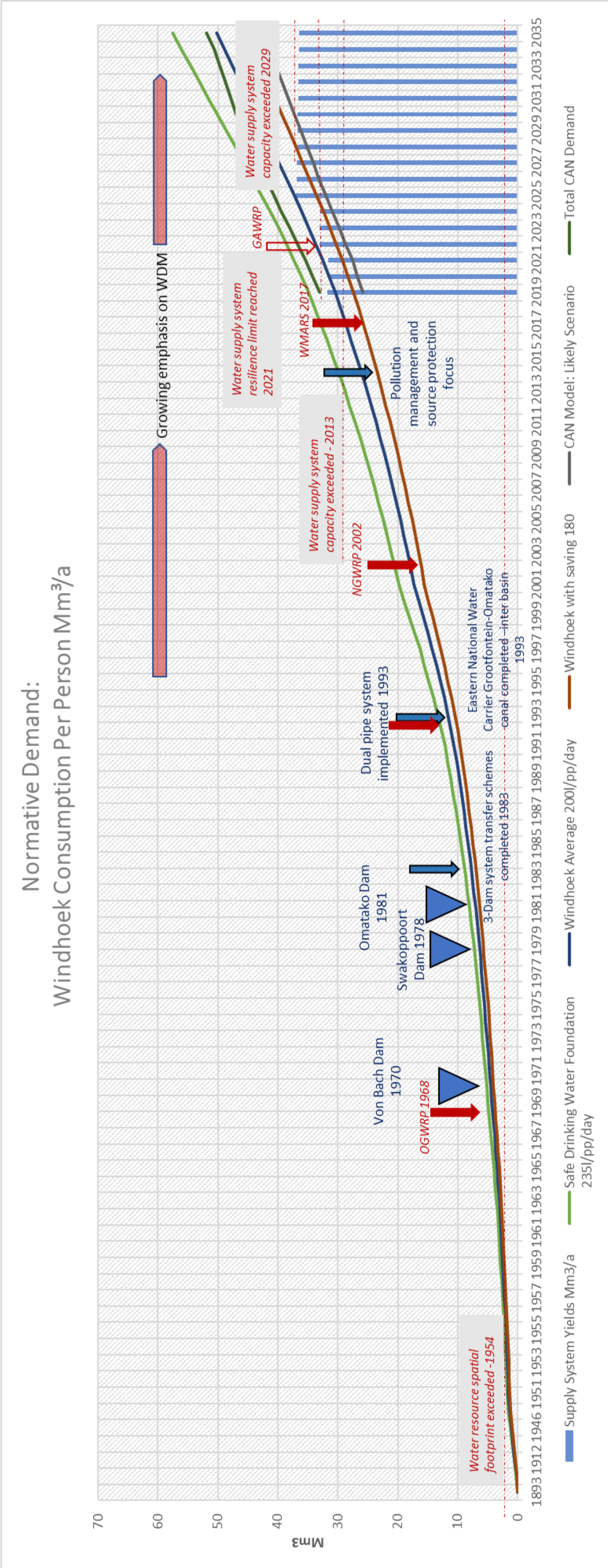

Figure 4: A Demand and Supply Narrative (Source BigenKuumba)

However, despite various augmentation schemes being brought on-line, water supply to the CAN is coming under pressure with the growth trajectory of demand. No significant new base water sources or supply infrastructure has been added to the supply system for several decades. The growing supply pressure has been mitigated through a combined strategy of an effective demand management programme in the CoW (but notably not in the smaller Karibib and Okahandja Municipalities), efforts from industrial bulk users to source their own groundwater supply and reuse, extension of the direct potable reuse scheme of CoW and importantly, expanding the WMARS (Windhoek Managed Aquifer Recharge System). Many of the mitigation measures are world class solutions and achieved remarkable success in stretching available resources. The result is a highly complex supply system that requires careful and continuous management of the water balance. Importantly, the supply system also requires close coordination between the bulk supplier (NamWater), and the increasingly complex augmentations systems operated by the CoW.

The severe drought event of 2017/18 brought the lack of a resilience in the supply system into stark relief. The resultant emergency steps taken have managed to avert disrupted water supply only by a very narrow margin.

The outcome of this drought event has understandably triggered concerns from stakeholders regarding the ability of the supply system to ensure water security in future inevitable drought events. The concern is that the water supply system to the CAN has reached an important capacity threshold and there is no longer sufficient confidence that the system will continue to deliver high levels of supply assurance without adding additional base water supply capacity.

Concerns regarding future water security is exacerbated by additional critical factors:

- Aging infrastructure and lack of redundancy margins in the core supply system;
- Lack of preventative maintenance in the bulk and especially municipal reticulation networks with a resultant asset stripping effect;
- A systemic deterioration of municipal financial sustainability that constrains capital expenditure in network expansion, upgrades and re-capitalisation;
- Escalating of operating costs of an energy intensive transfer system (see Fig 6 by illustration);
- Relentless increases in pollution levels impacting on the ongoing assurance of the three-dam system's full capacity being available to the supply system;
- A growing concern from stakeholders regarding the affordability of water services, exacerbated by the anticipated cost of the infrastructure required to expand the water supply system to meet an acceptable resilience margin; and
- A realization that the "easy" technical solutions to increase bulk water supply to the CAN have been largely exploited and that future solutions will necessitate complex and expensive (capital outlay and high operating cost) solutions to be brought on-line.

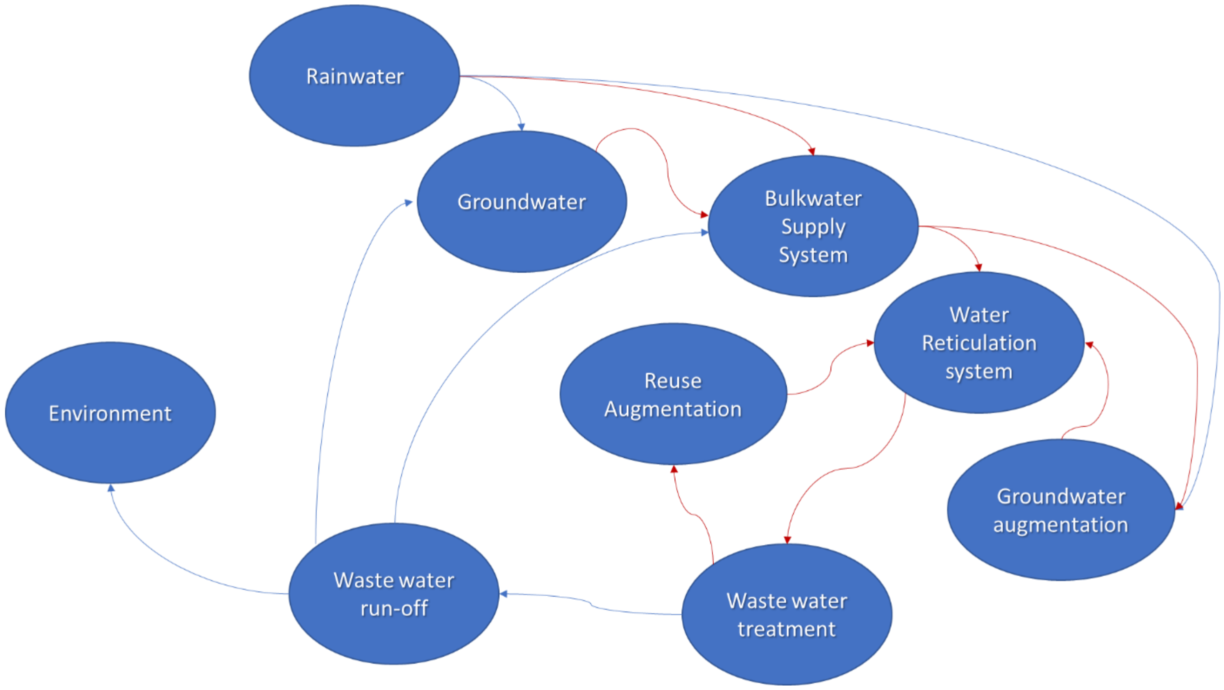

Figure 5: CAN Water Supply Systems: showing core elements and natural (blue) and infrastructure linkages (red)

Figure 6: Energy intensive transfer systems

4.3 WATER SUPPLY TO THE CENTRAL AREA: DESCRIBING THE SYSTEM

As mentioned above, the Central Area of Namibia has exceeded its ecological/natural resource water footprint for more than the past half-century. In response, a complex water supply system has evolved that requires intricate management of a dynamic water balance between the various water source elements comprising the system. This water balance is operated through a series of operational rules designed to prioritise the utilization of water supply sources so as to optimize the overall system's yield performance. The water supply system is anchored in the three-dam supply system but is augmented by amongst other inter-basin transfer schemes, reuse and groundwater abstraction. Figure 5 above and fig. 7 and fig. 8 below provide a high- level illustration of the bulk water supply system for the CAN supply area – this system measures some 350km from it northern most reaches to Windhoek in the south. Importantly, several industrial bulk users source water independently from water supply systems but sharing the same groundwater footprint of the Basin.

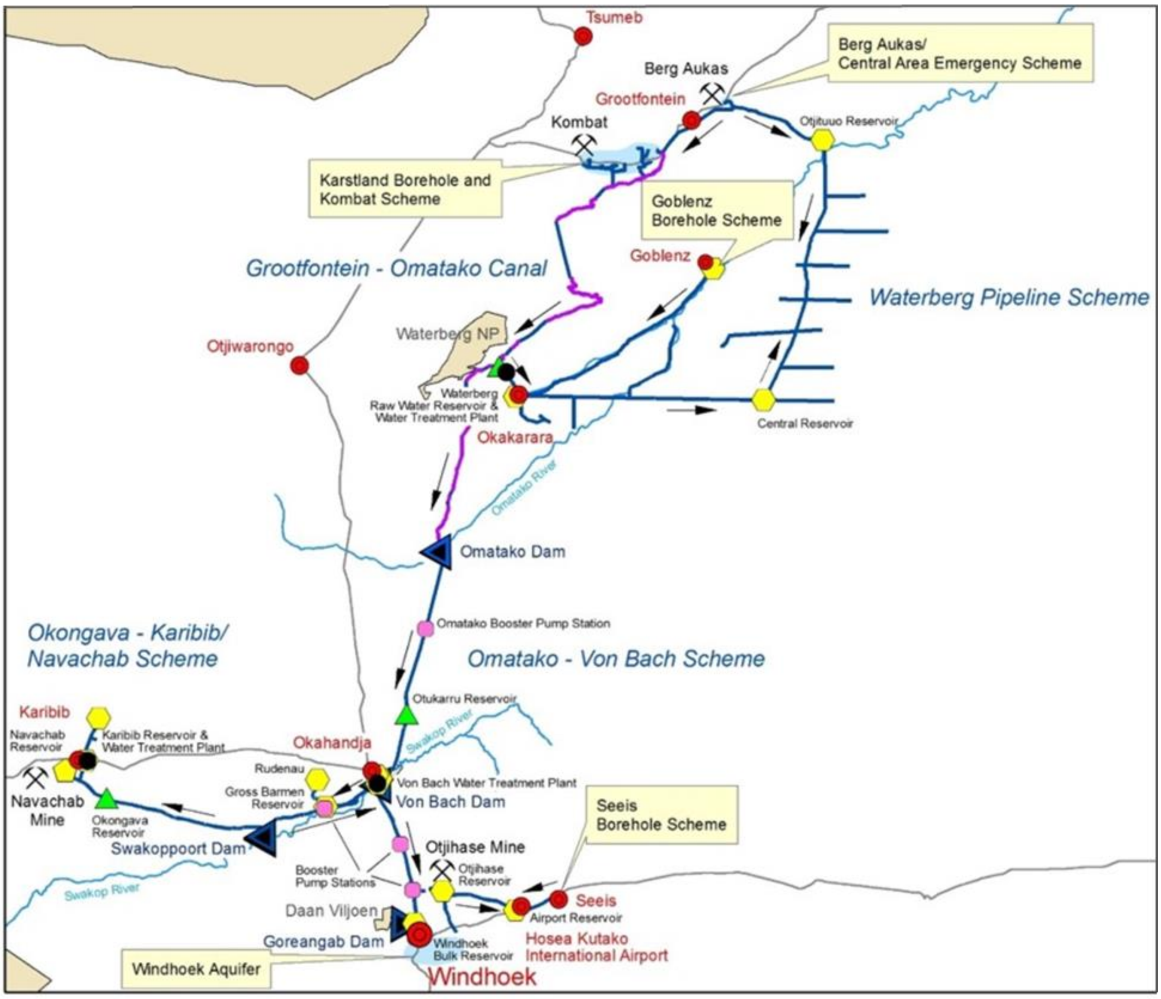

Figure 7: Bulk Water Supply to the Central Area of Namibia (Source: LCE-SCE)

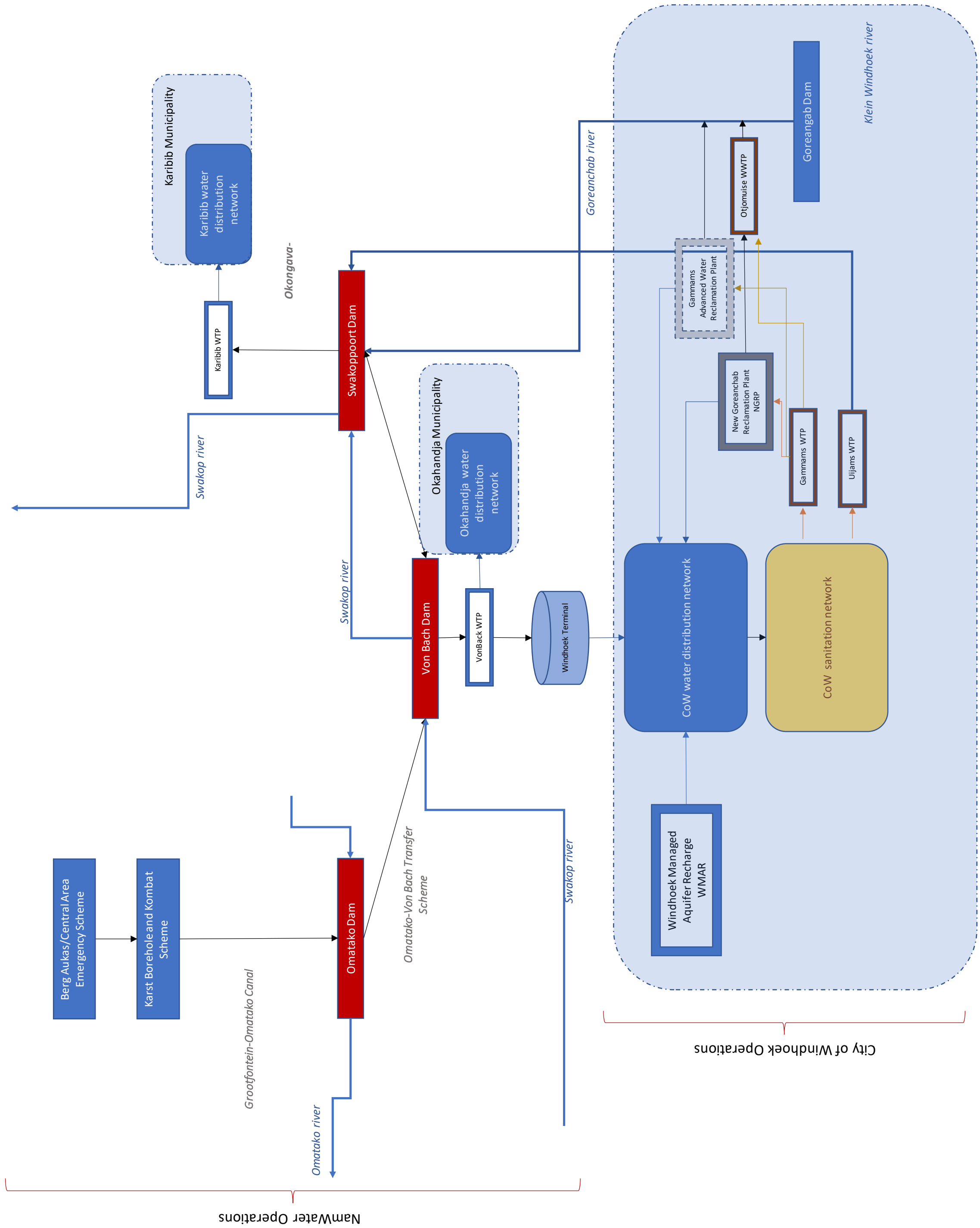

Figure 8: Simplified Water Supply System representation within the Swakop Upper-Omatako Basin (Source BigenKuumba)

The complexity of the system is apparent and is largely dependent on the surface water supply system of three-dams; Omatako Dam and the Von Bach and Swakoppoort Dams in the Swakop River. This surface water system is interlinked with transfer schemes to provide water to the Windhoek water distribution network via the Von Bach Water Treatment Works. The relative demand on the system is highly weighted towards the Von Bach Dam users with 88% of demand concentrated downstream of the Von Bach Dam. The City of Windhoek demand dominates the water supplied downstream from Von Bach (see Fig. 9).

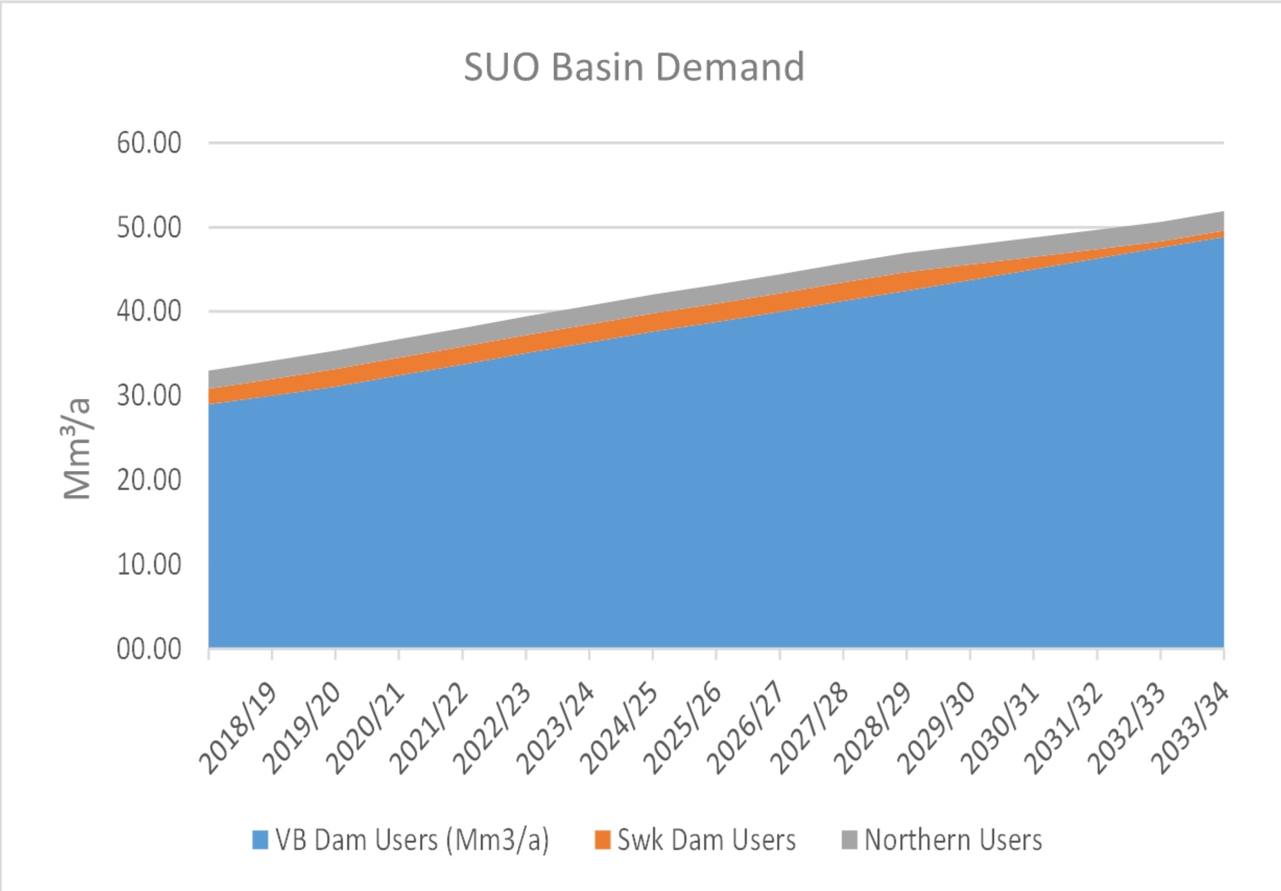

Figure 9: Distribution of water demand by source (Mm³/a)

Von Bach Dam's sustainable yield (95% assured yield) is 6.5Mm³/a, which is far less than the projected demand of 30.03Mm³/a. To augment the supply capacity of Von Bach Dam, a series of complex surface water transfer schemes have been constructed that interlinks the three dams to allow for a conjunctive use of 20Mm³/a. It follows that the transfer schemes allow for the optimization of surface water resources that almost double the combined sustainable yield of the three-dam system from 13Mm³/a. Relatively marginal augmentation of the Omatako Dam via the Grootfontein-Omatako canal system is achieved (the open canal systems has a reported loss rate of 45% in 2019 [9])[10] of only 0.047Mm³/a in 2019/20. More important augmentation is however

[9] NamWater Annual Water Conference: May 2020
[10] The canal was cleaned and repaired in 2017/18 to slightly improve its performance

achieved using Direct Potable Reuse of wastewater and more recently (since 2017) of a Managed Aquifer Recharge System.

Year	Northern Users (Upstream from Von Bach Dam) Mm³/a						
	ENWC Canal 1	ENWC Canal 2	Omatako - Von Bach	Kambazembi (Waterberg Water Service Area)	Rundu	NYSS	Total
2018/19	0.079	0.079	0.045	1.955	0.000	0.000	2.158
2019/20	0.080	0.080	0.047	1.966	0.000	0.000	2.173
2020/21	0.081	0.081	0.049	1.978	0.000	0.000	2.189
2021/22	0.081	0.081	0.051	1.985	0.000	0.000	2.198
2022/23	0.082	0.082	0.053	1.992	0.000	0.000	2.209
2023/24	0.082	0.082	0.055	2.000	0.000	0.000	2.219
2024/25	0.083	0.083	0.057	2.007	0.000	0.000	2.230
2025/26	0.084	0.084	0.059	2.015	0.000	0.000	2.242
2026/27	0.084	0.084	0.061	2.023	0.000	0.000	2.252
2027/28	0.085	0.085	0.063	2.031	0.000	0.000	2.264
2028/29	0.086	0.086	0.065	2.039	0.000	0.000	2.276
2029/30	0.087	0.087	0.065	2.047	0.000	0.000	2.286
2030/31	0.087	0.087	0.065	2.055	0.000	0.000	2.294
2031/32	0.088	0.088	0.065	2.061	0.000	0.000	2.302
2032/33	0.088	0.088	0.065	2.067	0.000	0.000	2.308
2033/34	0.089	0.089	0.065	2.073	0.000	0.000	2.316
2034/35	0.089	0.089	0.065	2.079	0.000	0.000	2.322

Table 1: Northern Use (Upstream form Von Bach Dam) (All volumes expressed as Mm³/a)

Year	Demand Zone (Mm³/a)			
	VB Dam Users	Swk Dam Users	Northern Users	Total CAN Demand
2018/19	29.01	1.83	2.16	33.00
2019/20	30.03	1.96	2.17	34.17
2020/21	31.09	2.09	2.19	35.37
2021/22	32.43	2.11	2.20	36.73
2022/23	33.71	2.12	2.21	38.04
2023/24	35.07	2.13	2.22	39.42
2024/25	36.34	2.14	2.23	40.71
2025/26	37.62	2.15	2.24	42.02
2026/27	38.76	2.17	2.25	43.18
2027/28	39.97	2.18	2.26	44.42
2028/29	41.25	2.20	2.28	45.73
2029/30	42.46	2.22	2.29	46.97
2030/31	43.73	1.84	2.29	47.86
2031/32	45.00	1.47	2.30	48.78
2032/33	46.29	1.10	2.31	49.69
2033/34	47.59	0.73	2.32	50.63
2034/35	48.84	0.75	2.32	51.91

Table 2: Demand Zone Projection[11] (All volumes expressed as Mm³/a)

11 Source: NamWater, (2020), Medium term water supply alternatives for the CAN (phase 2 interim report baseline modelling), Appendix A.
Note: All demands based on Likely Scenario

Year	Von Bach Dam Users Mm³/a								Swakkoppoort Users Mm³/a			
	Windhoek	Windhoek Industry	Okahandja	Airport Pipeline Users	Von Bach - Windhoek	Swakoppoort - Von Bach	Otjihase	Total	Swakoppoort - Okongava	Navachab	Karibib	Total
2018/19	25.261	0.588	1.894	0.284	0.589	0.096	0.296	29.008	0.065	1.314	0.450	1.829
2019/20	26.019	0.683	1.970	0.301	0.660	0.103	0.296	30.032	0.067	1.434	0.459	1.960
2020/21	26.799	0.779	2.047	0.318	0.739	0.110	0.298	31.090	0.070	1.554	0.469	2.093
2021/22	27.603	1.108	2.127	0.418	0.761	0.117	0.296	32.430	0.073	1.554	0.478	2.105
2022/23	28.431	1.369	2.192	0.518	0.784	0.123	0.296	33.713	0.076	1.554	0.488	2.118
2023/24	29.284	1.685	2.250	0.618	0.808	0.130	0.296	35.071	0.079	1.554	0.496	2.129
2024/25	30.017	2.025	2.311	0.718	0.832	0.137	0.296	36.336	0.082	1.554	0.505	2.141
2025/26	30.767	2.370	2.374	0.818	0.857	0.140	0.296	37.622	0.085	1.554	0.515	2.154
2026/27	31.536	2.548	2.439	0.918	0.883	0.143	0.296	38.763	0.088	1.554	0.527	2.169
2027/28	32.325	2.769	2.506	1.018	0.909	0.146	0.296	39.969	0.092	1.554	0.538	2.184
2028/29	33.133	3.045	2.575	1.118	0.936	0.149	0.296	41.252	0.096	1.554	0.549	2.199
2029/30	33.795	3.392	2.646	1.218	0.965	0.152	0.296	42.464	0.100	1.554	0.561	2.215
2030/31	34.471	3.776	2.719	1.318	0.993	0.155	0.296	43.728	0.104	1.165	0.573	1.842
2031/32	35.161	4.174	2.794	1.418	1.003	0.158	0.296	45.004	0.108	0.777	0.585	1.470
2032/33	35.864	4.563	2.871	1.518	1.013	0.161	0.296	46.286	0.112	0.388	0.598	1.098
2033/34	36.581	4.954	2.951	1.618	1.024	0.164	0.296	47.588	0.116	0.000	0.611	0.727
2034/35	37.313	5.333	3.007	1.697	1.034	0.164	0.296	48.844	0.121	0.000	0.624	0.745

Table 3: Von Bach and Swakoppoort Dam Use (All volumes expressed as Mm³/a)

Institutionally, the bulk water supply system is managed by NamWater, which is also responsible for the management of the water balance in the supply system. NamWater manages the bulk water supply system through the application of operational rules designed to optimize the use of the various water source elements based on their supply efficiency. For example, at the highest operational level, the system is designed to utilize surface water before extracting groundwater, as evaporation losses for surface water are very high. Similarly, rules for transfer between surface water sources prioritise transfers to Von Bach Dam due its primacy in the system, but also due to its relative storage efficiency (higher volume and lower evaporation losses) and critically, its pivotal role in supplying the largest urban area. Importantly, the system has evolved to allow operating rules to recharge groundwater aquifer sources (managed and operated by the CoW) utilizing treated surface water sources during times of higher dam levels as groundwater storage is more efficient due to lower evaporation losses. This water supply system is dependent on energy intensive pump infrastructure and the optimization of energy cost (carbon footprint) in the system is a key cost driver and influences the operational rules. The significance of energy costs in water supply is underscored when it is realised that NamWater's second largest supplier (after acquisition of desalinated water from Orano) is NamPower for electricity (at 19.4% of total operational cost).[12] NamPower, significantly, ranks NamWater as it second largest government owned client representing 8.12% of total sales.[13] Electricity supply to the water supply system is therefore an important operational risk in water security.

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[12] NamWater (PTY)Ltd. Integrated Annual Report 2018/19
[13] NamPower Annual Report 2019

Value	Unit		Von Bach Dam	Swakoppoort Dam	Omatako Dam	Three Dam Conjunctive use
Catchment area	km2		2920	5480	5320	
MAR	Mm3		18	22	32.5	72.5
Full supply surface area	km2		4.884	7.808	15.545	
Full Supply Capacity	Mm3		48.56	63.489	43.499	155.548
95% Assured Yield	Mm3/a		6.5	4.5	2	20
No. of years of inflow data	No.		43	36	32	43
Minimum Annual Inflow	Mm3/a		0	0.149	0.199	0.686
Maximum Annual Inflow	Mm3/a		119.517	170.923	112.38	322.459
Average Annual Inflow	Mm3/a		15.493	19.167	24.369	49.675
Median Annual Inflow	Mm3/a		9.596	9.43	14.95	30.464
No of years where inflow is less than the average	No.		28	25	22	27
No of years where inflow is less than the average	%		65	69	69	63
Average Rainfall	mm/a		320	360	368	349
Average Evaporation	mm/a		2400	2456	2247	2367
Average Evaporation vs Rainfall			7.5	6.8	6.1	6.8
Sediment inflow			1.50%	2.50%	0.50%	1.6%
Reduced yield due to sediment inflow (sediment flow once in 7 years)			0.21%	0.36%	0.07%	0.23%
MAR storage ratio			2.70	2.89	1.34	
MAR yield ratio			2.77	4.89	16.25	3.63

Table 4: Key water supply system parameters

4.4 WASTEWATER DISPOSAL AND POLLUTION RISK FROM THE CENTRAL AREA

A central characteristic of the water supply system in the Swakop Upper-Omatako Basin is the fact that almost all wastewater (industrial, domestic, treated and un-treated) produced in the basin remains within the catchment areas of the three-dam system (Karibib supply area being the only exception draining downstream of the Swakoppoort Dam). A further characteristic of the system is its increased dependence on water reuse to balance water demand. Windhoek has been an African pioneer of direct potable reuse through its New Goreangab Water Reclamation Plant (NGWRP), where treated wastewater has been blended with drinking water for more than 50 years. Water reclamation technology is not a new/unconventional water strategy and has been in continuous international use since the 1960's. The technology is based on the multiple treatment barriers concept (i.e. pre-ozonation, enhanced coagulation/dissolved air flotation/rapid sand filtration, and subsequent ozone, biological activated carbon/granular activated carbon, ultrafiltration (UF), chlorination and in some instances also reverse osmosis) to reduce associated risks and improve the water quality. Importantly, Windhoek blends reclaimed water into the potable water supply system to further augment the potable supply.

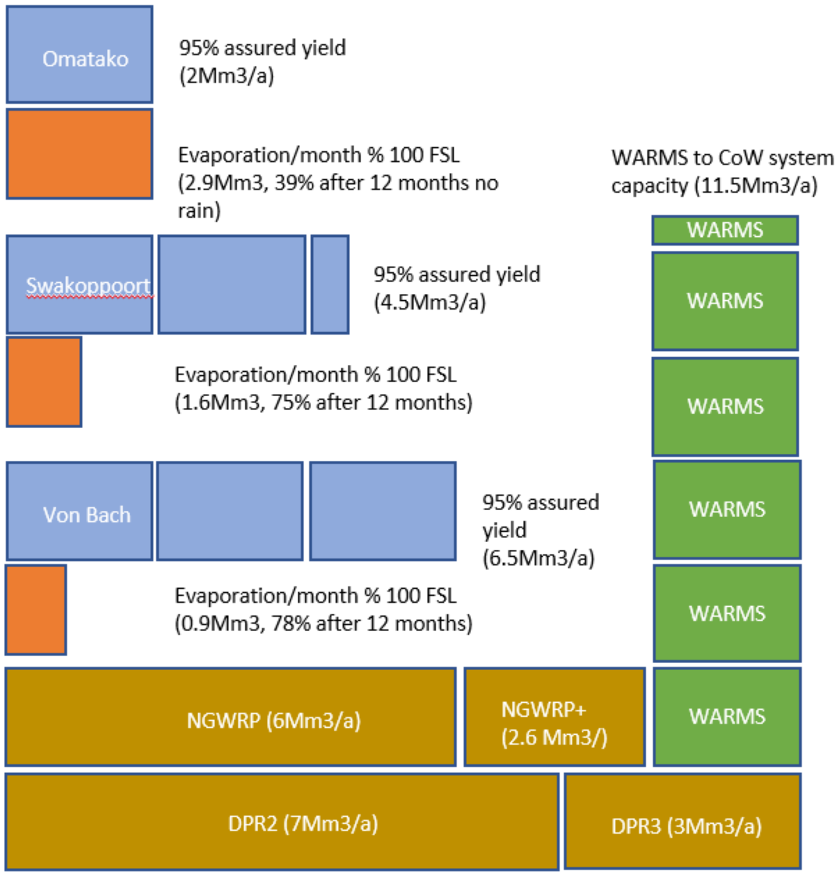


Figure 10: Comparison of water source sustainable yields

As illustrated in Figure 10 above, water reuse plays an increasingly crucial role in the current and future water balance of the water supply regime for the Central Area. The increasingly central role of water reuse and groundwater abstraction makes the supply system extraordinary sensitive to pollution. This acute risk impact was illustrated by the 2019 oil spill caused by Namibia Diaries' Avis Plant which resulted in a shutdown of both the Gammams Waste Water Treatment Plant and the New Goreangab Water Reclamation Plant for several months.[14]

Systemic pollution risk is further amplified by the fact that all wastewater runoff from the Windhoek and Okahandja areas end up in the Swakoppoort Dam's catchment. Consequently, long term deterioration of water quality in this dam has been reported. Almost all unsewered informal settlements are draining into the Klein Windhoek (The Mix) and Goreangab rivers (Big Bend, Havana, Hakahana), further exacerbating the long-term pollutant flows into the Swakoppoort Dam.

Should water quality in the Swakoppoort Dam deteriorates to the extent that this dam ceases either temporarily or permanently to be available as a potable water source, the impact on the water balance of the water supply system will be significant. It should be noted that Karibib is wholly dependent on Swakoppoort Dam for its water supply and has registered poor water quality as its priority concern as part of the stakeholder engagement process.

Pertinent Question

What more can be done to regulate, monitor and mitigate increasing risk of water pollution?

The water supply system is vulnerable to acute pollution events but is also experiencing a rise in systemic pollution risk leading to deterioration of water quality at the Swakoppoort Dam. The CoW is monitoring pollution hotspots and implemented a penalty system for acute polluters. Pollution sources include inter alia runoff from waste water treatment plants, stormwater, unsewered informal settlements, industry and oxidation pond seepage. Pollution monitoring is however not consistent - based on spot checks and ad hoc monitoring of known hotspots. Subsequently no in-line pollution monitoring system is in place and therefore no early warning for the DPR and WWTPs. The Ujams WWTP was constructed to reduce pollution volumes entering the Klein Windhoek -Swakop river systems. However, systemic pollution is increasing from the expansion of un-sewered informal settlements downstream from the existing WWTPs and water and water intensive industry.

[14] The Namibia Economist 14 February 2019 (https://economist.com.na/41926/general-news/rehabilitation-of-water-treatment-plants-estimated-at-n32-million/)

5. DEVELOPMENT OF WATER RESOURCES MODEL

5.1 AN INTERACTIVE MODEL AS A TOOL FOR UNDERSTANDING AND PLANNING IN THE WATER SECTOR

In the preceding section an overview is provided of how the integrated water supply system is working within the defined Swakop Upper Omatako Basin. In this section, the performance parameters of the system are unpacked to understand the system's limitations, robustness and to build an impression of the resilience margins in the supply system.

A basic stochastic water resource model was developed (using @RISK from Palisade) to illustrate the prominent features of the CAN water system, to improve the understanding of the inherent interdependencies and test sensitivities of a few scenarios. The stochastic model was built around a basic water balance for the following water balance zones:

- The Omatako Dam zone;
- The Swakoppoort Dam zone;
- The Von Bach Dam zone;
- The WMARS zone; and
- CoW zone

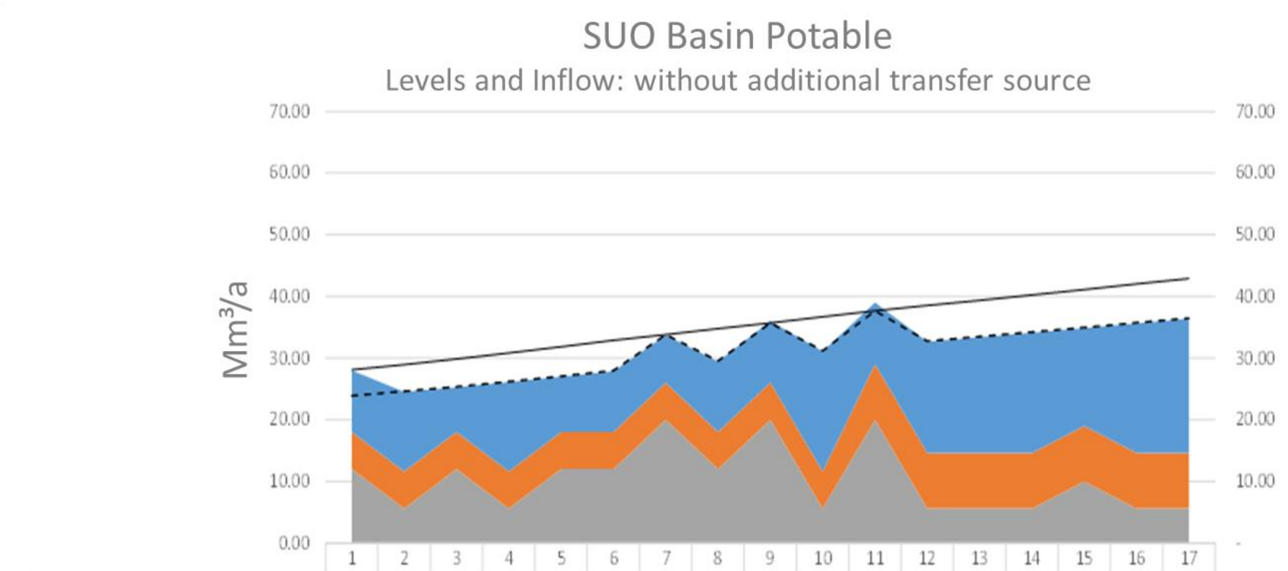
For each water balance zone the following was modelled:

- Inflows into the zone
    - Rainfall run-off;
    - Transfers from upstream zones; and
    - Groundwater inflow from aquifers.
- Outflow from the zone
    - Evaporation;
    - Transfers to a downstream zone;
    - Transfers out of the node to the environment;
    - Leakages/losses; and
    - Water use by consumers.

The primary stochastic variable was the rainfall run-off into each of the three-dams which was modelled based on historic annual inflow records.

The output from the stochastic model calculated the dam levels, aquifer levels and water security available to CoW for the period 2018 to 2034. (Year 1 represents 2018 and year 17 represents 2034). The contribution of each water source was also calculated to understand the relative importance of surface water, groundwater, water reuse and external augmentation.

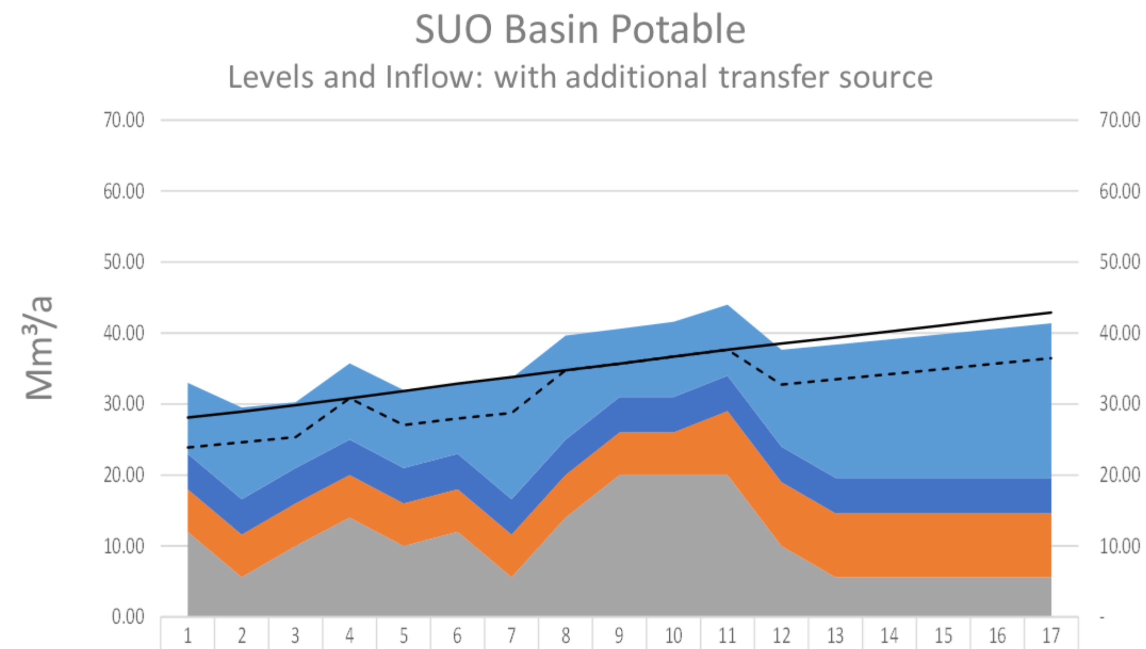
Examples of the stochastic model results are shown in the figures below. Figure 11 is a simulation of a scenario without any external transfer and it is evident that CoW will be subject to almost constant water restrictions except when Von Bach Dam receives significant rainfall run-off (grey spikes on graph). For most of the time CoW relies heavily on the WMARS (light blue areas).



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Total WMARS	10.00	12.92	7.26	14.51	8.98	9.87	7.72	11.44	10.00	19.49	10.00	18.05	18.77	19.51	15.86	21.03	21.78
Future external source	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DPR	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Von Bach supply	12.00	5.60	12.00	5.60	12.00	12.00	20.00	12.00	20.00	5.60	20.00	5.60	5.60	5.60	10.00	5.60	5.60
CoW WCDM potable demand	23.88	24.61	25.35	26.20	27.07	27.96	33.81	29.53	35.70	31.18	37.68	32.74	33.46	34.20	34.95	35.72	36.47
CoW Projected Potable demand	28.10	28.95	29.83	30.82	31.84	32.89	33.81	34.74	35.70	36.68	37.68	38.51	39.37	40.24	41.12	42.02	42.91

Figure 11: Simulated demand and supply without additional external water transfer source (Mm³/a)

In the second simulation (Fig. 12) it was assumed a 5 Mm³/a external source is introduced and it is evident that this can result in CoW having less water restrictions in the early stages of the simulation period, but would require additional augmentation by year 15.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Total WMARS	10.00	12.92	9.26	10.73	10.98	9.87	17.05	14.65	9.61	10.59	10.00	13.65	18.77	19.51	20.26	21.03	21.78
Future external source	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00
DPR	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	6.00	9.00	9.00	9.00	9.00	9.00	9.00	9.00
Von Bach supply	12.00	5.60	10.00	14.00	10.00	12.00	5.60	14.00	20.00	20.00	20.00	10.00	5.60	5.60	5.60	5.60	5.60
CoW WCDM potable demand	23.88	24.61	25.35	30.82	27.07	27.96	28.74	34.74	35.70	36.68	37.68	32.74	33.46	34.20	34.95	35.72	36.47
CoW Projected Potable demand	28.10	28.95	29.83	30.82	31.84	32.89	33.81	34.74	35.70	36.68	37.68	38.51	39.37	40.24	41.12	42.02	42.91

Figure 12: Simulated demand and supply with external water transfer source (Mm³/a)

5.2 KEY OBSERVATIONS FROM WATER RESOURCE ASSESSMENT MODELLING

The basic stochastic water resource model was developed to illustrate the characteristics of the water supply system, the interconnectivity of the water resources and the impact of operating rules on water resource utilisation. It is not the purpose of the model to replace/update the more comprehensive CAN Water Model. It is also useful to emphasise that the observations below largely affirm the findings of the various studies conducted on water supply in the Study Area. The following important observations are highlighted:

5.2.1 CLIMATE CONDITIONS

The local climate conditions experienced by Swakop/Omatako/Von Bach Dam catchments are similar, i.e. summer rainfall. Insignificant inter-basin climate variation was observed based on annual inflows. The **consequence** of this is:

- A drought in the CAN area is likely to impact all three dams in a similar manner.
- The impact of climate change (hotter summers, longer droughts, higher extreme event peaks etc.) will likely impact on the system through generally less frequent inflows, high peak inflow events and longer/severe drought condition periods.

5.2.2 LOW AVERAGE RAINFALL, HIGH RAINFALL VARIABILITY AND HIGH EVAPORATION

The CAN catchment area generally experiences low average rainfall combined with high evaporation rates. However, occasionally very high rainfall has been observed in the catchment of all three-dams. The **consequences** of these phenomena are:

- Low average and variable rainfall imply that large dams are required to capture as much as possible run-off from the catchment.
- High evaporation rates ideally require deep dams in order to reduce evaporation losses.
- If in-stream topography does not allow the construction of a deep dam, high evaporation losses will be incurred resulting in inefficient storage.
- Alternatives to address the inefficient storage could include:
    - transferring water to another catchment where more suitable dam sites are available;
    - transferring water to off-channel dam sites where water can be stored efficiently; and
    - transfer and treat water to store in a managed aquifer recharge system (MARS).
- In all the above cases the transfer rate needs to be adequate to avoid water spilling during the wet season. This requires large transfer schemes that, due to the rainfall variability, will not be able to be operated continuously.
- Due to the implied energy cost of water transfer, an optimal cost benefit can be determined for the size and cost of a storage and transfer system and the sustainable benefit that can be derived.

5.2.3 CHARACTERISTICS OF THREE-DAM SYSTEM

The three dams in the Swakop-Omatako catchment differ in terms of their hydrology, behaviour and function:

- Omatako Dam is a relatively shallow dam with high evaporation losses and therefore an inefficient dam for water storage. Water should therefore either be used as soon as possible or transferred from Omatako Dam to more efficient dams, as is indeed the current operating practise.
- The dam size combined with the occasional heavy rains events experienced in the catchment results in occasional large spills from Omatako Dam. This can in theory be captured by increasing the dam size or by intercepting and pumping the water to another dam with available storage. In order to transfer sufficient quantities, large transfer systems are required which may not be cost effective if only used intermittently.

Figure 13: The Three Dams: Swakoppoort, Omatako and Von Bach

Figure 14: Dam inflow modelling scenario (Dam Level % and Mm³/a Inflows, Firm Yield and Spill)

5.2.4 GROUNDWATER SOURCES

The current CAN surface water resources are inadequate to meet CAN demands and are augmented with groundwater resources from the Karst system located north of CAN, reuse and the local WMARS. The Karst aquifer's location requires long and complex transfer systems for augmentation. As a result of the high evaporation rates it is not efficient to store groundwater in Omatako Dam before transfer to CoW. Systems were developed to bypass Omatako Dam to reduce evaporation losses and transfer the water directly to Von Bach Dam. A consideration to further reduce evaporation losses in Von Bach Dam was assessed, but the benefit to cost ratio is low and not considered feasible. The **consequence** of this is that:

- Groundwater sources should ideally be used closer to demand centres or transferred directly to other managed aquifers or short-term storage facilities. Storage of groundwater in dams is inefficient and should be avoided.
- The WMARS size, when expanded to its full potential, is similar in size to the surface water resources, but does not suffer from high evaporation losses, making it a more efficient supply/storage source.

5.2.5 AQUIFER STORAGE AND RECOVERY (ASR)

ASR is required to maximise utilisation of non-firm yield from dams as natural recharge/recovery is typically too slow and difficult to control. ASR can assist with short term and long-term storage of reuse in times of low demand and high rainfall. ASR requires development of high capacity recharge/recovery and abstraction system capacity. Large aquifer capacity is required to achieve short- and long-term storage requirements and fully utilise reuse, firm and non-firm yield from surface resources. Expanded ASR can be developed in a shorter time compared to a future large-scale surface water augmentation schemes.

5.2.6 NEED FOR LONG TERM SUPPLY IN ADDITION TO THE THREE-DAM SYSTEM

The variable nature of the rainfall and relatively low yield that can reliably be abstracted from the local dams requires other sources of long-term storage where surplus water can be stored during times of surplus water.

The comparative water remaining in each of the three-dams after 1 year's evaporation assuming 100% full dams at the beginning of the year and no inflow for Omatako, Swakoppoort and Von Bach respectively are about 39%, 75% and 78% respectively. The consequence of this is that despite sizable dam storage capacity, the conversion of the run-off to assured yield is low and varies significantly and is generally very inefficient, e.g. Omatako Dam with a capacity of 43 Mm³/a only has an assured yield of 2 Mm³/a. Key observations regarding storage optimisation (and informing current water balance optimisation rules) of the supply system are:

- Effective size (yield) and efficiency of various water sources needs to be captured to maximise water security and cost. Omatako is a relatively inefficient and small source compared to Von Bach which is three times larger and twice more efficient to store. Water captured in Omatako therefore needs to be transferred to Von Bach as soon as possible.
- Conjunctive use of groundwater and surface water improves security of supply. E.g. 3 dams operated conjunctively with Karst aquifer that provides a clear and logical priority of use sequence to optimise the system's yield.
- Complex operating rules are required to optimise security of supply.
- CoW effluent returns drain to a key surface water source (Swakoppoort).
- Untreated/poorly treated effluent returned to surface water sources creates water quality challenges and compromises short-term water treatability. This situation requires a long-term solution in terms of effluent treatment and reuse to protect surface water resources.
- In order to maximise the yield from the system, additional source(s) of supply and associated infrastructure will be required. As demand grows the system will be required to operate closer and closer to its maximum yield which increases the risk of constrained/disrupted supply. The current CAN water supply system has a limited risk-free horizon and is **therefore not sufficiently resilient**.

- The development of additional external water sources (outside the Swakop-Omatako) is inevitable and the completion of the external source(s) will be required in the short- to medium-term (i.e. within 5-10 years) as current modelling already projects frequent water constrained periods.
- The current model only considered annual inflows into dams and provided insights on an annual averaged basis. A model with a monthly resolution should be used to confirm findings and for more detailed planning.

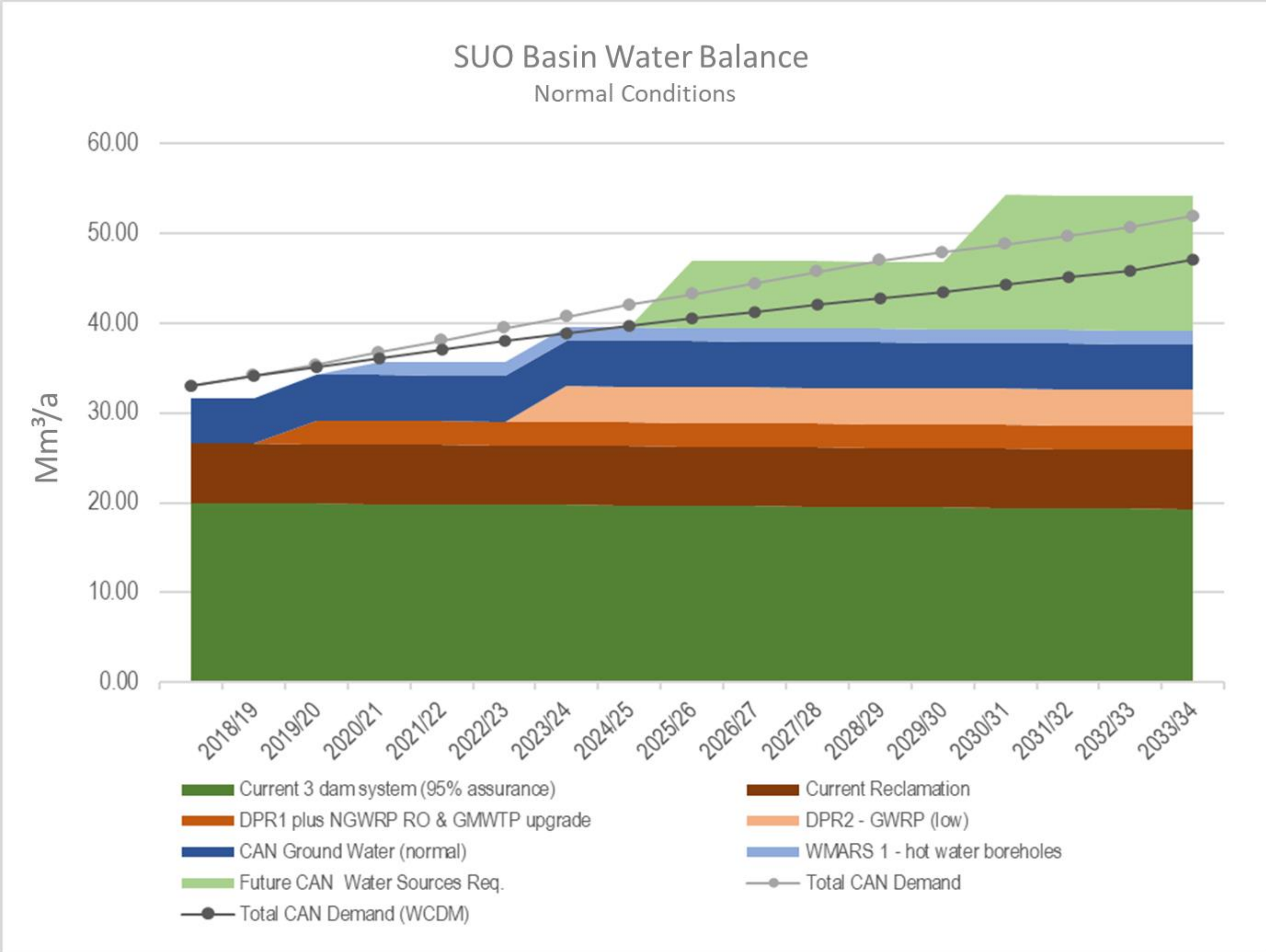


Figure 15: Demand projection under normal conditions (Mm³/a)

Figures 15 and 16 underscore the need for additional water source to be brought into the supply regime as the system is projected to run into capacity constraints under normal conditions and do not have resilience to meet drought conditions.

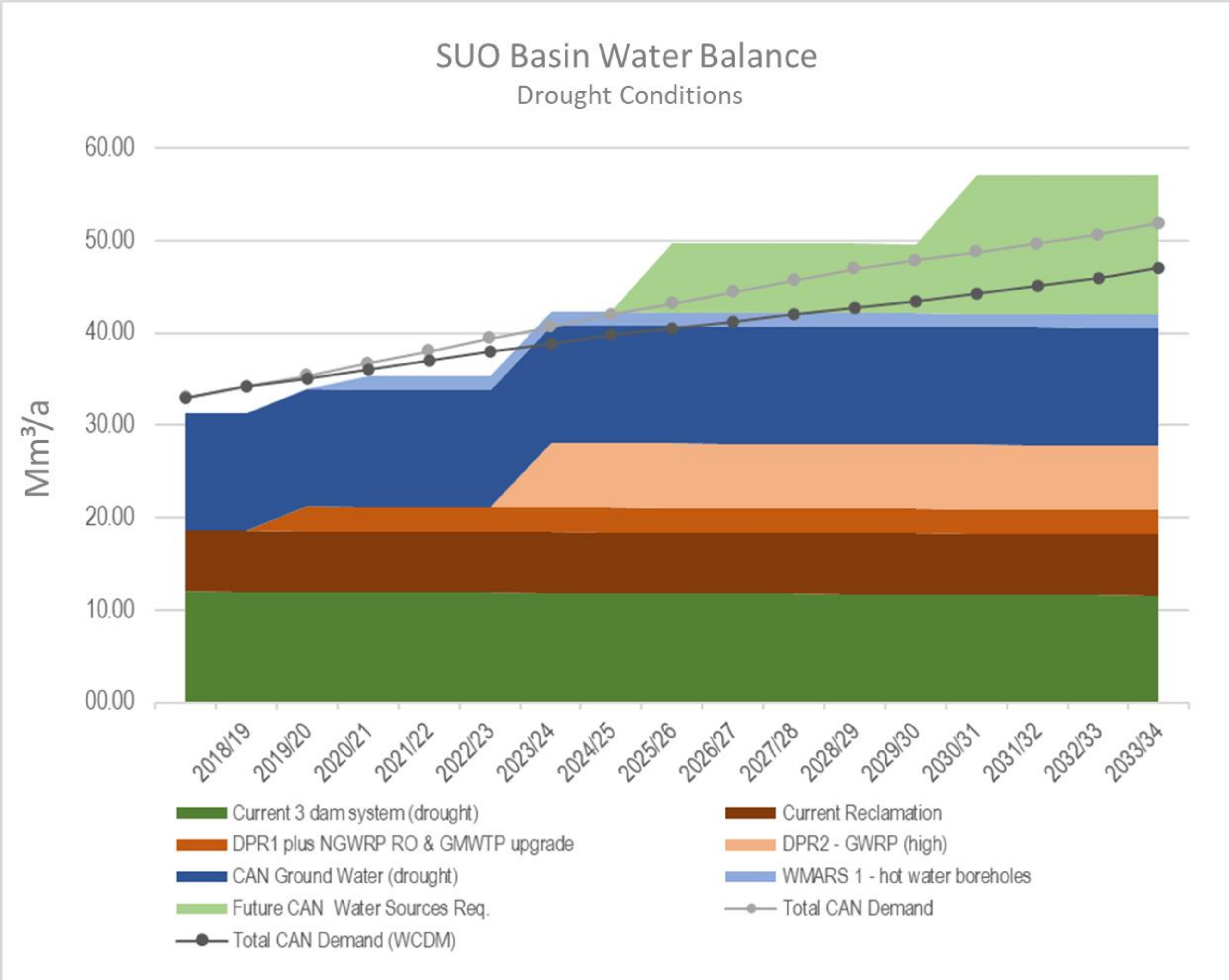


Figure 16: Demand under drought conditions (Mm³/a)

5.2.7 WATER CONSERVATION AND DEMAND MANAGEMENT

The per capita consumption of CoW is not excessive, the potential for further water demand management is thus limited in that demand management will not compensate for the increase in base demand. Awareness of water scarcity and demand sensitivity is already well established in both bulk and domestic users. However, continued effective demand management remains a mainstay in sustaining the water balance and is thus a key mitigation strategy. Given current variable rainfall, frequent water restrictions to conserve water are inevitable and occur regularly. The **consequence** of this is:

- The CoW (notably not Karibib or Okahandja) applies effective water demand management strategies that includes elements such as rising block tariffs, semi-purified effluent use, excessive use monitoring, communication campaigns and awareness programmes etc.
- The scope for further significant demand side water conservation is expected to be limited due to the already low levels of per capital water use, but requires constant attention to identify emerging trends and pockets of emerging inefficiency e.g. night flows, ageing infrastructure, leak detection repair and

low water use domestic devices. An active leak detection and repair programme is required to ensure water use remains efficient.

- In a water constrained area where little irrigation of gardens takes place, there is a high effluent return ratio. This is the ratio of effluent produced to potable water supplied into CoW.
- In a growing population, higher domestic demand therefore implies higher return flows from treated effluent and therefore an increased potential for water reuse. There is a growing opportunity for potable and to a lesser degree industrial water reuse.
- Demand management which in effect becomes associated with water rationing is an important constrain on economic activity and effects long-term investment decisions and job creation prospects.

Figure 17: Prepaid Communal Water: Demand Management through emphasis on the value of water

5.2.8 WATER RESOURCE RISK MANAGEMENT

Intuitively it can be argued that closer water resources are associated with fewer risks. Distant water resources are often associated with long transfer and pumping systems that can be compromised by power, operation and maintenance issues. Distant resources are, however, in many cases inevitable for augmentation. Local resources can be easily compromised by poorly treated effluent and other point/diffuse pollution sources. In the case of CoW it was noted that significant eutrophication problems have been reported in the Swakoppoort Dam, placing Von Bach Dam at similar risk through polluted water transfer. It is useful to note that the Goreangab Dam, located in Windhoek, is effectively unavailable for water supply due to its poor water quality. The **consequence** of this is that:

- The most proximate water source (WMARS) should be protected, expanded to its full potential and prioritised as the primary local source from which CoW can draw during emergency and drought conditions.
- The Von Bach and Swakoppoort surface water resources should be protected at all costs as these are currently the only relatively close surface water resources available for consumption and aquifer recharge.
- CoW should invest in catchment protection both in terms of natural as well as anthropogenic (urban) run-off. Preventing reduced and/or polluted run-off is typically less costly than to treat the effects of reduced yield and eutrophication.
- The conjunctive use of the three-dam system in combination with two aquifer systems, water reuse as well as aquifer recharge, require complex operating rules and these rules need to be monitored on a frequent basis to optimise system performance continuously.
- Frequent monitoring should be performed on effluent leaving CoW and the inflow into the Goreangab dam in order to identify and rectify pollution incidents.
- The efficient abstraction, storage and transfer of water from distant water sources should be operated in a manner that is risk based, updated on at least a monthly basis.
- The margin of safety between the current safe yield of all the water resources used by CoW is low compared to the projected demands. - underscoring the systems low resilience margins.

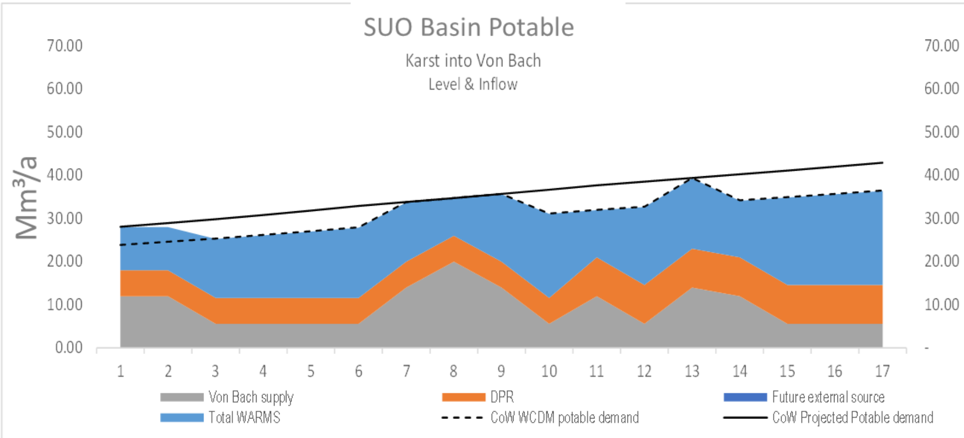
5.3 MODELLING SENSITIVITIES TO 'WHAT IF SCENARIOS'

In order to demonstrate the impact of a few key features of the water supply system, a few what-if scenarios were modelled and the results are discussed briefly below.

5.3.1 WHAT IF THE WMARS IS NOT RECHARGED?

The WMARS capacity can be expanded to an approximate 71 Mm³ and is currently recharged with treated water from the Von Bach treatment works and is also planned to be recharged from reclaimed water from the DPR2[15] facility.

The impact of not recharging WMARS is simulated by switching of the operating rule to transfer surplus water from Von Bach Dam and DPR2 recharge. The impact is catastrophic and results in a failure of the CoW water supply system as soon as the first prolonged drought occurs. It follows that the WMARS would be insufficiently recharged during times of surplus water to sustain supply during drought conditions. This outcome underscores the importance of banking all surplus surface water in the WMARS.



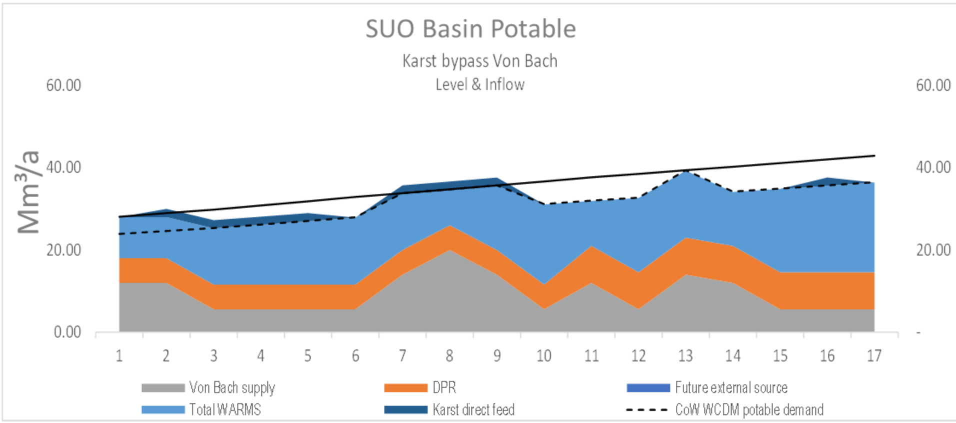


Figure 18: Modelling outcome examples of Karst groundwater bypassing Omatako and Von Bach Dams directly into WARMS (Mm³/a)

[15] DPR2 is also referred to as the planned Gammams Advanced Water Treatment Plant

5.3.2 WHAT IF THE TRANSFER SYSTEM BETWEEN KARST AQUIFER AND VON BACH FAILS?

The Karst aquifer can potentially yield between 30Mm³/and 10Mm³/a based on daily pumping rates.[16] The reported inflow into Von Bach was 6Mm³/for 2019/20[17] into the CAN water system as far south as Von Bach Dam through a complex canal, pipeline and pump system. This transfer system is notoriously inefficient due to high evaporation losses in the open canal (45% losses). Should this transfer system fail due to a lack of maintenance, the impact was modelled by switching off the rule to transfer Karst water when Von Bach Dam is low.

The impact is noticeable but takes time to be transmitted to Windhoek.

Figure 19: Grootfontein-Omatako Canal

5.3.3 WHAT IF POTABLE REUSE IS INTERRUPTED?

Direct potable reuse from the NGWRP contributes a significant portion of the potable water supply to the Basin. NGWRP is also planned to be expanded and to provide a fraction of reclaimed water for aquifer recharge. The impact of an interruption of the NGWRP due to a pollution event, poorly treated effluent or lack of maintenance was simulated by switching the rule off for reuse from effluent returned from CoW.

The impact is significant and was particularly noticeable during periods of drought and eventually leads to the failure of the CoW water supply system.

5.3.4 WHAT IF WATER IN SWAKOPPOORT DAM CANNOT BE USED AS A RESULT OF POLLUTION?

Swakoppoort Dam forms an integral part in the supply system, firstly to capture surplus run-off not captured by Von Bach Dam and secondly to capture return flows from CoW for transfer back to Von Bach Dam. Poorly treated effluent from CoW does reach Swakoppoort Dam and presents a real risk of sterilising Swakoppoort

[16] NamWater Presentation: CAN Water Conference June 2020
[17] Ditto

Dam for transfers to Von Bach Dam. This scenario was simulated by switching off all transfers from Swakoppoort to Von Bach Dam.

The impact is significant and results in lower yields from the three-dam system and eventually leads to the failure of the CoW water supply system.

5.3.5 WHAT IF AN EXTERNAL WATER SOURCES AUGMENTS THE CURRENT WATER RESOURCES?

All scenarios considered, even with improved operating rules and expanded WMARS and reuse, indicate that CoW will experience increased levels of water shortage, more frequent water restrictions and an increased risk of running out of water. The impact of a new external sources introduced in the CoW was modelled by adding a different quantum of water into the system.

The impact of adding a 10 Mm^3/a external source was significant and improved the water security levels/resilience margin significantly. When considering a long-distance transfer scheme it will be very capital inefficient to construct a system for only 10Mm^3/a.

In planning an external water source consideration should be given to regional demands and a planning horizon of 20 years and more.

5.4 CONCLUSIONS AND RECOMMENDATIONS

5.4.1 TECHNICAL AND WATER RESOURCE MANAGEMENT ASPECTS

The current **water supply system is constrained** and although a number of different resources are used conjunctively, the **margin of safety/resilience is low** i.e. the difference between the assured supply from these resources and the project demand is very small. This presents a significant medium to long term **water security risk** and is reflective of a **low resilience margin**.

Several aspects of the water supply system can be implemented in the **short term to increase the system yield** and assurance of supply. These include the expansion of the water reuse system, improved quality of effluent discharged into the Swakop river catchment and the expansion of the WMARS. However, the **long-term water security** can only be sustainably addressed by

Pertinent Question:

Which unconventional water supply strategies can still be explored?

Typical examples of unconventional water strategies include:

- deep storage;
- international water sharing;
- virtual water;
- deep groundwater;
- artificial recharge;
- rainfall enhancement;
- rainwater capture;
- grey water harvesting;
- fog water;
- desalination;
- iceberg water harvesting;
- wastewater reuse; and
- water demand management.

developing **new external water resources**. Some of the external water sources mooted in recent studies include long distance transfer systems from the Okavango River and desalinated water from the Atlantic Ocean. The external water source should be large enough to cater for regional demands and designed to cater for long term demand projections of 20 years and beyond.

A high-level water resource model was developed to strategically test the interaction and dependencies of the current water resources and test operating rules. It was found that complex operating rules are essential to optimise the current water resources.

The current water supply system incorporates surface water sources, groundwater sources, water reuse and managed aquifer recharge. The integration and maximum utilisation of these water sources requires **complex operating rules**. Bulk off-takers/users do not have direct control over all the resources and are reliant on other stakeholders to comply with the operating rules without having access to real time operational data. This presents a short-term **operational risk and exacerbates the impact of supply disruption**. An integrated real time **decision support system** is desirable to capture real time data and climate data in order to apply operating rules and assess short, medium- and long-term water security. The decision support system will have to be operated by a **multi-stakeholder workgroup** that includes stakeholders involved in all aspects of the water system.

Apart from the complex operating rules that are currently focussed on water quantity, water quality aspects also need to be integrated to establish a real time **water and salt balance**. This matter is further discussed under the environmental heading.

5.4.2 SOCIO-ECONOMIC AND FINANCIAL ASPECTS

Growing cities, especially those impacted by climate change and urbanisation, will require significant funding to improve and expand water resources. These improvements require both the upgrade/expansion of the WMARS, local wastewater treatment systems, local potable reuse and desalination systems as well as regional bulk transfer systems. Detailed cost estimates are required as part of a structured project preparation process since, the level of investment required will be significant.

Planning and prioritising the technical solutions required has to a large degree commenced, but it is also important to consider how this infrastructure will be funded and how investment, operating and maintenance cost will be recovered from the water users. A delayed decision on implementing cost recovery of future investment requirements can lead to a tariff shock – which may result in tariff increase resistance and affordability challenges for the urban poor. It is essential that a long-term financial model be developed to forecast investment and cost recovery requirements. It is also essential that the outcomes of this model be communicated with the relevant stakeholders timeously.

Increased urbanisation attracts all spheres of society, including unemployed people. The population demographics of the Basin may over time change from a relatively self-sufficient urban community to a community with a fair percentage of unemployed. This may further put pressure on cost recovery requirements as a portion of the water users will have to be funded by those who can afford to pay.

The socio-economic changes also need to be modelled in order to understand the type of scenarios the Basin may have to face in decades to come.

5.4.3 ENVIRONMENTAL ASPECTS

Water is inextricably linked to the environment. Unfortunately, the impact of urbanisation will always have a significant detrimental environmental impact if not deliberately managed otherwise. CoW is generally recognised as a leader regarding potable water reuse with a reputation as a clean city. However, the areas that require attention are the effluent produced at the Gammams and Ujams wastewater treatment works. The effluent produced impacts on the ability to reuse (and expanding reuse source water) the water at the NGWRP and impacts on the usability of the water from the Swakoppoort Dam. Salt accumulation because of repeated reuse is also a matter that will have to be addressed in the long term. During periods of drought no salts can bleed out of the CoW system via river runoff and will have to be artificially bled out of the system through side-stream desalination. The resulting brine by-products will require additional treatment and disposal. The risk associated with informal settlements not having access to sanitation services on the water system is noteworthy as well.

Water resource modelling often focusses on water quantity aspects but does not integrate the water quality aspects into the water resource modelling. It is recommended that impact of reuse, salt accumulation and wastewater inflow and discharge within the CoW system, be integrated with water management models in order to understand the long term impact, but also to prevent short term shocks to the overall supply system.

5.4.4 INSTITUTIONAL AND LEGAL ASPECTS

Water use rights and water trading in the context of the preceding paragraphs can become a political and socio-economic quagmire if proper policies and legislation are not in place to regulate its use and allocation. The arguably archaic RSA 1954 Water Act remains fundamentally based on riparian water rights, a legal principle that has been challenged by many countries from a basic human rights perspective. There is a definite need to revise the current water legislation and adapt to more appropriate water legislation approach (its noteworthy that draft legislation has made progress in this regard but remains unimplemented). The revised water legislation should also further clarify and revise the current responsibilities of the various tiers of government responsible for managing water.

Regional water utilities are by nature monopolistic as users are not able to develop alternative solutions with their own capital. This inherent monopolistic feature of the water industry often leaves room for inefficiencies and bloated overhead structures. To avoid this, independent oversight should be provided to continuously check that utilities are efficient, effective and comply with legislation. Another mechanism that often keeps regional utilities in check is a comprehensive and actively managed service level agreement. The service level agreement should include aspects of governance, projects, reserves, financial management, long term planning, funding, water quality, water security etc.

A key weakness in the regulatory framework is the lack of a fully functional and operational Water Regulator Namibia, similar to the role the Electricity Control Board (ECB) currently plays.

Figure 20: Von Bach Water Treatment Plant

6. CURRENT PLANS AND PLANNING

6.1 INSTITUTIONAL PLANNING FRAMEWORK

The current institutional framework for planning within the water sector is complex. At the highest level is an inter-Ministerial Cabinet Committee on Water Supply Security coordinated drought emergency responses provides funding for priority interventions. This Cabinet Committee coordinates the planning, prioritisation and execution of projects under the emergency water supply infrastructure programme. This fund is managed through the Technical Committee of Experts.

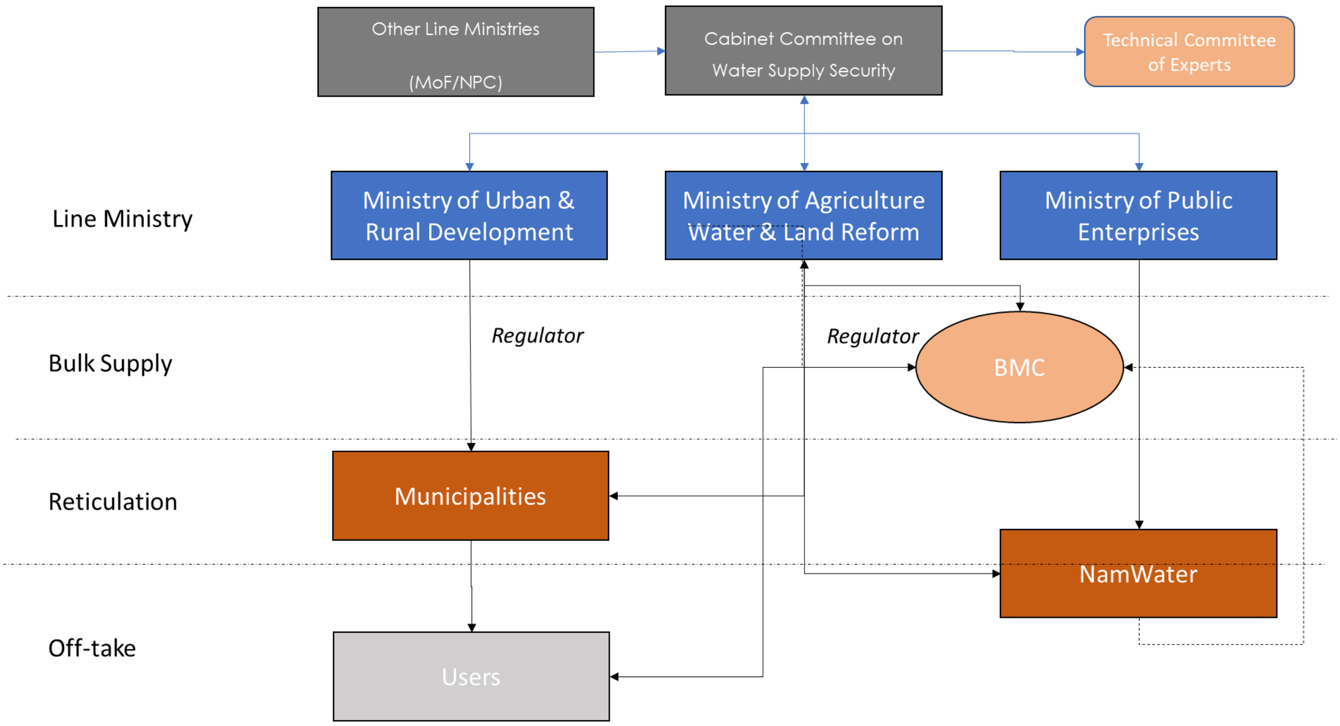


Figure 21: Institutional Framework for water policy and planning

It is also apparent, looking at the graphic depiction of the institutional framework above, that line ministerial linkages to the water sector are somewhat complex. In effect a matrix structure of reporting, regulation and ministerial control exists. It follows that a similar matrix influences budget allocation, planning decisions and executive decision making in the water sector. Whereas a Regulator has been created for the water sector under the Ministry of Agriculture, Water and Land Reform as a potential locus of coordination, this regulatory functions remain far from fully operational.

6.2 PLANS AND PLANNING: CONTEXTUALISING THE EVOLVING META NARRATIVE IN WATER SECTOR PLANNING

A complex overlay of plans exist that collectively form the planning framework of the water sector. Figure 23 below summarises key policies and plans in a broad planning hierarchy. It follows that a comprehensive planning framework does exist that informs decision-making from National, bulk supply and local distribution network planning. In addition to this broad planning framework, a dense and broadly mutually reinforcing policy, area-based and project specific planning corpus has been established.

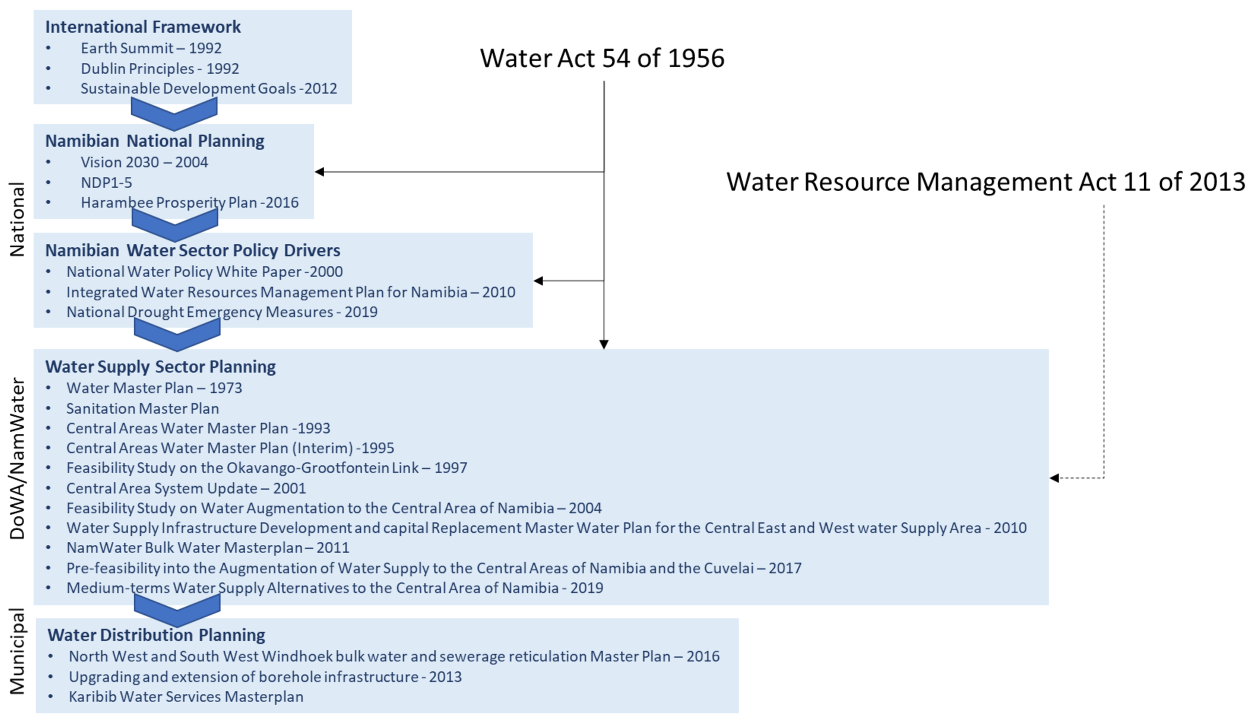


Figure 22: Summary of selected plans in the water sector (source BigenKuumba)

Namibia arguably does not lack for policy and planning in the water sector. The main thrust of water policy did however shift in emphasis over the decades. The key shifts in the evolving planning focus over the decades are summarised in Figure 23 below. The evolving story/narrative is dominated by meta strategy responses:

a) In the pre-1970 period the strategic narrative was informed by a growing realisation that the urban centre in the Basin was exceeding its natural geographic water supply footprint. While an innovative augmentation response was implemented through the OGWRP in 1968 – the meta narrative was dominated by the planning for a bulk water supply system that facilitated water transfers to Windhoek to meet growing demand. The outcome of this process was the three-dam supply system, the various water transfer schemes between those and their linkage to Windhoek. Importantly, the design parameters that informed the three-dam system were the optimisation of the dams and not the projected supply. Consequently, a perception of a safe supply capacity and capacity margin took hold and subsequently resulted in a decades long de-emphasis of the continuation of expanding the bulk supply system.

Water Planning Narrative: adding layers

	Pre-1970	1970's	1980's	1990's	2000's	2010's	2020
	Water Security	*Construction*	*Construction*	*Construction slows down*	*Optimisation and Augmentation*	*Optimisation and Augmentation*	*Water Security*
Dominant narrative	Supply footprint exceeded Decade of Planning a National Water Supply System	Decade of building large scale bulk water infrastructure	Completing the three-dam transfer systems	1st section of Eastern National Water Carrier gets added to the system	Making the system efficient • Reclamation • Demand management	The search continue for augmentation solutions • Pollution control	Maintaining focus on augmentation, but seeking new bulk supply solution
Planning focus	Creating core infrastructure paramount Water reuse enter supply system			• Key focus on upgrading elements of the bulk supply system - efficient utilisation of surplus water sources • Completion of the ENWC to complete link to Okavango • Growing emphasis on system optimisation • Modelling becomes integral to planning in efficiency and setting operating rules for bulk system	• Upgrading reuse – NGWRP come on-line • Drought bring on revisiting completion of ENWC's completion – several options are considered – incl desalination (rejected). Okavango preferred option • Emphasis on demand management • Growing emphasis on urban growth and network expansion	• Augmentation alternatives main key focus and gets fully exploited • Karst aquifer • Windhoek Aquifer as MARS prioritised • Renewed focus on Demand management • Growing dependence on efficiency of managing bulk water system • Environmental considerations becomes important • ENWC de-emphasised	• Supply system limitations exposed to drought • Continued focus on reuse • WMARS gets implemented • Large number of new bulk supply sources investigated and prioritised • Long term solution emphasise Okavango river source • Desalination re-emerges as an alternative supply

Figure 23: The evolving planning narrative in water(Source: BigenKuumba)

b) The 1970's and 1980's decades were dominated by the construction of the three-dam system and its interrelated transfer systems. This interlinked supply system was largely completed in the 1980's. The planning narrative now evolved to look at future bulk water sources. Thinking at the time favoured the utilization of the Okavango River as a future water source to the central area of Namibia. The infrastructure enabling the abstraction of water from the Okavango from Rundu is the Eastern National Water Carrier (ENWC) and), which was planned in stages, the first being the Grootfontein-Omatako link. The Grootfontein-Omatako Canal was subsequently completed in 1993. Following this milestone, the narrative started to de-emphasise the creation of new bulk supply infrastructure in favour of optimising the use of the installed system. This trend broadly followed contemporary international thinking at the time as financial and environmental impact considerations of water infrastructure tempered the construction of new infrastructure while the supply system had spare capacity.

c) The 1990's thus experienced a marked shift towards resource modelling to lay the foundation of an optimally managed system that is able to exploit available water sources efficiently. It follows that NamWater was spinned-off in 1997 from the state as utility provider with a mandate to become an efficient water provider with a cost recovery tariff mandate.

d) The emphasis on optimisation continues into the 21st century's first decades. As the reserve capacity of the bulk supply system slowly got taken up, the focus on efficiency and resource optimisation intensified. An intense drought period in the middle of the decade briefly reintroduces completion of the ENWC as an emergency measure. Emphasis in planning during this period however further expanded augmentation of direct potable re-use and growing emphasis on effective demand management. Importantly, the compound effect of urbanisation puts pressure on the expansion of distribution networks, a focus that will remain for decades to come. Systematic deterioration of municipal balance sheets takes place which increasingly undermines the capacity to spend on capital projects and compromise preventative maintenance programmes. Major new infrastructure, such as the Orano desalination plant, is constructed privately, outstripping NamWater's balance sheet capacity and priorities.

e) After 2010 it became clear that the capacity of the bulk supply system is being reached. Various documents put the date at which the capacity of the system will be exceeded variably between 2012 and 2013. This decade will finally see the full exploitation of viable augmentation options – notably introducing the key WMARS groundwater source into the supply system. Another severe drought episode puts the system under severe pressure and the decade ends with appreciation that an additional water resource that allows a safe resilience margin is becoming inevitable. Importantly, the drought drives almost all bulk users to become strategically less reliant on NamWater and municipal water supply and introduce water saving and reuse measures. NamWater uses this decade to sophisticate its operational management and introduces an enterprise-wide planned maintenance solution. After some decades, water security is firmly back on the agenda.

What will happen in the short-, medium- and long-term future? It is to be expected that the emphasis on augmentation through demand management, reuse and manged groundwater recharge, optimisation and efficiency of use will remain. Careful management of the bulk supply system is likely to continue with an additional advantage of delaying the mayor new capital cost of bringing a new bulk water source into the system. A major financial downturn after 2016 placed government liquidity under severe pressure. The Covid-19 pandemic extends recessionary conditions beyond 2020, placing further pressure on liquidity and balance sheet capacity. In response, the NDP 6 emphasise the use of PPPs and by implication, project finance for most infrastructure initiatives, specifically water. This changing context is likely to result in significant changes regarding:

- Transaction processes: Utilising the PPP transactional route involves the relative new PPP Act 4 of 2017 in conjunction with the Public Procurement Act 15 of 2015. This legislation requires a rigorous and staged project preparation process that could potentially add significantly to project lead times (see Fig 24);
- The use of a PPP transactional framework implies an economic tariff recovery regime that would meet investment grade return expectations. This transactional framework will thus require critical tariff reform measures to ensure affordability.
- Introducing a PPP framework is likely to incorporate concessionary contracts (such as already in place in the CoW) in the bulk supply system, with several potential implications for NamWater as monopoly bulk water supplier and revenue models.

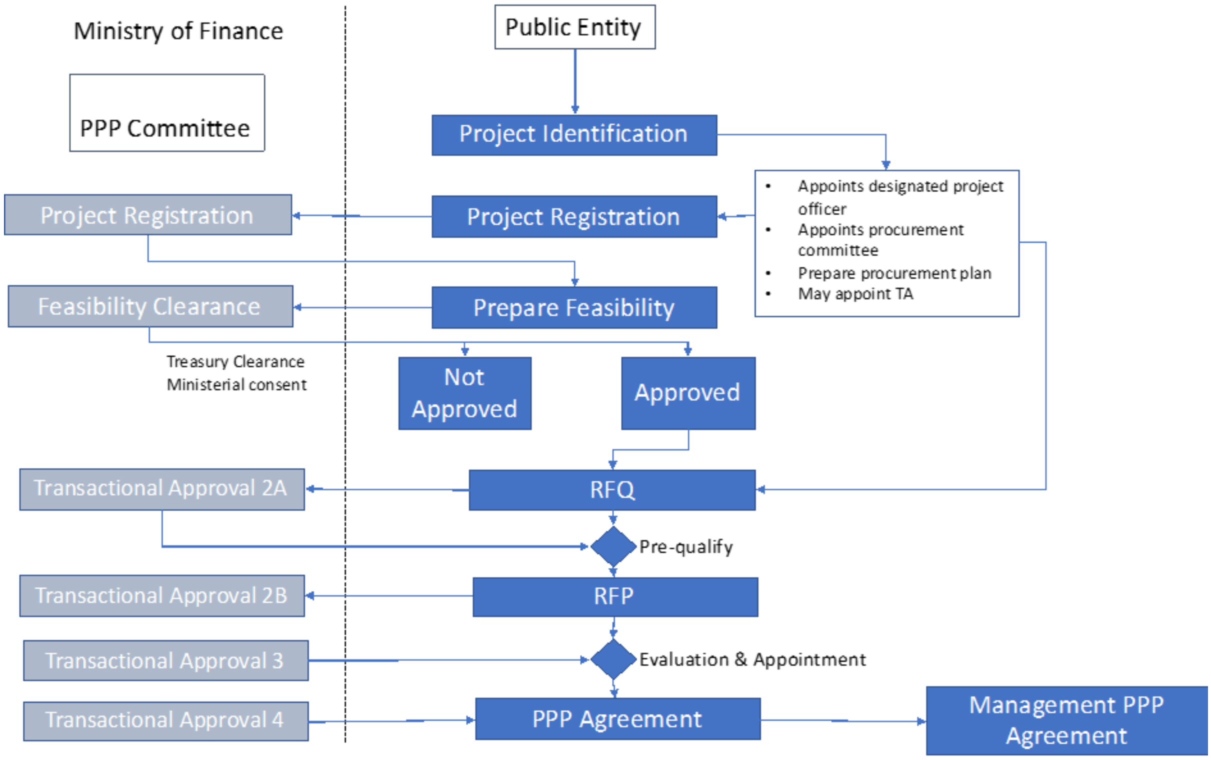


Figure 24: Regulated Namibian PPP transaction flow under Act 4 of 2017 (Source: BigenKuumba)

6.3 PLANS AND PROJECTS IN PLACE: SHORT- AND MEDIUM-TERM PROJECT AGENDA

There are two short-terms project programmes under implementation. These are:

a) Projects forming part of the Emergency Water Infrastructure Plan pertinent to the Swakop Upper-Omatako Basin. The Technical Committee of Experts reporting to the Cabinet Committee on Water Supply Security has been established in response to a severe drought period. A state of emergency was declared in 2019 in response to this natural disaster and a budget allocation of N$2.8bn created to address emergency measures to mitigate the effect of the drought. The priority projects implemented under the auspices of the TCE are:
   - Kombat & Berg Aukas power supply upgrade;
   - Omatako to Von Bach pump stations refurbishment; and
   - Abenab borehole development and linking to the ENWC.

b) Project forming part of the NamWater Bulk Supply programme. These projects are:
   a. Recently completed: Kombat Scheme upgrade with construction of a 1.75km pipeline section between the boreholes and the booster pump station at a cost of N$14.5m
   b. Projects in design and construction stage:
      i. Kombat power supply upgrade;
      ii. Von Bach dam sluices and other equipment rehabilitation and replacement;
      iii. Completion of the investigation of medium-term supply alternatives to the Central Area of Namibia; and
      iv. Consulting work to size a new reservoir for Von Bach-Windhoek-Brakwater.

The Medium-term supply alternatives for the Central Area of Namibia (March 2019) suggests a dual strategy based on a high probability of supply shortfalls expected within the Basin and the nature of providing an additional source of supply to the system. This strategy provides for a short-terms element based upon:

a) Medium-term water supply:
    a. To implement all known augmentation sources of supply with a 2-5-year implementation period;
    b. Continuous improvement in water use efficiency (i.e. addressing water losses in the system) and upgrading existing sources of supply (i.e. additional potable reuse, extending use of WMARS);
    c. The aim of medium-term interventions is aimed at reducing water supply shortfalls in an 8-10-year period, while long-term supply options can be implemented.

b) Long-term water supply
    a. The CAN study suggests that a long-term base supply of a new water source needs to be in place by 2022 to avoid large-scale shortfalls.
    b. The study concludes that there are only two sources available with sufficient capacity, namely the Okavango River and desalination of seawater.
    c. Importantly, the CAN study assumed an implementation period for its long-terms interventions from 2015/16. No concrete steps have however been taken in the period leading up to 2020 towards selecting or proceeding with any long-term option.

High level cost estimates suggest a funding requirement of some N$1.5bn over 4 years (2015/16 base year).

6.4 THE CURRENT PLANNING FRAMEWORK: CONCLUSIONS

The key plan informing the decision-making, prioritisation, programming and budgetary decisions in the Swakop Upper-Omatako Basin is the comprehensive cluster of studies that forms the Central Area of Namibia planning framework, prepared under the auspices of NamWater. This CAN framework guides prioritisation, programming and budgetary allocation and sets in place a well-researched and detailed framework for annual and medium-term budgeting and execution.

The key challenges observed form the current framework are the following:

a) Despite detailed investigations, studies and option evaluation, there remains no clear or firm decision as to which long term solution to the water supply challenge is preferred. It follows decision-making is dominated by a short-term 2-3-year supply scenario depending on individual rain seasons and dam levels. Due to long project implementation lead times, the continuous delay to commit to a new bulk source of supply is risky and undermines establishment of a healthy resilience margin;
b) The approval status of plans remains unclear. It follows that the plans retain a decision-information purpose, but do not clearly inform budget decisions and importantly, do not link to clearly defined implementation programmes;
c) Several key plan documents are not in the public domain and therefore not formally accessible to stakeholder input. The most important of these are the Emergency Water Infrastructure Plan and the medium-long terms strategy pertaining to water supply solutions to the CAN area.
d) The lack of stakeholder participation in the preparation of technical plans and technical consideration of infrastructure options and alternatives, has created an information vacuum and contributes to widespread concerns and uncertainty regarding water security;
e) Plans are not explicitly linked to a resourcing framework. Municipal-level plans are largely unfunded and almost entirely dependent on inter-governmental capital grants. NamWater's and municipal projects are not transparently resourced, giving rise to concerns regarding lack of implementation and unclear timelines in resolving long term water security challenges;
f) It follows that plans and planning exist within an apparent incoherent and ad hoc implementation framework and based on pay-as-you-go on budget availability. As a result, major infrastructure projects have very long lead times (the WMARS took from 2004 to 2020 to be implemented, the ENWC link between Rundu and Grootfontein was prioritised for completion in 2009, later adjusted to 2011 and ultimately 2023). It remains unfunded with uncertainty regarding implementation).
g) Considering that an external water source needs to be in place by 2022, it is unlikely that lead times can be met in the available timeframe.
h) An emergency response framework to the 2017/18 drought event is not a sufficient solution to the long-term external water source challenge faced by the Basin.

7. RESULTS OF STAKEHOLDER ENGAGEMENT

7.1 THE ENGAGEMENT PROCESS

The intent at the onset of the development of an IWRMP for the Swakop Upper-Omatako Basin was to engage stakeholders through a series of 3 workshops. The workshops were planned thematically:

a) Stakeholder Mapping and Issues and Options Workshop: the purpose of this workshop was
   a. To ensure all relevant stakeholders are engaged;
   b. To clarify stakeholder roles and nature of relation to water sector;
   c. To understand their strength of association;
   d. To inform the role of the BMC; and
   e. Develop a common understanding of issues, options and challenges in the water sector.
b) Strategic Action Plan Workshop: the broad purpose of this workshop was to populate a prioritized series of interventions for the Basin IWRMP.
c) Final consolidation workshop to agree on the Swakop Upper-Omatako Basin Plan.

As mentioned above, the Covid-19 pandemic disrupted the anticipated stakeholder engagement programme. It was not possible to facilitate inter-active workshops with relatively large groups of people due to lockdown restrictions. Considering ongoing uncertainty regarding lockdown restrictions, the process of stakeholder engagements had to be reconsidered. Instead of developing the Basin SAP through a series of workshops, it was decided to allow engagement through a consultative draft report.

However, a series of 31 in-depth interviews were held between March and June 2020 with a range of selected stakeholders. These semi-structured interviews were based on a series of questions to elicit specific responses from stakeholders. The input from the stakeholder interviews were highly informative and provided a very rich background to stakeholder views regarding issues in the water sector and directly informed content of this report. Interviews were held with representatives of the following broad categories:

- Government stakeholders;
- Bulk suppliers;
- Municipalities;
- Bulk users; and
- Sector experts.

A series of two stakeholder workshops were conducted and were informed by the interview outcomes received. The first such workshop concluded a stakeholder mapping exercise and captured key issues and options. The second workshop validated the Strategic Action Plan contained in this report.

Figure 25: Group discussion practicing social distancing: 2 July 2020

7.2 STAKEHOLDER MAPPING OUTCOME

A contact list of stakeholders was compiled and formed the basis for identifying stakeholders and key experts invited to workshops and contacted for interviews. This list incorporates the consultative list for this distribution of this draft report.

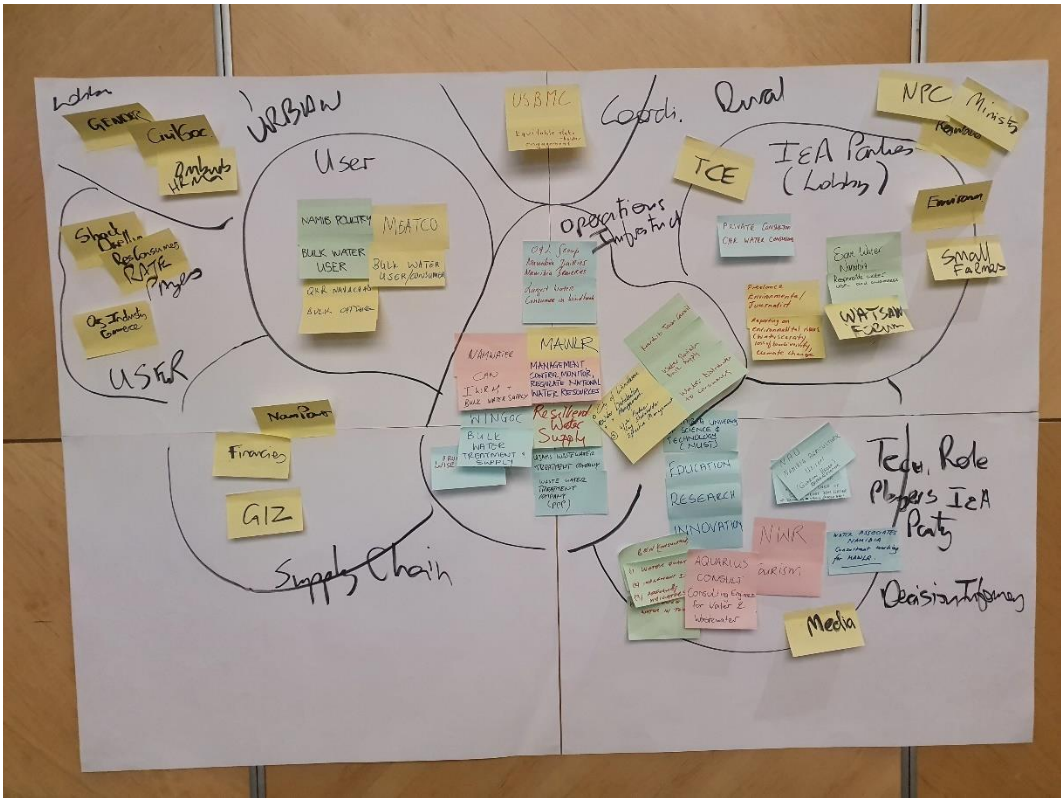


Figure 26: Consolidated stakeholder mapping outcome

Figure 27: Stakeholder mapping: Break-away feedback

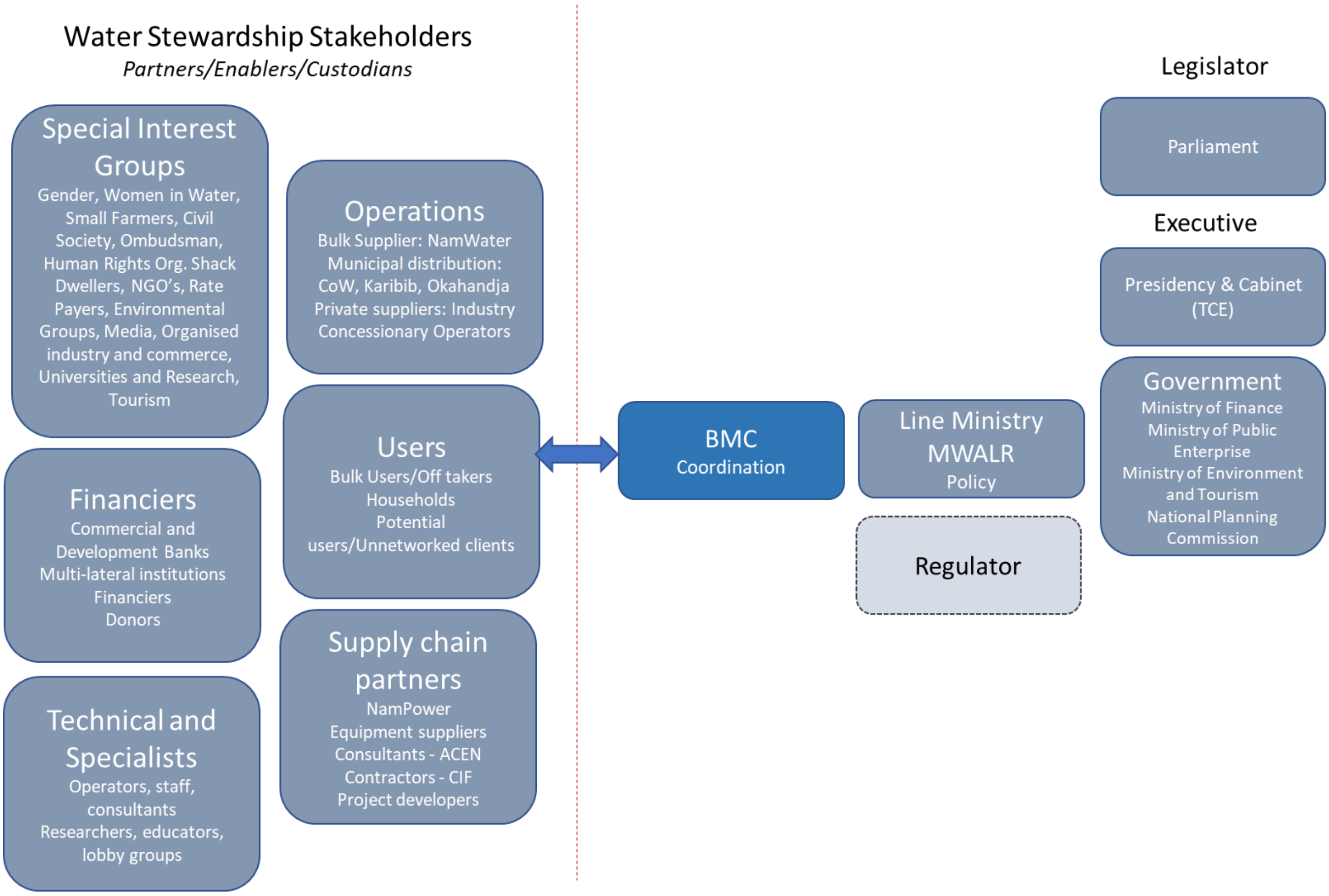


Figure 28: Water Stewardship Stakeholder Map

The outcome of the workshop identified several stakeholder groupings that were combined into Water Stewardship stakeholder clusters:

a) Special Interest Groups; these are organized stakeholder representative groups with a stake in water;
b) Financiers; organisations that have an interest to participate in the resourcing of water infrastructure;
c) Technical experts and specialists; crucial individuals that have deep expertise in water to contribute;
d) Operational entities; bulk water suppliers, municipal distributers, private operators, organisations that provide services in water value chain;
e) Users; large scale bulk users (i.e. mines and industrial users), individual households and potential users; and
f) Supply chain partners; NamPower, equipment suppliers (i.e. pumps, pipes, chemicals, manufacturers), consultants, contractors and project developers.

Please note that there are two broad as yet unresolved approaches to the definition of the Water Regulator as used in this report:

- Viewing the MAWLR as the de facto Water Regulator
- Establishing an independent Water Regulator similar to that of the Electricity Control Board

These clusters are potential water stewardship stakeholders through which the BMC can channel its coordination and information dissemination efforts. However, it is crucial to recognize Government Stakeholders in the water sector – these include the line ministry and several related ministries interacting with the water cluster.

7.3 STAKEHOLDER VIEWS/CONCERNS/ISSUES

Through a process of interviews and the reaffirmation of the workshop participants, a series of broad themes have been collated that inform the views, concerns and priority issues regarding the water sector. Stakeholder interviews elicited very rich input on a very wide range of issues related to the water sector. These inputs were broadly clustered into 5 themes based on the priority attached through the engagement by stakeholders. It is important to recognize that these themes are not definitive, but broadly indicative of what stakeholders consider being of importance. Each stakeholder response provided much detail and rich in specifics – dominated by intervention (i.e. respondents focused on “what” and not “why”). Water security and issues pertaining to water resilience clearly dominated responses and is likely to be expected following the recent drought episode.

The most pertinent issues raised are (also see figure 30 below):

Relative importance Ranking	**Response category/cluster**	**Working definition of issue**
1	Water Security and Resilience	Range of concerns/issues pertaining to the sufficiency of water resources and future secure of supply. Issues raised talk directly to a concern that the current supply

Relative importance Ranking	Response category/cluster	Working definition of issue
		system does not have a sufficient resilience margin to accommodate future shocks and stress.
2	Security of Supply	This range of concerns pertains to the bulk and reticulation system's robustness to ensure uninterrupted supply. The issues raised reflect a concern that infrastructure is deteriorating, and that infrastructure failing is expected to increase.
3	Institutional matters	A cluster of concerns were raised that lament lack of communication, slow decision-making cycles, lack of implementation, lack of accountability and monitoring.
4	Financial Sustainability	Concerns raised regarding financial sustainability, availability of capital finance at the scale required, lack of preventative maintenance budget, and anticipated tariff shocks and affordability.
5	Water Quality	Range of concerns that address perceived problems with water quality, pollution risk

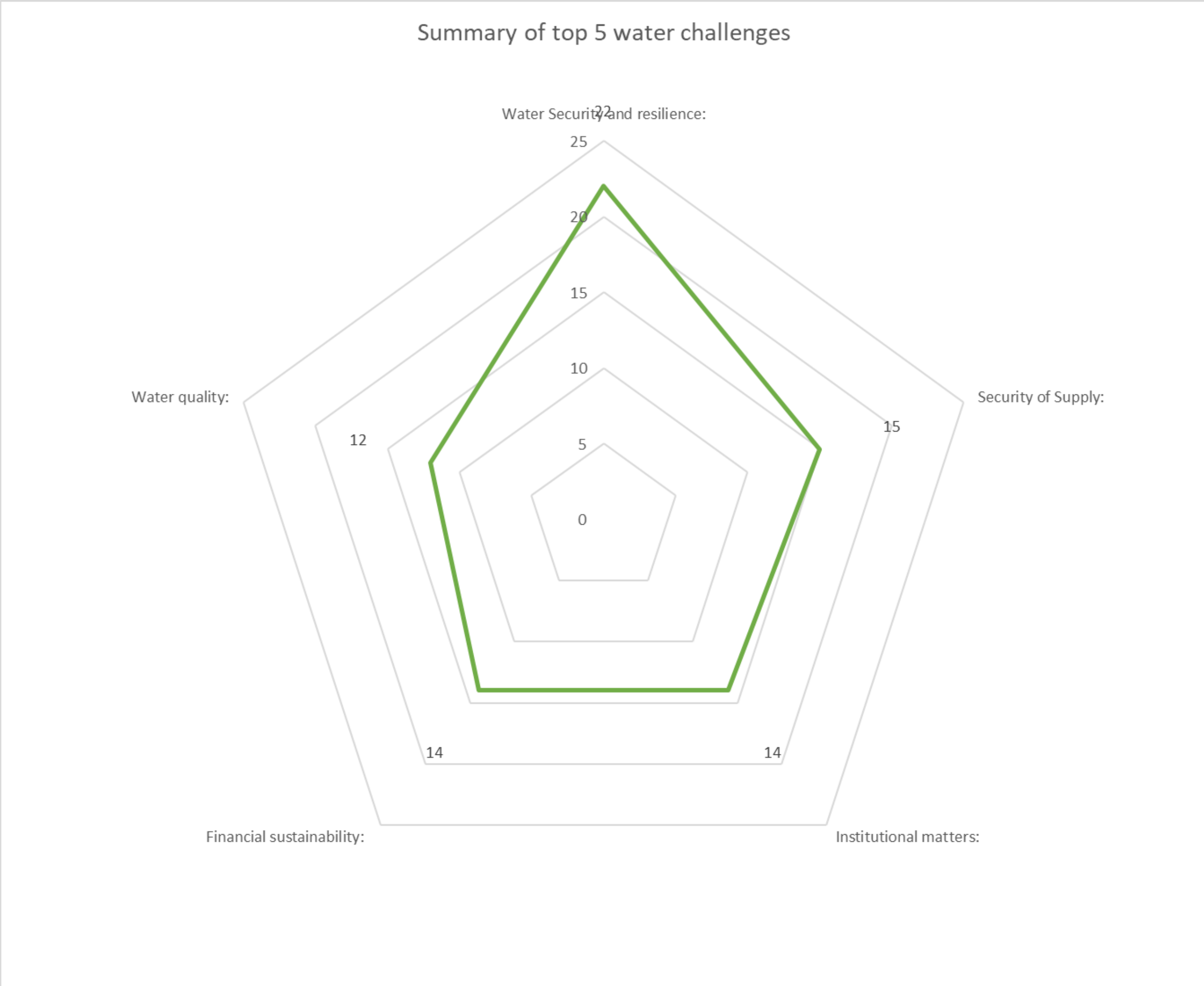


Figure 29: Outcome of stakeholder interviews: Top 5 priorities

The graph above (Fig. 29) provides an impression of the relative importance attached to the issue clusters when they were asked to rank their response.

It is useful to observe that there was a marked difference between user and supplier stakeholders' responses:

Users tend to be relatively uninformed pertaining to plans, expressing frustration regarding lack of implementation and low confidence in current supplier dispensation's sustainability. Issues of accountability, transparency, communication "*lots of plans -poor implementation*".

Supplier stakeholders tend to be better informed regarding plans but often express a lack of detailed understanding of strategies. Respondents tended to focus on their specific area of responsibility (i.e. pollution control, demand management) and thus somewhat lack integrated prioritisation commonality.

8. STRATEGY

8.1 ASPIRATIONS

In this section an aspirational statement is proposed that tells a BMC story in the future.

In 2030 the Chairperson of the BMC delivers his/her report and reflects on the past decade. In preparing the report the Chairman looked back upon IWRMP for the Swakop Upper-Omatako and can make the following observations:

a) A looming water supply crisis has been largely averted through the timeous construction of a new water source for the Basin. This major project was delivered using sustainable technology and utilizing innovative funding instruments that will ensure affordable tariffs to end users. Business and industry could use the newfound water security to plan investments and it has had a marked impact on confidence and investment. Job creation and sustainable livelihoods have seen a marked upswing and people's confidence in the future returned with a significant economic growth phase.

b) Government expressed satisfaction that the water supply system has a sufficient resilience margin to ensure uninterrupted supply in light of worsening climate conditions and expected more frequent drought periods.

c) A Water Regulator Namibia has been operational for some years and assisted in a review of tariffs that allows sustainable reinvestment in infrastructure assets and seamless management of an integrated water service. A continuous pollution monitoring system is in place and has succeeded to reduce systemic deterioration of the Swakoppoort Dam.

d) Urban growth remains high, but proactive planning has succeeded in the provision of safe potable water to all informal areas and sanitation services to all urban settlements. Expansion of the sewer networks are allowing additional reuse options to be developed. The water network is able to meet the aspirations of all through the introduction of an economic tariff based on full cost recovery while incorporating a subsidized water and sanitation social tariff to the urban poor.

e) Municipalities in the basin remain acknowledged world leaders in the application of best of breed technologies systems in water supply and wastewater treatment. In addition, demand management practices have resulted in a highly efficient water supply system with state-of-the-art water loss control systems, demand management practices and customer communication.

f) Practical solutions have been found to extend the semi-purified water system to support an innovative urban agriculture project consisting of small-scale farmers improving food security.

g) Stakeholders are continuously updated on plans and can monitor implementation of projects to allow for a transparent supply system across all institutions involved in the water supply chain. This transparency has boosted confidence and a high level of trust exists in the supply system between suppliers and users. The system optimization is done on a regular basis and is published on the NamWater website, allowing complete transparency to stakeholders with an active interest in water.

h) Planned programme budgeting has been introduced that allows medium-term budgeting and monitoring of project implementation on a rolling annual basis. Financiers can plan their engagement in the water sector with a range of transactional models to engage with. PPP operators, similarly, have advance notice of projects and several transactional models through which to partner with NamWater and municipalities.

i) *Unsolicited PPP proposals was allowed in an amended PPP legislative framework and successfully implemented.*

8.2 VISION, MISSION, VALUES

8.2.1 VISION STATEMENT

Through the process in of stakeholder engagement several key words allow the encapsulation of the prevailing sentiment. These were mirrored Proposed Vision Statement for the BMC :

"Driving[18] a resilient water supply system[19] to the Swakop Upper Omatako Basin[20] and promoting a culture of innovative[21] water stewardship[22] for long term water sustainability[23] supporting economic development[24]"

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Stakeholder engagement suggested an explanation and unpacking of the various elements in the vision statement – for that reason explanatory footnotes are added

8.2.2 WATER SYSTEMS MANAGEMENT MISSION

Proposed Water Systems Management Mission:

"Our BMC's mission is to provide a conduit of information between stakeholders in the water sector. We will do this by:

- *Working jointly with stakeholders in a spirit of partnership and joint water stewardship*
- *Fulfilling a coordination and facilitating role*
- *Aligned and in collaboration with responsible water institutions*
- *Excellent communication and feedback to our stakeholders"*

[18] "Driving" selected by stakeholders in place of 'facilitating"
[19] An aspects placing emphasis on water resilience concept
[20] Defining the Basin
[21] Preserving the culture of innovation that exists in existing thinking
[22] Emphasis on the concept of water stewardship and a water partnership milieu
[23] Emphasis on water sustainability concept
[24] Economic development added through stakeholder engagement

8.2.3 OBJECTIVES

Proposed objectives for the BMC:

- *To develop a 'big picture" understanding of the water sector challenges in the Basin and frame an BMC leadership around such an big picture/key issue agenda*
- *Promote Integrated Water Management and a culture of shared water stewardship*
- *Advocate long term water security and the optimal management of the water supply system*
- *Provide an institutional conduit between policy makers and practitioners*
- *Coordinate joint action by stakeholders on critical issues of common interest*
- *Provide a dialogical platform for stakeholder engagement and water policy consultation*
- *Access point to water knowledge resources and information dissemination*
- *Monitor optimal management of water resources*
- *Evaluate efficiency, effectiveness and equitability of water sector performance and promote accountability*

8.2.4 DEFINING THE PRIORITY AGENDA FOR CHANGE

The aim of this section is to articulate an agenda for change; i.e. what can the BMC promote to improve water management practice based on the various stakeholder. This change agenda is captured under three heading; what do we need to continue doing well (persist), what can we improve upon (adapt) and what we should do a lot better (transform):

Persist:

- Continue to provide thought leadership and Innovation in water augmentation such as managed aquifer reuse, semi-purified reuse;
- Provide effective demand management strategies; and
- Provide good quality water and water quality monitoring according to the safety standard.

Adapt

- Continuously improve on the optimal management of the water supply system;
- Significantly improve on pollution monitoring, control and risk management; and
- Improve communication with bulk users.

Transform

- Commit to a long-term solution to provide water security;
- Facilitate a transition to planned programme development and implementation;
- Establish a revolving project preparation fund to finance project feasibility studies under the PPP Act's requirements;
- Communication and building of institutional trust in the water management system;
- Improve on the resourcing of the water supply system through tariff reform and public sector funding reform;
- Operationalize the Water Regulator Namibia function;

- Allow transparent tariff increases ;
- Implement a planned maintenance programme in the whole water value chain;
- Encourage innovation in the water value chain using creative procurement strategies, transactional models and financing solutions;
- Commit to a programme to provide sewerage solution and access to water in informal settlements;
- Review municipal infrastructure standards and quality monitoring requirements so as to ensure affordable infrastructure for all;
- Improve stakeholder communication; and
- Develop a community water programme aiming to reach out to civil society stakeholders – such as investigating the use of semi-purified water for urban agriculture.

8.2.5 SUGGESTED VALUES

Key values of the workings of the BMC:

- ***Partnership*** – providing a partnership platform for engagement of all stakeholders in the water sector
- ***Positively engaged*** - in a spirit of constructive critique and a desire to contribute to improvements in water stewardship
- ***Transparent*** – promoting transparency and accountability in the water sector
- ***Open*** – allowing a diversity of ideas to be debated and considered
- ***Equitable*** – recognizing that competing ideas and scarce resources necessitate moderation and adherence to equitable values
- ***Coordination*** - adding value by connecting the dots and assisting water role players to explore synergies
- ***Participative*** – allowing a platform for dialogue in exploring water futures
- ***Sharing*** – providing an information and viewpoint sharing platform to stakeholders

It is noteworthy that some stakeholders view the role of the BMC as more interventionist and an important influence whose advise has to be binding to some extent and enforce accountability in accordance.

9. TOWARDS A STRATEGIC ACTION PLAN

9.1 NOTES AND OBSERVATIONS

The key strategic question to populate is: ***"what can add value and meaning to the existing strategies and plans pertaining to the Swakop Upper-Omatako Basin?"***

It should be noted that technical Municipal Master Plans and NamWater's CAN studies provide a clear and comprehensive water planning and strategic framework. What value can be added to these technical studies and strategies?

It should also be noted that the BMC has clear institutional limitations, lacks operational capacity and financial means to assume an executive role in the water sector. What strategies can the BMC then pursue in improving water sector performance in the Basin?

In light of these contextual questions, inputs received, and issues identified, four strategic focus areas and specific strategic interventions are proposed expanded below.

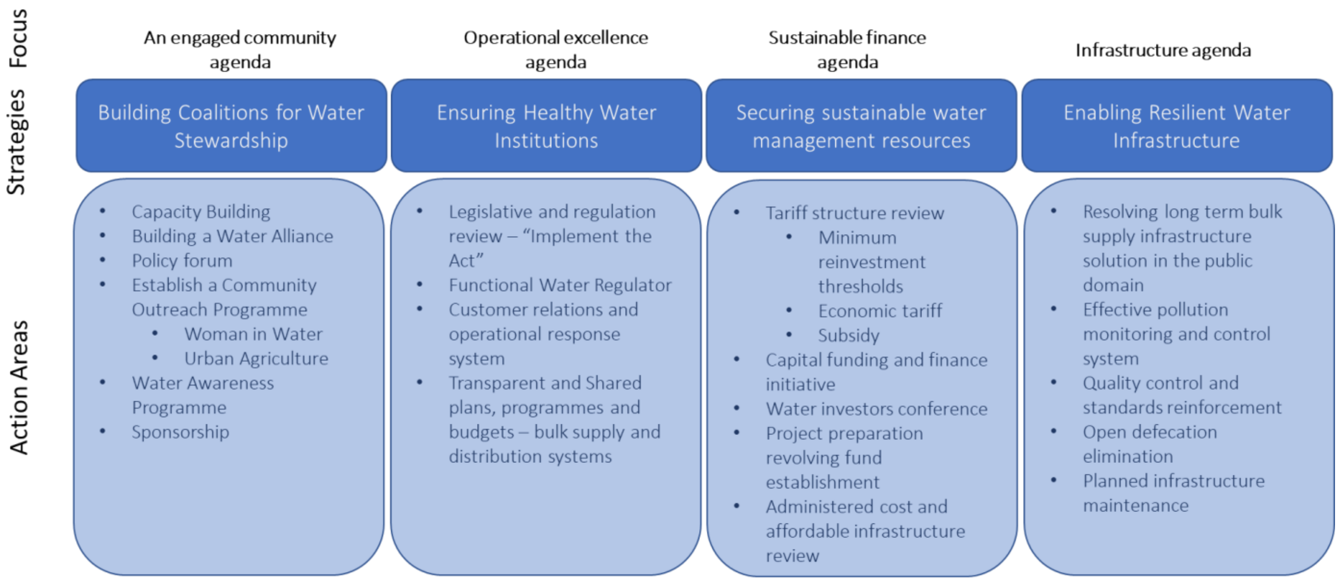

Figure 30: BMC Strategic Action Plan.

It is important to note that stakeholders created a priority sequence from the strategic interventions set out in Fig. 31 above:

- **The highest priority was attached to addressing the finalization of the legislation and associated regulations. There is a strong view that a legal framework will go a long way to address the challenges in the system;**
- **The second most important priority was attached to resolving the future bulk supply infrastructure option in the public domain;**
- **The third priority relates to the finalization of an intermediate action for water supply in the Basin;**
- **The fourth most important priority identified is for the creation of multi-year plans, budgets and implementation programmes that can be reported against and monitored effectively; and**
- **The fifth priority is to foster water awareness through inter alia, communicating the above priorities to stakeholders and communities.**

9.2 BUILDING COALITIONS FOR WATER STEWARDSHIP

Problem statement: There is a distinct expressed need to improve the flow of information from and enable effective stakeholder partition in the decision-making processes of water institution.

Strategic Intent: To harvest the energy of engaged water stakeholders in improving the decision-making and participate in the evolving water futures debates.

Proposed Actions:

- Building a Water Alliance of stakeholders
- Establish a Policy Forum under the auspices of the BMC allowing stakeholders to contribute to policy development and enrich decision-making processes
- Establish a Community Outreach Programme to make water real to ordinary people through project outreach
- Woman in Water - encourage a more vocal and visible participation of women in the water
- Urban Agriculture - as a pilot project that can act as a catalyst project
- Water Awareness Programme - assist in rolling out and framing a water communication programme
- Sponsorship - facilitate sponsorship (with possible rewards) for corporate support and recognition in responsible water management

9.2 ENSURING HEALTHY WATER INSTITUTIONS

Problem statement: There is a widely recognised disjunction between the applicable legislative framework and the required institutional framework for a health water sector institutional framework.

Strategic Intent: To facilitate a finalization of the water sector legal framework with the view to formalize and capacitate critical institutions – such as a Water Regulator along the lines of the ECB.

Proposed Actions:

- Legislative and regulation review - with the view to finalize legislation and applicable regulations
- Functional Water Regulator to provide an effective accountability and control framework
- Customer relations and operational response system – being a key issues raised by stakeholders
- Transparent and Shared plans, programmes and budgets – bulk supply and distribution systems – creating a virtuous link between planning and implementation – a key weakness in the current system.

9.3 SECURING SUSTAINABLE WATER MANAGEMENT RESOURCES

Problem statement: The water sector is underfunded. It has neither the means to meet its required capital expenditure, but also fails to sustain its operational expenditure in a sustainable manner.

Strategic Intent: To unlock a sustainable funding, financing, revenue stream and subsidy regime to ensure sustainability

Proposed Actions:

- Tariff structure review
- Set Minimum reinvestment thresholds
- Introduce a differentiated Economic and Social tariff structure into the current tariff regime
- Capital funding and finance initiative
- Water investors conference
- Project preparation revolving fund establishment
- Administered cost and affordable infrastructure review

9.4 ENABLING RESILIENT WATER INFRASTUCTURE

Problem statement: The key strategic decision regarding what additional water source will be utilized to meet the water security challenges of the Basin remains uncertain. Certainty regarding water security will remain elusive until a final decision is taken regarding priority investments and investment sequencing.

Strategic Intent: To expedite selection of long-term water strategic decision-making through a public discourse.

Proposed Actions:

- Resolving long term bulk supply infrastructure solution in the public domain
- Regular updating of the Water balance Model through a stakeholder working group as part of a stakeholder information sharing platform
- Effective pollution monitoring and control system
- Quality control and standards reinforcement

10. ROLES RESPONSIBILITIES AND TIME FRAMES

Strategy	***Action***	***Institutional responsibility***	***Time frame***	***Indicative budget***
Building coalitions for Water Stewardship	• Water sector capacity building • Building a Water Alliance of stakeholders • Establish a Policy Forum under the auspices of the BMC allowing stakeholders to contribute to policy development and enrich decision-making processes • Establish a Community Outreach Programme to make water real to ordinary people through project outreach • Women in Water -	All BMC BMC with MAWLR BMC BMC/MAWLR	Ongoing activity Ongoing activity 3-Months 3-months Ongoing initiative	N$1m/a N$1m/a

Strategy	***Action***	***Institutional responsibility***	***Time frame***	***Indicative budget***
	encourage a more vocal and visible participation of women in the water • Urban Agriculture - as a pilot project that can act as a catalyst project using semi-purified water • Informal Car Wash capitalization programmed promoting more water efficient technologies • Water Awareness Programme - assist in rolling out and framing a water communication programme • Sponsorship - facilitate sponsorship (with possible rewards) for corporate support and recognition in responsible water management	BMC/CoW/MAWLR BMC with all Municipalities BMC	3-month viability study 3-month in planning Annual programme 2021 annual programme with annual renewal	

Strategy	***Action***	***Institutional responsibility***	***Time frame***	***Indicative budget***
Ensuring healthy water institutions	• Legislative and regulation review - with the view to finalize legislation and applicable regulations • Functional Water Regulator to provide an effective accountability and control framework • Customer relations and operational response system – being a key issue raised by stakeholders • Transparent and Shared plans, programmes and budgets – bulk supply and distribution systems – creating a virtuous link between planning and implementation – a key weakness in the current system.	BMC working group with MAWLR, NamWater, Municipal stakeholders MAWLR BMC bulk users working group with NamWater and Municipalities BMC, MAWLR, NamWater, Municipalities and TCE	12-months review 24 -months 6- months Annual programme aligned to financial year cycle	N$250 000 N$5m/a N$0 N$0

Strategy	***Action***	***Institutional responsibility***	***Time frame***	***Indicative budget***
Securing sustainable water management resources	• Tariff structure review • Set Minimum reinvestment thresholds • Introduce a differentiated Economic and Social tariff structure into the current tariff regime • Capital funding and finance initiative • Water investors conference • Project preparation revolving fund establishment • Administered cost and affordable infrastructure review	BMC, NamWater, Municipalities Water Regulator Namibia Water Regulator Namibia BMC in partnership with development finance institutions/donor community MAWLR, Ministry of Finance, PPP Unit NamWater, Municipalities, Ministry of Finance, MAWLR BMC working group, ACEN, CIF	12-months with bi-annual reviews 24 -months 24-months 6-months 8-months 1 financial cycle, thereafter annual review 6-months	N$1.5m N$0 N$750 000 1-2% of capital budgets N$100 000
Enabling resilient water infrastructure	• Resolving long term bulk supply infrastructure solution in the public domain • Regular updating of the Water balance Model through a stakeholder working group	NamWater, TCE, MAWLR with BMC stakeholder participation, and local authorities BMC/NamWater/Bulk Users	12-months Monthly or bi-monthly	N$50 000 for public awareness campaign N$0 – NamWater

Strategy	***Action***	***Institutional responsibility***	***Time frame***	***Indicative budget***
	as part of a stakeholder information sharing platform • Effective pollution monitoring and control system • Quality control and standards reinforcement	Water Regulator Namibia, Municipalities, NamWater MAWLR/ Water Regulator Namibia	System in place within 3 years – reporting monthly and annually	N$10m capex and N$1m/a operating expenditure

11. ENDNOTE

This report is the culmination of a stakeholder engagement process to which a number of people volunteered their time and knowledge. The BMC comprises of volunteers that committed time, effort and knowledge in assimilating stakeholder input into a coherent framework to guide the BMC's actions going forward.

It is recognised that the action agenda is, on the one hand, too comprehensive to be executed within the institutional limitations of the BMC. On the other hand, a number of important water related issues could arguably be added to the action list above. The BMC will however use the above action agenda as a broad stakeholder mandate to annually inform and review its work.

This report is therefore not as such an end product, but a milestone in becoming a living working document supporting the water sector in the Swakop Upper-Omatako Basin.

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