Kazungula Water Supply and Sanitation Project: Feasibility Report

Project Name: Kazungula Water Supply and Sanitation Project

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Quality Assurance Checklist:

In preparing this Document CRIDF can confirm that it has followed CRIDF internal general procedures including, appropriate CRIDF generic scope of work and that it has undergone appropriate QA and quality control procedures as detailed in CRIDFs QA manual. Furthermore, CRIDF can confirm the applicable specific internal process and procedures have been followed as appropriate:

- CRIDFs cost benefit assessments (CBAs) guideline have been applied as appropriate;
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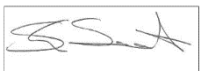
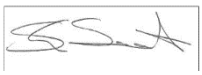
- The appropriate CRIDF screens.

Lead Author(s)	Warwick Weeks, Stuart Seath 	CRIDF QA Checked	Stuart Seath 	CRIDF process QC	Chuma Nombewu 	CRIDF Approved:	Charles Reeve, Leonard Magara
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Disclaimer

The British Government's Department for International Development (DFID) financed this work as part of the United Kingdom's aid programme. However, the views and recommendations contained in this report are those of the consultant, and DFID is not responsible for, or bound by the recommendations made.

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List of Acronyms

Acronym	Long-Form
AfDB	African Development Bank
BCR	Benefit-Cost Ratio
BOD	Biological Oxygen Demand
BoQ	Bill of Quantity
BPI	Business Process Improvement
CBA	Cost-Benefit Analysis
CCRA	Climate Change Risk Assessment
COMESA	Common Market for Eastern and Southern Africa
CRIDF	Climate Resilient Infrastructure Development Facility
CRU	Climate Research Unit
DFID	Department for International Development
DISS	Department for Infrastructure Support Services
DNI	Distribution Network Improvement
DWA	Department of Water Affairs
EIA	Environmental Impact Assessment
ENPV	Economic Net Present Value
ERR	Economic Rate of Return
FIRR	Financial Internal Rate of Return
FNPV	Financial Net Present Value
GESI	Gender Equality and Social Inclusion
GIZ	Gesellschaft fur Internationale Zusammenarbeit
IM	Immediate Measures
IMR	Infant Mortality Rate
IS	Institutional Strengthening
KDC	Kazungula District Council
LMC	Low Mechanical Content

Acronym	Long-Form
LoS	Level of Service
MAP	Mean Annual Precipitation
MAR	Mean Annual Run-off
MLGH	Ministry of Local Government & Housing
MoU	Memorandum of Understanding
NGO	Non-Governmental Organisation
NRW	Non-Revenue Water
NWASCO	National Water and Sanitation Council
O&M	Operation & Maintenance
OHT	Over Head Tank
RC	Reinforced Concrete
RDA	Roads Development Agency (Zambia)
SADC	Southern African Development Community
SEA	Strategic Environmental Assessment
SIWI	Stockholm International Water Institute
SPI	Standard Precipitation Index
STP/STW	Sewage Treatment Plant/Works
SWSC	Southern Water and Sewerage Company Limited
ToR	Terms of Reference
U5MR	Under 5 Infant Mortality Rate
UFW	Unaccounted for Water
VIP	Ventilated Improved Pit
WHO	Work Health Organisation
WSS	Water Supply and Sanitation
WTW	Water Treatment Plant / Works (to avoid confusion with WTP – Willingness to Pay, WTW will be used in this report)
WTP	Willingness to Pay
ZEMA	Zambian Environmental Management Authority

Executive Summary

Introduction

CRIDF is DFID's water infrastructure programme for Southern Africa. Working to deliver sustainable small-scale climate resilient infrastructure across 11 SADC countries.

The 12 Towns Water and Sanitation Project, first identified in studies by the Gesellschaft fur Internationale Zusammenarbeit GmbH (GIZ) seven years ago, aims to provide sustainable and equitable access to safe water and adequate sanitation to a prioritised 12 border towns in Zambia.

Kazungula town is a rapidly expanding settlement located within the Kazungula District, approximately 80km west of Livingstone on the banks of the Zambezi River. The town holds a unique position as a quadripoint where four Southern African countries meet (Zambia, Zimbabwe, Namibia and Botswana).

This Feasibility Study is targeted at improvements to the water supply and sanitation system in Kazungula town.

Social Assessment

- The town is still peri-urban with a mix of income groups, most of whom are low-income families who depend on cross-border trading. There are a limited number of government officials who also occupy formal houses. High income earners, business, commercial and industrial customers are yet to establish presence largely due to the absence of a reliable water supply and sanitation system.
- Socio-cultural characteristics indicate a mix of communalism associated with rural life and individualistic lifestyle associate with urban life. Communalistic households, mostly in the poor section of the town, unite to share costs for facilities such as stand pipes and monthly payments and live off limited resources. The urbanised group is smaller, not yet "emotionally" attached to the town, and mostly consists of civil servants.
- In the midst of observed and recorded poverty levels in the town, the proposed combination of infrastructure development projects, led by potable water and sanitation, will bring hope for employment and skills development for a majority of poor households in Kazungula and surrounding villages.
- There is a risk of actual cost of operation and maintenance of a modern WSS system being unaffordable, which will put SWSC resources under pressure in short to medium term because high tariff customers (business, institutions, industry, etc.) will take time to establish and create a constant high water demand to achieve cross-subsidisation.
- Willingness to pay has been demonstrated; however there are still concerns regarding ability to pay for higher costs especially if tariffs factor capital redemption costs.

- The town may develop into a largely peri-urban settlement composed of a large portion of poor households.

Population growth has been based the 2010 census, health clinic records, historical regional growth rates (4.4% pa), the United Nations (UN) projected growth rate to 2030 (2.25% pa) and discussions with local authorities as to current and future population growth. The projected population is presented in the following table.

	2014	2015	2020	2025	2030
Phasing		Immediate	Phase 1	Phase 2	Phase 3
Medium Scenario: Medium net migration projection	5,500	7,500	9,500	12,500	22,300

The discrepancy between historical growth rates and those projected by the UN implies the need for a phased investment strategy. This will comprise short-term 'immediate measures' (2015) to meet the needs of the poor and existing population followed by three phases (as in table above) of upgrading to meet the projected needs up to 2030.

Technical Assessment

.The current water infrastructure comprises –

- Raw water abstraction from the Zambezi River (pumps mounted on a floating pontoon)
- Pump main to treatment plant (mostly bypassed, with only basic chlorination of the untreated water).
- A distribution system with limited coverage.

The following options are applicable to Kazungula water supply:

- The technically preferred water source is the Zambezi River
- The existing Water Treatment Plant requires refurbishment, but in future a new treatment plant will be required – possibly at a higher location
- Additional storage is required
- Upgrade of the distribution system to supply current and future demand.
- It is proposed to take a phased approach to network expansion.
- The concept of zonal management is being introduced in this project.
- The water in Kazungula can be mostly distributed by gravity.

The current sanitation infrastructure comprises

- A small number of septic tanks
- Pit latrines (conventional and improved)
- Open defecation.
- A public toilet block at the border post.

The following options are applicable to the Kazungula sanitation:

- Phased approach to improvements in sanitation.
- Behaviour change programme
- User financed upgrading of domestic facilities, however development of standards through the behavioural change programme
- Construction public / communal ablution blocks.
- Construction of a limited waterborne sewerage, with ponds for treatment.

The water supply and sanitation interventions in Kazungula will be undertaken in four phases, i.e. Immediate Measures (1 and 2), Phase 1, Phase 2 and Phase 3. The phases are linked to the growth of the population and therefore the increased demand for services.

The interventions proposed are designed to be climate resilient, prioritising services to the poor. The project will require an EIA but it is considered that the environmental impact can be fully mitigated using conventional solutions.

The projected water demand growth is shown in the following table, and includes allowance for system losses and differences in demand between commercial / institutional and domestic.

Water Supply	2014	2015	2020	2025	2030
Total Production Required (m^3/d)	439.0	544.9	893.2	1,228.6	2,517.6

Estimated Costs

The combined estimated cost of the water, sanitation and institutional interventions are summarised in the following table.

	Immediate Measures 1	Immediate Measures 2	Phase 1	Phase 2	Phase 3	Total (US$)
Water Supply	297,000	436,100	2,563,440	3,119,600	948,530	**7,364,670**
Sewerage	128,000	0	1,172,720	2,000,600	962,000	**4,263,320**
Institutional Strengthening	0	25,000	60,000	25,000	40,000	**150,000**
Total (US$)	**425,000**	**461,100**	**3,796,160**	**5,145,200**	**1,950,530**	**11,777,990**

The combined estimated operational and maintenance costs for the water and sanitation after proposed interventions are summarised in the following table.

	Immediate Measures	Phase 1	Phase 2	Phase 3
	US$	US$	US$	US$
Water Supply Infrastructure	28,733	39,355	95,866	158,918
Sewerage Infrastructure (and behavioural change)	8,323	29,839	54,109	82,155
Total (US$)	**36,056**	**69,194**	**149,975**	**241,073**

Financial and Economic Assessment

Based on the CRIDF CBA tool, there is an overwhelming socio-economic justification for the project. The project as a standalone entity is however not commercially viable – the revenue generated by the project is not sufficient to cover the investment cost over the project life. Traditional financing is therefore not appropriate for the project and long term development/concessional loans or grant funding are required to cover most of the capital investment. The CBA indicates that the project will be operationally sustainable, as annual cost-recovery over the project life is positive, and tariff levels are deemed affordable. Domestic demand, O&M costs, and water supply coverage are however critical to the operational sustainability of the infrastructure. As such, should these parameters vary significantly over time; SWSC may need to adjust the phased project investments as appropriate.

Cost-Benefit Analysis (CBA) Summary		
Budget		
CRIDF project preparation (anticipated)	US$505,885	GBP333,125
Capital investment required (total project investment)	US$11,777,990 Note – this includes the capital costs expected to be funded by the bridge project ($436,100) and a budget for institutional strengthening	GBP7,755,798
Total Budget	US$12,283,862	GBP8,088,923

Cost-Benefit Analysis (CBA) Summary		
Beneficiaries		
Direct beneficiary households	1,146 (2015), expected to increase to 4646 (2030)	
Indirect beneficiaries	Indirect beneficiaries include the a significant transitory population made up of regional traffic passing through Kazungula; surrounding and downstream communities, tourism enterprises and cross border communities in Botswana	
Assumed number of people per household	4.8	
Analysis timeframe	30 years	
Financial appraisal performance indicators (3.7% Discount Rate)		
Financial Net Present Value (FNPV)	US$ -8,344,172	
Financial Internal Rate of Return (FIRR)	-6.56%	
Financial Benefit Cost Ratio (FBCR)	0.24	
Economic appraisal performance indicators		
	3.5% SDR	10% SDR
Economic Net Present Value (ENPV)	US$ 27,528,162	US$ 7,595,089
Economic Rate of Return (ERR)	26.33%	26.33%
Economic Benefit-Cost Ratio (EBCR)	4.11	2.26
Sustainability		
The project in isolation is not commercially viable hence long term developmental/concessional loans and/or grant funding are required to cover most of the capital investment. The financial appraisal indicates that the project is operationally sustainable. Annual revenues generated exceed the annual operation and maintenance requirements of the infrastructure over the project life. Moreover the assumed tariffs for services appear to be well within various international affordability benchmarks. Domestic demand, O&M costs, and water supply coverage are critical to the operational sustainability of the infrastructure. Should these parameters vary over time; the SWSC may need to adjust the phasing of investments as appropriate.		

Institutional Assessment

For improvements in the water and sanitation system to have a long term benefit, the investment into infrastructure should be accompanied by the institutional strengthening of the utility.

The Southern Water and Sewage Company was established in 1999 as a commercial utility jointly owned by eleven local authorities[1] in the Southern Province of Zambia. SWSC is mandated to provide water and sewerage services to 20 urban and peri-urban areas. The Kazungula system is run as a sub-branch of the larger base of Livingstone, which forms the company's 'Southern' operations.

The following Institutional Strengthening (IS) is recommended:

- The IS component would be part of and a condition of the infrastructure capital finance package.
- The IS would support SWSC to prepare a new Operations Organisational Structure showing human resources required for both Water Supply and Sewerage for Livingstone and Kazungula combined.
- The Organisational Structure for the combined Livingstone and Kazungula operations is likely but not confined to include Scientific staff, WTW staff, STW staff, Distribution Staff, M&E staff, Ops Control Room Operator, Statistician, Instrument technician, Stores and Purchasing, Budget controller, Admin assistant.
- The IS would review the Commercial Department to ensure that it was configured to work with the Operations department particularly with regard to the benefits of DNI's.
- The IS would support SWSC appoint staff into the new Org Structure.
- The IS would support SWSC to identify training needs and prepare an appropriate training program.
- Some of the training requirements could be included in the Kazungula infrastructure contracts.
- The training plan would include operational and commercial training needs to run the DNI's.
- The training plan would include the preparation, control and use of 'operational budgets'.
- The training plan would include components that would support the full transition of SWSC to a 'business culture'.
- The training plan would include the benefits of operational information, how to collect it, record it and use as a management tool. The information system is likely to be centred in a dedicated room [control room] and probably located in Livingstone.

[1] Extracted from SWSC 2012-2017 Business Plan

- The IS will look at and support the concept of Kazungula becoming a 'model' town for SWSC so that the benefits of the new business approach can be replicated in other SWSC towns.
- The IS would review the support activities required from other SWSC departments, e.g. Stores and Purchasing to ensure the efficient functioning of services in Kazungula.
- The IS would review the Planning processes in SWSC and make recommendations including frequent planning coordination meetings with stakeholders.
- The IS would review the internal SWSC processes for supervising construction of new infrastructure and make recommendations.
- The IS would review and make recommendations of the SWSC HR department to ensure continued support to Kazungula.
- The IS would review and make recommendations for operating the STW and small bore sewage system, and how to ensure full compliance with the final effluent from the STW.

Phase	Proposed Institutional Strengthening	Budget
Immediate Measures	• Institutional Strengthening Assessment made of SWSC using the above recommendations as TOR's. • IS implementation plan is developed. • A Training Program is developed and integrated into SWSC program. • Awareness, training and education campaigns (including aspects like promoting yard and domestic connections to the water and sewerage network, compliance on bill payment, and utility-customer communications) • The 'model town' concept is developed.	$25,000
Phase 1	• Phase 1 of the IS and Training program is implemented in accordance with IS Assessment.	$60,000
Phase 2	• Phase 2 of the IS and Training program is implemented in accordance with IS Assessment.	$25,000
Phase 3	• IS and Training needs are reviewed.	$40,000

It is expected that the improved supply and revenue generation could pose opportunities to expand the supply to surrounding communities, breweries and other wet industries. The proposed interventions reduce capital cost by maximising the use of existing infrastructure, while promoting appropriate technology options, such as replacing the pressure filters with the better known rapid sand filters that are also used in the Livingstone supply system. The design philosophy of 'Low Mechanical Content' LMC is incorporated throughout the designs of both water supply and sewerage projects.

Environmental Assessment

An environmental assessment was undertaken as part of the Feasibility Study, and the Zambian Environmental Management Agency (ZEMA) were closely consulted during the work. Kazungula is located in a relatively fragile environment with highly permeable soils, flood risk and high biodiversity. A range of potential positive and negative environmental impacts were identified for the construction and operation phase. Mitigation measures have been proposed to minimise any possible negative impacts. Overall the positive impacts on the environment, society and economy are thought to largely outweigh the relatively minor possible negative impacts.

The construction of the sewage treatment lagoons and discharge of effluent to surface water will require a number of permits (further detailed in the main body of this report), and will also require an Environmental Impact Assessment (EIA). Further studies as to the vulnerability of flooding at the sites identified by stakeholders for the sewage treatment plants and pump station will be required. Possible flood proofing measures may be required.

Assessment of Potential Financiers

A number of potential financiers have been approached and have shown interest in supporting the project. It may be necessary to aggregate Kazungula with other eligible "12 Towns" to make a package attractive to the bigger institutions. Possible funders include: Zambia's Devolution Trust Fund (administered by NWASCO), AfDB, KfW, EIB, World Bank and GETF.

It is assumed that the costs of the raw water abstraction/transmission works would be covered by the bridge construction project. It is also proposed that CRIDF consider supporting some of the actions identified for the Immediate Measures phase.

Implementation Plan

Initially it was proposed to construct the required infrastructure to meet 2030 demands in a single investment. The subsequent Cost-Benefit Analysis (CBA) showed that this was not viable, therefore a phased approach has been adopted enabling investments to be made as the town grows and providing some flexibility if the population growth differs from the predicted.

The Feasibility Study looks at the period until 2030 and has phased the project into Immediate Measures, Phase 1 (2020), Phase 2 (2025) and Phase 3 (2030). The study recommends that sanitation improvements are carried out in the same phases, to match the implementation of improved water supply. It should be noted that the dates linked to the phases are the dates when the infrastructure will need to be in place to meet the demand. Therefore to meet these dates, probably more than two years for planning, funding and construction needs to precede the demand / phase date.

The Medium Scenario population projection has been used for the design of the water supply and sanitation system. The actual population growth should be monitored to allow sufficient planning time to upgrade the

system in a phased approach, i.e. although the phasing has currently been linked to implementation years, it may be necessary to implement earlier or later based on actual population growth (or increase in water demand).

Recommendations

The Feasibility Study makes the following recommendations:

1. It is recommended that the proposed improvements are implemented in phases to accommodate variations with the population growth. The 'immediate measures' should be effected as soon as possible to provide early relief to the most critical problems.
2. It is recommended that services to the poor are prioritised; this is reflected in the Feasibility Study report.
3. It is recommended that the detailed designs are Climate Resilient and consistent with the infrastructure/processes in Livingstone and implemented using 'appropriate' technology. The design philosophy of 'Low Mechanical Content' LMC has been incorporated throughout the designs of both water supply and sewerage projects.
4. It is recommended that Institutional Strengthening is integral with the improvements and a condition of the capital funding.
5. It is recommended that the SWSC commercial improvements are fully harmonised with the infrastructure designs and linked through institutional strengthening e.g. Billing linked to DNI management. Thus improving services and supporting sustainability.
6. Grant funding is required for the project capital investment. It is recommended that CRIDF consider providing grant funds for part of the 'Immediate Measures' phase of the project (with the Kazungula Bridge Project who have indicated they will fund specific components in the IM phase around relocating the water supply intake). The total investment required for the 'Immediate Measures' is US$ 886,100 – of this it is expected the Bridge Project will provide US$ 436,100. It is therefore recommended CRIDF consider funding the remaining 'Immediate Measures' investment of approximately US$ 450,000.
7. In addition, it is recommended that CRIDF support SWSC in leveraging external grant financing for the remaining capital investment requirements in the subsequent phases of the project. It is recommended that CFIDF supports the immediate measures Phase through to Bankability and Financial Closure.
8. It is recommended that procurement of the IM phase to be in accordance with CRIDF rules, assuming that CRIDF supports the capital financing of the IM. Procurement of later phases to be in accordance with the appropriate Financiers and SWSC & MLGH rules. Detailed design to be by Consulting Engineers managed by SWSC/MLGH & Financiers through a PMU and in accordance with 12 Towns strategy.
9. It is recommended that SWSC takes immediate action to acquire the 3 pieces of land required for the New Intake, WTW and STW.

10. It is recommended that surface water pollution problems are addressed by KDC as a priority to improve lifestyles and minimise sanitation related health problems.
11. It is recommended that SWSC investigates commercial opportunities to sell services to Botswana especially to the Border Post [transboundary] and to neighbouring larger communities outside the existing service area.
12. This feasibility study has been carried out to determine broad parameters for the determination of the bankability of the Kazungula Water and Sanitation Improvement Project. The following field work should be included in the detailed design phase and Financial Closure:
    a. Land survey of the area.
    b. Details of bridge survey, 4000 house development, old construction drawings and any other mapping
    c. Floodline determination.
    d. Geotechnical assessment to determine founding, ground water table, nature of material at treatment facility, bedding material, road to WWTW.
    e. Raw water quality analyses.

Introduction

The Climate Resilient Infrastructure Development Facility (CRIDF)

CRIDF is DFID's water infrastructure programme for Southern Africa. Working to deliver sustainable small-scale infrastructure across 11 SADC countries, the demand-driven programme focuses on water services, water resource management, and water for livelihoods, fostering sustainable development of the region's water resources and addressing the water, food and energy nexus. The Facility prepares small-scale water infrastructure projects and facilitates access to finance for the implementation of these projects. Such interventions provide the entry point and platform for CRIDF to engage with, support and influence key SADC interventions, River Basin Organisations and national stakeholders. Activities are selected according to a set of CRIDF principles to ensure that investments align with strategic objectives that have been developed specifically for each SADC river basin.

As a result of CRIDF's work, poor communities in countries of the SADC region will benefit from climate-resilient water infrastructure. The conditions for enhanced cooperation between stakeholders in shared river basins will be improved, and the evidence base, demonstrating the national benefits of cooperation on shared waters, will be strengthened. Through these outputs and outcomes the CRIDF programme will contribute to peaceful, climate-resilient and sustainable planning and management of shared waters in SADC, generating current and future benefits to the poor.

The Kazungula Feasibility Study has been undertaken by CRIDF, as delegated by the UK Government Department for International Development (DFID) on behalf of the Government of the Republic of Zambia (GRZ), Kazungula District Council (KDC) and the Southern Water and Sewerage Company (SWSC).

Zambia Border Towns Project

The 12 Towns Water and Sanitation Project, first identified in studies by the *Gesellschaft fur Internationale Zusammenarbeit GmbH* (GIZ) seven years ago, aims to provide sustainable and equitable access to safe water and adequate sanitation to a prioritised 12 border towns in Zambia. Various entities continued to cite the project in the intervening years, and the SADC Regional Water Infrastructure Investment Conference held in Maseru (Lesotho) in September 2011 identified it as a priority project.

The 12 Towns

- Kazungula-Kasane (Zambia-Botswana)
- Chirundu-Chirundu (Zambia-Zimbabwe)
- Luangwa-Zumbo-Kanyemba (Zambia-Mozambique-Zimbabwe)
- Chanje-Maluera (Zambia-Mozambique)
- Chipata (Mwami)-Mchinji (Zambia-Malawi)
- Nakonde-Tunduma (Zambia-Tanzania)
- Mpulungu-Kasanga-Mutungu (Zambia-Tanzania-DRC)
- Nchelenge-Kilwa (Zambia-DRC)
- Kalabo-Mussuma (Zambia-Angola)
- Kasumbalesa-Kasumbulesa (Zambia-DRC)
- Chavuma-Caripande (Zambia-Angola)
- Sesheke-Katima Mulilo (Zambia-Namibia)

This Project is of key regional importance, as it links directly with initiatives to facilitate regional trade and investment, by upgrading basic facilities at the entry points of Zambia located along strategic trade and transport routes, this including the COMESA-EAC-SADC Tripartite Trade and Transport Facilitation Programme envisaged to improve regional tourism and reduce the incidence of cross-border waterborne diseases. This regional Programme is geared at:

- **Market integration**: the removal of tariff and non-tariff barriers and implementation of trade facilitation measures;
- **Infrastructure development**: concentrating on improving the region's infrastructure so as to improve the efficiency of regional trade flows and transport network (road, rail, water and air and including ICT and energy);
- **Industrial development:** to improve productive capacity and competitiveness and programmes that can take advantage of improvements in market integration and infrastructure development.

Following engagements with the Government of Zambia and various key stakeholders, the Climate Resilient Infrastructure Development Facility (CRIDF) undertook a mission with the objective of identifying the three highest priority towns from the original 12 Town Project through reviewing relevant documentation and stakeholder engagement and to assess whether each of the prioritised three towns is eligible for CRIDF support. Kazungula-Kasane, Chipata (Mwami)-Mchinji and Chirundu-Chirundu were prioritised for CRIDF support with input from key stakeholders. Later Chanida-Maluera was also added to this prioritised list.

This shortlist was developed based on the rationale of assessing where CRIDF's support was most effectively directed, in coordination with other agencies. There are numerous stakeholders involved in the 12 Towns Project, and as such, CRIDF undertook an additional activity to evaluate the framework for CRIDF's ongoing involvement in the project and collaboration with the stakeholders.

Providing water supply and sanitation services at these key border towns will facilitate the wider trade and transport objectives, reduce the risk of inter-country transmission of diseases such as Cholera, and provide

basic infrastructure for the towns to develop in a manner that does not pose environmental health risks on their expanding populations. With investment in border posts, roads and bridges, and expected increases in regional traffic flows between the countries, the numbers of users of the water and sanitation services by both the host populations and visitors is expected to increase considerably in the coming years.

Kazungula Town

Kazungula town is located within the Kazungula District, approximately 80km west of Livingstone in the South of Zambia on the banks of the Zambezi River. The town holds a unique position as a quadripoint where four Southern African countries meet (Zambia, Zimbabwe, Namibia and Botswana), making it highly strategic for trade within the region. Whilst Kazungula is currently a relatively small settlement, the population has grown considerably in recent years, expanding by nearly 50% between 2010 and 2014. In 2015, the population was estimated as 5,500.

Presently the border traffic crosses the Zambezi using a ferry. This is an inefficient and at times unsafe mode of river crossing, which restricts cross-border flows. A bridge positioned across the Zambezi has been planned for many years with construction finally starting in 2014. A new bridge, replacing the river ferry, is being constructed; which is expected to significantly increase cross-border flows, which in turn is expected to cause considerable expansion in the population and commercial activities of Kazungula town.

Figure 1: Artist impression of the future Kazungula Bridge

Kazungula lies at an increasingly important cross road for SADC. The completion of the bridge over the Zambezi will speed up transport links between the wet north and the dry south of SADC, enabling a regional response to climate change. The bridge will link SADC's fastest growing economies in Angola and Zambia, with the region's highest agricultural potential, to the largest markets to the south. Increased trading of agricultural and mining products through this hub will increase cooperation between the SADC Member States, deepening regional ties and strengthening regional economies. The likely establishment of bonded warehouse facilities and one-stop border controls will enable trading in perishable goods, will encourage regionally based tourism and will provide increased job opportunities to at least four SADC states.

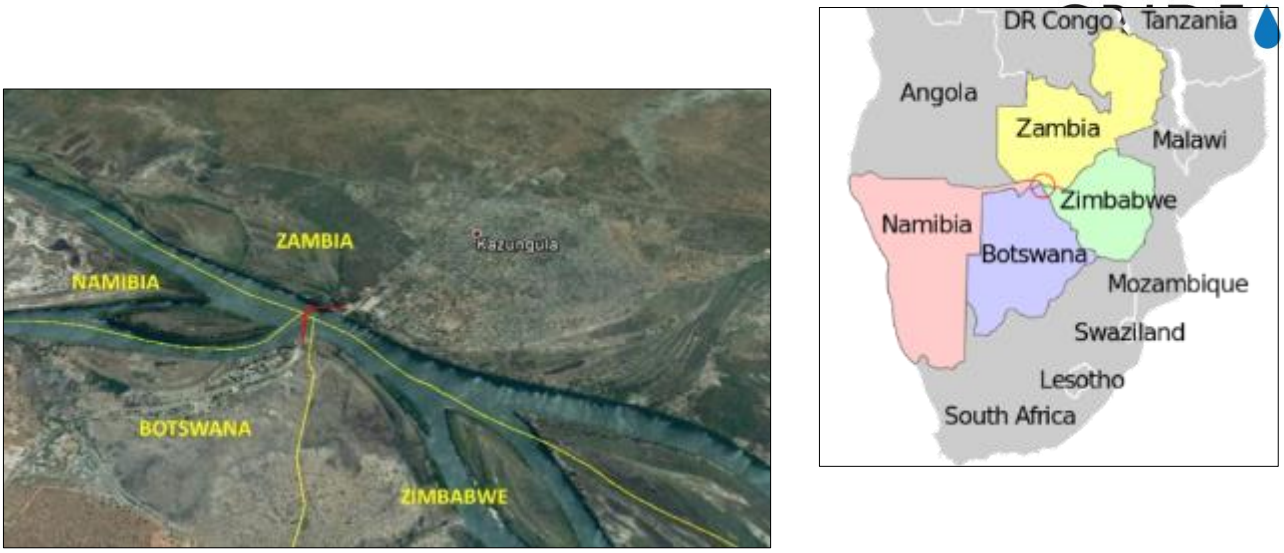

Figure 2: Satellite Image and SADC Map showing the location of Kazungula Town

The Government of the Republic of Zambia (GRZ) has recognised Kazungula' s growth potential, having upgraded the settlement to town status, which is now the District Capital. Associated with this status is the establishment of numerous district government offices, construction of a new district hospital and a high school. In addition to these developments, a 'One Stop' border post is planned, which will improve border crossing times – potentially leading to increased traffic numbers.

There has been considerable rural-urban migration to the town in recent years, highlighted by the 'shanty town' settlement that has developed in the Makalanguza Suburb, to the east of the border post.

To accommodate the ongoing and future development, the District Council has created a Town Strategic Plan, which includes a planned 4,000 home construction project, an industrial and commerial zone to the north west of the town, and tourism lodges to be developed along the banks of the Zambezi.

The current water supply system, managed by the Southern Water and Sewerage Company (SWSC), is inadequate to meet the current demand of the town, let alone the projected population increase in future. The water that is provided through the piped system is not adequately treated, being pumped directly from the Zambezi and supplied to the population after only basic chlorination. There is a significant proportion of the population without sanitation facilities, and cross-border visitors often have to use the bush to defecate. These issues pose significant risk for water and sanitation related diseases, both for the population and cross border flows, which will only intensify with population growth, unless an intervention is made.

The Feasibility Study

Following the scoping study and stakeholder consultation, CRIDF proceeded to undertake a Feasibility Study for Kazungula border town, which took place between May 2014 and July 2015, in partnership with the Southern Water and Sewerage Company (SWSC), the water and sewerage utility of the area, and Kazungula District Council.

This report updates the Kazungula Border Town Water Supply and Sanitation Feasibility Report dated July 2015. This update is produced as a stand-alone document, without references to the previous report.

The Feasibility Report details a series of phased improvements proposed to the water supply and sanitation system in the town, together with the requisite institutional strengthening and behavioural change components to sustain the improvements over time. This report has been produced by CRIDF on behalf of SWSC, and for the attention of other primary stakeholders including the Kazungula District Council and Ministry of Local Government and Housing.

The Feasibility Report has been divided into the following main sections:

- Social Assessment
- Technical Assessment
- Financial and Economic Assessment
- Environmental Assessment
- Institutional Assessment
- Risk Assessment
- Conclusions and Recommendations

Review and Analysis of Previous Studies

The corner stone of the work carried out during the Feasibility Study has been the strategic visions of the Government of Zambia through the Southern Water and Sewerage Company, the Kazungula District Council and the Kazungula Bridge Project under the Road Development Authority (RDA), Zambia. The strategic visions are set out in the 'SWSC Five Year Strategic Plan 2012-2017' and 'Kazungula District Council Strategic Plan' and the various reports and documents made available by the RDA.

The visions from the above documents form an overall optimistic projection of growth and economic development for Kazungula through to the end of Feasibility Study design horizon of 2030. The growth projections are primarily associated with Kazungula's new town status and the transboundary bridge potential at the intersection of four countries.

The current water supply system was constructed in 2002 and there have been no new studies carried out since. There are no record drawings available of the existing system. There is no existing public sewerage system although both the SWSC and KDC strategic plans refer to the need for a public sewerage system in the future.

The RDA have made the Bridge documentation available to the Feasibility Study team, specifically the Environmental Impact and Social Impact information related to the relocation of people effected by the bridge construction. The proposed 'One Stop' border post proposals have been shared with the Feasibility Study team so that the impact of the new bridge could be assessed.

A significant amount of the data for the Feasibility Study has been collected through a series of formal and informal meetings between the stakeholders and the CRIDF study team. More than 47 stakeholder meetings were conducted between May and June 2014 (see **Annex 1**).

Social Assessment

This section of the report details considerations around social issues related to the project and focuses on the different stakeholders involved to examine the relevant social, socio-economic and cultural factors in the area, and population projections that have informed the design of the interventions.

Stakeholder Identification and Analysis

Primary Stakeholders Identified

The following stakeholders have been identified as primary role players in the development and eventual management of the Kazungula Water Supply and Sanitation System. The list is not presented in any order of priority.

Community of Kazungula Town

The community of Kazungula Town are the primary beneficiaries of public water supply and sanitation services, current and planned. The community consists of residents of an unplanned settlement and those in the formalised section of the town. In terms of the laws that govern water supply and sanitation provision in Zambia, only residents of the town should be supplied by a water utility such as SWSC. However, in regards to the situation in Kazungula, the water utility has had to provide water to the new village of Lumbo, which is where the resettled community is located, and to the unplanned section of the town, Makalanguza (these settlements are both included in the supply design). The Kazungula town population size is currently estimated at around 5,500 and consists of a mix of indigenous residents, economic migrants and government officials.

Government of Zambia

The Government of Zambia, directly represented by the **Kazungula District Commissioner**, is the highest authority in the proposed project. Various other departments and entities of national government are currently part of the development of Kazungula Town including the development of housing infrastructure, health facilities, roads infrastructure, border facilities, safety and security, and education. National government develops overarching policy on land ownership and development, water resource management, potable water supply and sanitation, decentralisation, environmental protection and other such related policies. Any agreements regarding external funding required for the development of the Kazungula Water Supply and Sanitation project have to be sanctioned by national government.

Southern Water and Sewerage Company Limited

The Southern Water and Sewerage Company (SWSC) is a public water utility serving urban areas in all districts of the Southern Province. SWSC is currently responsible for operation and maintenance of the

current water supply system in Kazungula Town including extension of the system to unserved areas and expansion in underserved portions of the town. In this regard, SWSC is the direct client of the project planning process supported through CRIDF and eventually the main player in leading the pre-development planning processes. SWSC is accountable to the local authority for Kazungula District and has to obtain approval for project development from the local authority whose functions include overseeing land development and use in the town. The company will also be responsible for post-development operation and maintenance of the proposed scheme.

NWASCO

The National Water and Sanitation Coordinating Council is Zambia's water and sanitation sector regulator. NWASCO oversees the implementation of applicable legislation governing domestic water supply and sanitation, sets regulations and standards to be adhered to, and regulates the establishment and performance of private and public water utilities in the country. In this regard, all water supply and sanitation systems must be developed and managed in accordance with national standards and performance targets agreed between NWASCO and the relevant water utility, in this case SWSC.

Kazungula District Council

The Kazungula District Council, established in 2000, is the local authority for the Kazungula District and therefore the delegated custodian of land administration, allocation and land use in the town. The District Council is the *de facto* "owner" of the water supply and sanitation infrastructure as a local authority although the actual authority to develop, operate and maintain the infrastructure is delegated to SWSC as a public water supply and sanitation provider for the urban area. Rural water supply and sanitation schemes remain the responsibility of the District Council. As a local authority for the town, the district council has political authority on how water supply and sewerage are developed for the town, including approval of the designs, levels of service and integration of the system into existing or planned town services such as housing, roads and storm water.

Department of Local Government

The Kazungula District Council does not have administrative powers to execute full town planning functions related to land use and development. These powers are held by the Department of Local Government (under the Ministry of Local Government and Housing) and include all land development and building approvals. The Ministry is also responsible for government housing development schemes including the planned housing project for Kazungula Town.

Traditional Leadership: Chiefs

The township falls within an area that was previously under the authority of two traditional leaders (Chiefs), viz. Chief Sekute and Chief Nyawa. The road from the main Sesheke-Livingstone intersection to the border

separated the two Chiefdoms to the west and to the east. Although the town is under jurisdiction of the District Council, there remain portions on the periphery consisting of villages, modern villages and shanty towns which directly impact on the population and cultural dynamics of the town. Some villagers still regard the town to be under their Chiefs and thereby giving them unhindered access to the land designated as an urban area. In this regard, the role of the two Chiefs in any future planning of the town remains important.

Zambian Environmental Management Agency

The Zambian Environmental Management Agency (ZEMA) regulates the implementation of any development that may negatively impact on the environment and ensures general environmental compliance of impacting facilities. The ZEMA applies applicable environmental legislation to ensure compliance both in terms of set standards and procedures required before any potential environmental impact developments are permitted to take place. An extensive water supply and sanitation system such as the one proposed for Kazungula, falls within requirements for specific pre-development procedures prescribed by ZEMA.

Department of Health

The Department of Health is responsible for regulating drinking and raw water quality standards in Zambia but also monitors and records the prevalence of incidence of disease, including water-related diseases. The Department's local health centre in Kazungula even assists with recording population numbers based on clinic visits and outreach programmes.

Roads Development Agency

The Road Development Agency (RDA) is an agency of government responsible for the construction and maintenance of national roads and related transport infrastructure in Zambia. The ZEMA is currently representing the Government of Zambia in the joint construction of the Kazungula Bridge across Zambezi River into Botswana and has been responsible for facilitating the relocation of 38 families to a new location outside the Kazungula Town. In the immediate term, the RDA has taken responsibility for funding required water system changes necessitated by the development of the new bridge and border facilities (intake relocation).

Department of Water Affairs

The Department of Water Affairs is responsible for water resource management in Zambia and represents the Government of Zambia in international river management structures. The Department issues permits for abstraction of raw water from sources such as Zambezi.

Secondary Stakeholders

In addition to primary stakeholders who will play a direct role in the actual development of Kazungula Water Supply and Sanitation, a number of stakeholders have direct interest in the development and stand to benefit

from the system once in operation. These include those whose activities are restricted by the lack of a fully developed water and sanitation system in the town.

Private property developers

Private property developers who have bought residential plots in the town will benefit from the development of a water supply and sanitation system to connect their new houses.

Border Post

A modern water and sanitation system will support the proper functioning of the border facility.

Business and Tourism Investors

Business and tourism investors require a water supply and sanitation system to develop commercial, industrial and lodging facilities in the town.

SADC

The Southern Africa Development Community has a vested interest in a developed town to support the movement of goods and people across Zambezi River linking a number of countries.

Stakeholder Analysis

The following table presents an analysis of each of the identified stakeholders considering their interests, support, resource base, power, potential alliances and participation levels in developing the Kazungula Water Supply and Sanitation project.

Table 1: Stakeholder Analysis

Stakeholder	Classification	Knowledge of the Project	Support Position	Interests	Alliances	Resources	Power	Participation Level
1) Community of Kazungula	Beneficiary or recipient of the service – water supply and sanitation	Limited to what the water utility (SWSC) and councillors have shared with them.	Community supports the development of a modern, reliable water supply and sanitation system for the town	Main interest is to be provided with Accessible Affordable Acceptable water supply and sanitation to support the development of housing, reduce disease, promote anti-poverty productive uses, and create jobs and skills.	Kazungula District Council, Chiefs and SWSC	The community may be able to provide limited contributions to support infrastructure development	Choice of technology; level of service; payment of services	Inform, Consult, Involve, Partner and Empower
2) Government of Zambia	State Authority	Aware of the feasibility study; was responsible for selection of the three priority border towns in	Supports the proposed development of an urban water supply and sanitation system	Developing Kazungula into an administrative centre for the District; supporting human settlement and urbanisation; Increasing cross border trade and	All primary stakeholders: KDC, SWSC, Community, Traditional Leadership, and all departments and state	Government can make decisions regarding the allocation and use of the resources to support the	Funding; approval of international funding; policies and laws; land use	Inform, Consult and Involve

Stakeholder	Classification	Knowledge of the Project	Support Position	Interests	Alliances	Resources	Power	Participation Level
		Zambia		regional development; promoting tourism development	agencies	development an urban water supply and sanitation system		
3) Kazungula District Council	Local Authority	Fully aware of the proposed water supply and sanitation project – both councillors and administrators	Supports the proposed development integrated into their approved town plan	Improving water supply and sanitation in the town to support housing, commercial, light industrial and tourism development. Aligning the water supply system within the approved town plan.	All parties; primary allies are the SWSC, the community, traditional leaders and District Commissioner	KDC can provide limited non-financial resources to support the project (e.g. land) and also mobilise government funding	Land allocation; system design; integration; levels of service	Partner (with SWSC as implementing agent)
4) SWSC	Service Provider (Water Utility)	Fully aware of the proposed project	Supports the development of a new system for Kazungula Town	Improving water supply through development of a reliable, modern water supply and sewerage system; increasing	Primary: central government, KDC, community, traditional leaders; and	SWSC can make decisions regarding allocation and use of	System design; technology choices; levels of service;	Lead and Partner

Stakeholder	Classification	Knowledge of the Project	Support Position	Interests	Alliances	Resources	Power	Participation Level
				revenue base by extending supply and covering unserved areas; sustain operations	private developers	resources in consultation and partnership with the local authority and central government.	costs; system operation and maintenance	
5) NWASCO	Regulator	Unknown / Undetermined	Unknown	Compliance with set national standards regarding levels of service; compliance of the utility to agreed performance targets; affordability	Central government	Setting tariffs	Regulation	Inform and Consult
6) Ministry or Department of Local Government and Housing	Authority	Limited	Supports comprehensive development of Kazungula as a town and administrative centre for the district	Strengthening decentralisation; housing development; development of local municipal services and amenities	KDC District Commissioner Other government departments	The Ministry has direct influence on allocation and use of funds to support this development	Funding; land use; town planning approvals	Inform, Consult, Involve and Partner

Stakeholder	Classification	Knowledge of the Project	Support Position	Interests	Alliances	Resources	Power	Participation Level
7) Traditional Leaders	Authority	Limited	Supports the development of Kazungula as an urban area with all services	Establishment of an administrative centre in Kazungula; Creation of jobs for nearby communities	Government; KDC	Limited to lobbying for funding of the project	Changing perceptions of rural-urban migrants	Inform and Consult
8) Department of Health	Regulator	Limited (Kazungula District Health Office)	Supports the supply of potable water and development of dignified and safe sanitation	Reduction of water related diseases; improved public health; reliable water supply to the newly built hospital	Central government; ZEMA; KDC; SWSC	Limited	Regulation of drinking water quality standards	Inform and Consult
9) ZEMA	Regulator	The local office (Livingstone) is aware of the proposed development	Supports the development	Protection of the environment; adherence to legislation and compliance to regulations and procedures; minimisation of environmental pollution	All government agencies	Limited	Approval of development after completion of EIA	Inform and Consult

Stakeholder	Classification	Knowledge of the Project	Support Position	Interests	Alliances	Resources	Power	Participation Level
10) Roads Agency	Service Provider	The Livingstone office is aware of the development	Supports the development of a new water system	Increased movement of goods and people across the border	All government agencies but primarily with SWSC	Limited to funding all water system changes resulting from bridge project	Funding of a small portion of the development	Inform and Partner
11) Department of Water Affairs	Authority	Unknown	Unknown	Abstraction of water within applicable international agreements	All government agencies, primarily with SWSC	Limited	Approval of abstraction permit	Inform and Consult
12) Private Developers and Business	Investors	Unknown	Expected to be positive;	Accessing reliable quality water supply and sanitation to support their businesses and investments	SWSC and KDC	Potential for contributing funds for capital infrastructure	Payment of services; facility development	Inform, Consult, Partner

Recommended Stakeholder Collaboration

This feasibility study provided an opportunity to identify and consult primary stakeholders. All stakeholders engaged expressed support for the proposed development and there has not been any outright opposition. Noting that the project will involve numerous role players, it is important to put forward clear recommendations on how stakeholders could work collaboratively to effectively and efficiently execute the proposed project, from planning to implementation. The following recommendations are made:

- **Stakeholder engagement** – Given the multiplicity of role players involved and the different levels of awareness and understanding, it is crucial that all primary stakeholders are well informed of the proposed development once all approvals have been received to proceed. A clear public and stakeholder engagement and communication plan must be developed to guide this process. This should include different levels of engagement (from information sharing to collaboration and partnerships) and should form part of the initial project establishment process. SWSC and KDC must lead this process as partners involved directly in the project.
- **Integration** – the development of a modern/urban water supply and sanitation system has to be integrated into the bigger vision of establishing a viable border town. This requires a clear and deliberate integration of the proposed water supply and sanitation system with the development of internal roads, storm water, amenities and other facilities to support social and economic activities in town. Kazungula District Council must lead this process as the authority regarding spatial planning and development.
- **Coordination** – The various parties must establish effective mechanisms of coordinating their inputs, especially those directly playing specific roles in developing the proposed infrastructure (SWSC, KDC, DC, ZEMA and RDA). It is proposed that a representative coordinative structure be established to establish required processes, coordinate planning, receive reports and oversee implementation processes.

Social Organisation, Livelihoods and Impact of Project

Cultural Dynamics

Kazungula Town was established as an urban area (formal town) on land that was previously classified as a rural area. Remnants of this history are still visible around the town as it gradually develops into a planned town. Different cultural and linguistic groups currently share this space and it is expected that this fusion of cultures and traditions will continue and will lead to a multi-linguistic and multi-cultural town in future. The current levels of knowledge, attitudes and practices suggest a predominantly rural population settled in what is now developing into a formalised town. Amongst others, the following are notable traits defining the character of the current Kazungula community:

- The large group of previously rural residents have kept a sense of communality which is demonstrated by sharing of limited amenities and facilities such as communal standpipes (a group of

households jointly contributes money to buy pipes, shares usage and collectively pays for water consumption from the communal/group standpipe).

- Most residents, especially those found in the unplanned section of the town, organise themselves into groups according to where they originate from, indicating some attempt to maintain some cultural homogeneity. The same attribute emerged during negotiations to resettle a section of the old settlement to accommodate the new bridge and border facilities.
- The affected group chose to have a new village established for them (Lumbo) inside a portion of land allocated by their Chief, instead of occupying vacant/available plots in the planned settlement. They argued that they want to maintain group identity and rural heritage of their cultural and linguistic group as opposed to being dispersed and mixed with "new" residents. This area is included within the scope of the water supply extensions.
- A large portion of residents use unimproved pit latrines which they deem acceptable although these facilities do not meet basic standards of safety, durability and privacy. Only a few formalised houses have on-site water borne sanitation.
- A large portion of the new residents located in the shanty section (Makalanguza) survive on limited income and utilise natural material to construct structures for shelter.
- Some unoccupied pieces of land and backyards are used for rain-fed subsistence farming and vegetable gardening

It is however noted that other practices normally associated with rural life such as livestock breeding are not prevalent. This may be due to limited space available for such practices and a subtle recognition that Kazungula is an urban area.

It is also noted that the uncontrolled influx of people into the area due to the attraction of cross-border trading has also led to new trends associated with urban life. These include the prevalence of victimless crime such as prostitution and illegal trading in foreign currencies.

Household Income and Willingness to Pay

According to the Kazungula District Council, the district is largely rural (95%) and a large portion of its residents live below the poverty line. Approximately three quarters (¾) of the current population of Kazungula Town are traders and the rest are government officials. Their livelihoods show a degree of vulnerability (trading amongst themselves, high dependence on cross border trade[2], limited access to natural resources, etc.) except for existing communal measures of support, existence of extended family structures and adjusting lifestyle to cope with minimal income. Commercial, tourism and industrial activities are yet to develop leaving a lot of the current population outside formal employment.

Agricultural activity as an income generator is also very limited largely due to the unfavourable soil conditions in the area around the town. Traditional family food security measures (subsistence farming, stock farming,

[2] It is expected that current unregulated cross border trade will decrease markedly after the completion of the bridge and the one-stop border facility which is a direct threat to a majority of current Kazungula residents

etc.) are limited. The poor community of Makalanguza faces other threats due to its location and proximity to the river bank – flooding, health, safety, etc. Although measures have been put in place by the local authority to relocate this community to a higher zone within a planned settlement, occupation remains low due to a majority of the dwellers being unable to pay for the costs of the stands. Makalanguza is included within the priority zones to supply water to in the project.

Willingness to pay is demonstrably high according to SWSC and 100% recovery is achievable. Poor households in the unplanned section of the town have devised measures to cope with payment of water consumption by clustering as neighbours and jointly contributing the monthly flat rate for a shared stand pipe (access is also controlled by the cluster). The risk of non-compliance remains especially factoring a history of culture of non-payment for services (fully subsidised) in Zambian rural areas until recent times. One other factor which is likely to reduce this level of recovery is the seemingly erratic water supply due to its limited supply capacity.

Cultural dynamics in the area are also likely to affect designs of dry sanitation systems or communal water borne systems. Sustained health and hygiene education is required.

The following issues must be taken into consideration:

- Sanitation is viewed as a private matter, therefore as much privacy as possible must be factored into sanitation systems
- Direct handling of human waste is not accepted, meaning that systems which use periodic excreta collection may not be accepted

Social Organisation

As highlighted earlier, the Kazungula town is developing from what is essentially a rural population base. The entrance of new residents and formalisation of the town is gradually turning the area into an urban area. The town is still peri-urban – exuding a mixture of urban and rural life, displayed both in terms of dominant lifestyle and settlement pattern and housing structures.

Its social dynamics present a town with two faces – the first consists of native residents mixed with new residents who originate from surrounding villages who still conduct themselves in ways that project communal living arrangements (including paying allegiance to their traditional leadership); and the second face consist of an urbanised group (mostly government workers who have relocated to the new town) who still view Kazungula town as a place where they work and stay but do not see it as “home”. In this regard, the first group is easy to organise as a community whilst the second group is yet to develop a strong sense of community in Kazungula.

Based on this understanding, project development planning (communication, consultation, community involvement, etc.) must consider the fact that the first group derives its power and influence by acting as a collective (one community with shared background, history, interests and needs), whereas the second group sees itself as outsiders, not intrinsically connected to the town or its people and acting mostly as individuals rather than as a collective. The first group has built community facilities through joint efforts (including

monetary contributions), and the second group acts as individual households (own standpipe, own sanitation system, etc.) and engages directly with the local authority in regards to accessing municipal services. The first group is likely to be receptive of system designs and levels of service built on shared access and costs, whilst the second group will want to be provided with water supply and sanitation designed around household connections and consumption costs recovered from individual plot/house owners. The planned system design of demand zones (DNIs) can be appropriate for the first group, considering that domestic connections with meters are also factored into the design that would cater for the latter.

In addition to non-formal structures of social organisation, the District Council has established Area Development Committees at ward and zonal levels and these serve as forums for community participation in local governance.

Possible Social Impact of Proposed Development

The development of a modern reliable water supply and sanitation system is the ultimate catalyst for development of Kazungula as a viable settlement and modern town. The proposed project will unblock residential, commercial, light industrial and tourism developments which will in the immediate term create employment and small enterprises, and in the long term create a revenue base for the development and sustainability of Kazungula as observed in other border towns in the area. There are however a lot of dependencies for the town to emerge a fully developed urban settlement.

A few notable positive results are expected to derive from the investment in an urban water supply and sanitation infrastructure alone:

a) Value creation for housing development and improvement in housing conditions due to improved and reliable access to potable water and sanitation. Proposed new development of 4000 houses will also benefit highly from availability, accessibility and reliability of water supply and sanitation in the town. A lack of this will mean the proposed development will not be sustainable.

b) At household level, the development will lead to a reduction of vulnerability from water and sanitation related illnesses such as diarrhoea, bilharzia and cholera. It will also reduce safety risks associated with collecting water from the river.

c) Improved and increased access will also lead to utilisation of water for productive purposes (food gardens, etc.) contributing to food security and reducing vulnerability

d) An improved sanitation system is an absolute necessity to secure human dignity for the poor who are currently using bushes and unsafe sanitation facilities

e) Investment in other sectors such as small scale agriculture and light industry will also be unblocked over time

f) The project and the system will provide opportunities for job creation and skills development during implementation and thereafter

g) A reliable system will support growth, income generation, employment, hygiene and education leading to an improved quality of life for the people of Kazungula

Gender Equality and Social Inclusion (GESI)

Introduction

The gender equality and social inclusion (GESI) assessment for the proposed Kazungula Border Town Water Supply and Sanitation Project was completed using socio-economic baseline information gathered during the first phase of the project. The research process included key informant interviews and field visits to Kazungula District Council and the Southern Water Supply Company. The assessment is also based on a careful review and analysis of relevant updated documents from government partners in Zambia. During the initial socio-economic study, in-depth discussions and interviews were conducted with key stakeholders and implementing partners, and with representatives from other organizations who are grappling with how to effectively supply water and sanitation to Kazungula Town. Interviewees also included project beneficiaries, water supply authority officials, and non-governmental organizations (NGOs) active in the area, civil society representatives, and local government representatives. Some group discussions were also conducted in nearby rural villages, where rural women were met, as well as with community groups which manage communal stand posts in the informal settlement section of Kazungula Town.

The premise of the assessment is that urban water supply and sanitation projects that aim at full coverage must acknowledge the differences and inequalities existing between different groups and a clear determination to ensure equitable access to water supply and other related benefits. The assessment therefore provides a basis for identifying and recommending additional efforts to understand the different socio-cultural contexts and conditions prevailing in the project community and the various barriers that limit access to water supply and sanitation services.

The initial socio-economic assessment completed during feasibility of the project used five normative criteria (availability, accessibility, appropriate technology, affordability, and acceptability) to assess project feasibility. In addition the assessment also looked at the community's current state in regards to public participation, governance and accountability, impact and sustainability, and transparency. Amongst other key findings of the socio-economic survey, the following highlight potential impact on gender equality and social inclusion:

a) Due to the lack of security of tenure for poor residents who reside in the informal section of the new town, these poor residents may be reluctant to make investments in water supply and sanitation. There will be difficulties in that the proposed water supply and sanitation project cannot support WASH improvements in informal settlements. Government's policy does not allow SWSC to provide water supply and sewerage services in rural and informal settlements.

b) Related to the point above, the cited policy provisions lead to fragmented institutional responsibilities for water supply and sanitation in areas where urban centres must share water supply systems with rural and informal settlements. Poor coordination in this regard will occasionally result in

inconsistencies and contradictions making it difficult for people to determine who to turn to and whom to hold accountable for water supply and sanitation.

c) Administrative and organizational procedures for customer registration and connection, such as the requirements for each connection to be registered and billed as a unit, could disproportionately burden those without formal stands/plots, or even exclude some people from decision-making roles during project design.

d) In the informal section of the town, persons with disabilities, children, older people, pregnant women and many others face physical barriers in accessing facilities because of inappropriate design such as limited space, and facilities that require to squat, small doors.

e) Affordability is emerging as a potential factor for exclusion in regards to the design of a modern urban water supply and sanitation network. The standards and levels of services proposed are appropriate for working people (mostly government officials). For people living in the informal section and the rural areas, affordability of services poses a great concern – they may be unable to provide the local contribution for water supplies or to build a safe toilet facility without a subsidy.

f) The town emerged from two distinct factors – formalisation of the area into a town to serve the needs of government in regards to establishment of a district administrative centre, and rural-urban migration due to the position of the town as a border town and an emerging urban centre. The town is still therefore largely rural and influenced by cultural norms and standards of living. A majority of its residents, who moved from rural areas, still experience socio-cultural stigmatisation and face cultural barriers that are deeply entrenched in the Zambian rural society impacting their access to water supply and sanitation.

g) The location of the town and its central spatial function (movement of people and goods across the Zambezi) has attracted social crimes and women and children have become direct victims. There are growing cases of child and women trafficking and prostitution in the area. Such incidences directly poses further social and health problems such as the spread of HIV/AIDS infections. This disproportionately affects women and children. In addition, current and future infrastructure development projects will worsen the spread of such infections outside the town due to the inevitable increase in migrant labour These negative effects particularly affect women because of their unequal access to resources such as land, skills, technology, information which enable them to generate income in the case of husband's death.

h) Urbanisation in the Kazungula area will not radically alter the dominant division of labour within households. Such patterns are visible in the area where most men are involved in salaried work and trade and women remain the primary caregivers and homemakers. In this regard, household chores are predominantly performed by women, in addition to their participation in income-generating (border trading) activities to support their families. This division remains dominant in Kazungula.

i) The balance between water for human consumption and water for productive use has not been strongly factored in the project design, given that the water system is primarily designed as an urban

water supply system. It has not factored multiple water use that include water for productive use required by the rural and informal settlement dwellers.

j) The poorer section of the town is also located in a flood zone. The increasing negative impacts of climate change are therefore likely to disproportionately affect the very poor as they live in locations vulnerable to landslides, flooding, etc.

The socio-economic analysis established that there is indeed a risk of social exclusion that may impact the poorer residents of Kazungula. The following were highlighted:

- In order to provide an appropriate modern urban water supply system to cater for Kazungula's estimated 25 000 residents, large capital investment is required. This will also mean high cost of operation and maintenance, and therefore the risk of this cost not being covered by current tariffs and revenue streams in the first fifteen to twenty years before the maturity of commercial and industrial developments (to enable cross-subsidisation). If tariffs go high, nearly 75% of the population may not be able to afford.
- A higher level of service for both water supply and sewerage may affect the poorer sections of Kazungula adversely in terms of costs and spatial appropriateness. Other technology choices such as communal taps and communal ablutions must be accessed for their acceptability.

Amongst its key recommendations, the socio-economic study completed in the feasibility study phase recommended that: thus

- The scheme must be designed with appropriate levels of service and targeting to ensure that all residents of Kazungula are served considering their needs, affordability and acceptability of serve standards. In this regard, it is important to specifically ensure that women, children and the poor are targeted.
- Capacity Development is needed to strengthen capacity of SWSC and District Council (KDC) staff and other stakeholders (especially rural leaders) to work with women, the poor and those living with disabilities and to address social issues.

Findings and Related Issues

Access to resources

An African Development Bank Country report suggests that the socio-economic situation in Zambia has been worsening over the years with women and children having to deal with the major brunt of this poor economic situation. According to the Zambia Vulnerability Assessment (2002 – 2003)[3], about 56% of the population is classified as poor, while poverty is more pronounced in the rural areas. The national PRSP (2002-2004) indicates that about 60% of Female Headed Households (FHH) are classified as extremely poor, as opposed

[3] AfDB Country Report – Zambia Country Gender Profile 2005

to 51% of the Male Headed Households (MHH). This situation has been worsened in terms of food poverty where 61% of FHH faced food shortage compared to 52% of MHH in 2001/ 2002. The proportions of stunted children (below 5 years of age) are higher in FHH (54%) than in MHH (49%). According to the Living Conditions Survey (2002), 62% of the people in rural areas were poor compared to 45% in urban areas.

In the Kazungula District, the 2010 Census indicate that 51% of its population are females, and that over 45% of its population is youthful. Kazungula will therefore emerge as a town with a lot of young people than the national average given the high migration rate in search for work and trading opportunities. Female employment is generally low.

The long-term impact of labour migration into the town will also be felt in villages of origin. The impact of long separations on family structures can be great. Migration has long been a feature of rural life in Kazungula District given that it has never had an urban area. Such displacement separates people from traditional support networks, making them more vulnerable to exploitation and high-risk behaviours, and less able to exercise their rights in “new” areas.

Access to land (plots) is not legally restricted by marriage or gender but given the unequal access to financial resources, more men than women own plots. This means more male-headed households will be served at higher levels of service than female-headed households who are likely to remain in the informal section of the town.

Access to Water Supply and Sanitation

Some of the constraints related to effective supply of safe water and sanitation coverage are related to weak institutional capacity of SWSC especially its ability to raise funding to implement a fully-fledged water scheme in Kazungula. This is now worsened by the increasing population without water supply and sanitation services in poor urban communities and surrounding rural areas. The effect of a combination of these factors is most severe on the poor. Poor water supply and sanitation services in poor urban areas have been the cause of annual outbreaks of waterborne diseases during the rainy season, which not only puts a heavy economic burden on the already impoverished communities, but also strains the public health services. Poor operation and maintenance of urban water supply facilities not only restricts services to a small number of consumers, but also leads to relatively high water charges for the urban poor which particularly affects women as the main users of potable water. It also increases the burden on women and children who are the main couriers and transporters of water in terms of walking distances, waiting time and security at water points.

Statistically, there are indications that:

- More male headed households than female headed households have access to water at higher levels of service. Most female headed households are in the poor informal settlement and therefore use communal stand posts
- Similarly more male headed households than female headed households have access to safer sanitation (septic tanks). The poorer section, which is also an informal settlement, uses unsafe sanitation facilities (latrines).

Knowledge, beliefs and perceptions

Kazungula Town remains 75% rural and therefore there is persistence of ingrained cultural systems that tend to discriminate against women. There are existing discriminatory laws, customs, and traditional practices that undermine women's economic and financial rights. In addition, there is still evidence of cultural beliefs, practices and norms that:

- restrict women's roles to subsistence production and nurturing of dependents;
- increase the burden of women in households including caring for the elderly and the disabled
- define women's position in society in terms of sexuality, fertility, sexual and reproductive rights

Practices and participation

A gender-based review of living patterns and practices reveals that women are the main producers of food for household subsistence. This is however restricted to small portions of land in a high density peri-urban space.

Zambia is the most urbanized country in Sub-Saharan Africa after South Africa, with about 50% of its total population living in urban areas (CSO 2000). Men have a long history of migration to urban centres for wage employment under the colonial migrant labour policy. By contrast, women have migrated to towns for economic and, mainly, social reasons, for example to join husbands already working in towns, to join relatives, or to escape from abusive marriage. Females who migrate to urban areas on their own face more difficulties than males in their search for housing and meaningful income generating activities. Due largely to discriminatory policies and practices, many women are engaged in petty trading and illegal/risky income generating activities.

Headship of a household is a very important role as it entails responsibilities such as finding housing for family members, food or cash provisioning to support the family. In a developing urban area such as Kazungula, ownership of a dwelling can also provide a means of income-generation (rental for migrant labourers or to run a small business from) among other social and economic benefits. However, women face more constraints than men in efforts to own housing for their families. This is mainly due to limited economic resources not legislative restrictions.

Legal rights and status

The Zambian legal system does not limit women participation in leading societal structures at political or administrative level. However there are still existing cultural practices and norms that undermine the full attainment of women's rights and participation.

Power and decision making

Observations alone indicate some progress in terms of female representation in the civil service, and in political leadership[4]. The general state is that female representation at political and administrative level is still low compared to men. Some of the barriers, using the Census Gender Disaggregated Data, include:

- high illiteracy levels among women especially in rural areas
- gender biased cultural beliefs, myths, negative traditional practices and stereotyping which discourage and prevent women from actively participating in public life
- women's poor economic resource base
- biased structures of political parties and their electoral processes that do not support the effective participation of women.

Most households in the district (77%) are headed by men, but the proportion of female-headed households has risen from 16% in 2001 to 24% in 2010. The rise in female-headed households is more predominant in rural areas, and can be attributed in part to the out-migration of the male population. However, even with this rise, less than 10% of all households report female ownership of all the main assets – house, land, and livestock.

In some ways, women have become more empowered. Many have managed the household independently, or chosen new professions. However, the Zambian society remains largely patriarchal, with strong traditions that assign higher status to men.

Decision-making is applicable at various levels, including the household level. Household dynamics include power struggles between the genders, for example over issues of division of labour, sexual and reproductive rights, employment, control over productive resources that enter the household, and benefits derived from personal work, as well as work of other family members. Observations and previous studies in Zambia revealed that household decision-making is dominated by men, and that the basis of power (for men) and powerlessness (for women) largely lies in socio-cultural factors.

Summary of Findings

Table 2 provides a summary of the GESI findings.

In addition to the findings, information has also been drawn on from both the Cost Benefit Analysis and Support Systems components of the design report to complete the GESI Rating Tool, which is included in **Annex 8**. The GESI Rating Tool rates the following questions: Does or is the Activity:

- Includes analysis and/or consultation on gender related issues;

[4] Kazungula District Commissioner was a woman at the time of the first field visit.

- Expected to narrow gender disparities, including through specific actions to address the distinct needs of women/ girls and/or men/ boys/ and/or marginalised or vulnerable groups and/or to have positive impact(s) on gender equality and/or social inclusion;
- Includes mechanisms to monitor gender impact and facilitate gender disaggregated analysis.

Based on the Rating Tool, the Kazungula WSS project scores 9 out of 12, which places the project in the 'encouraging' category.

Table 2: GESI issues of the proposed Kazungula Water Supply and Sanitation Project

CRITERIA	KEY ISSUES
Availability	Water availability is an issue that affects all residents. There is no direct discrimination due to social or gender status. Poorer sections and the rural periphery also use water from the river directly exposing them to water borne diseases and safety risks.
Accessibility	The current water supply system is accessed mostly by residents in the formal section of the town. There are only two connections to the informal poorer section of the town. The proposed design focuses on the formal section of the town in line with local government policy. However, there is a high possibility that a majority of Kazungula's residents will be classified as poor and therefore the risk is that the scheme may only serve about 25% of the population.
Appropriate Technology	Technologies used in the current water supply and sewage scheme are not fully appropriate. The water purification plant is becoming expensive to maintain due to this, and the usage of unlined pit latrines in informal settlements and on-site septic tanks in the formal houses is a public health risk given the soil conditions and high water table. The proposed scheme has factored the usage of appropriate low maintenance water treatment and reticulation scheme for the formal sections. Similarly the sewerage designs address appropriate technology, however the designs for both water supply and sanitation do not fully address the needs and abilities of the poorer sections. The safety of women and the burden of water collection for women and children remain key issues in the current system. The proposed scheme addresses these issues by reducing the distance of water collection and proposing VIP sanitation system combined with shared ablution blocks for the poorer informal and rural sections. The new scheme has factored usability for disabled, aged and fragile members of the community.
Affordability	This is an issue that affects effective maintenance of the current system (sprawling

CRITERIA	KEY ISSUES
	reticulation network with limited connections). It will continue to be an issue especially if the area becomes a semi-urban settlement with a majority portion composed of rural informal settlements.
Acceptability	The proposed system is largely acceptable in terms of ergonomics and suitability for the served population.
Public Participation	The current local government system of public representation at the lowest level (ward system) allows for inputs from the residents in influencing public infrastructure choices. There are established community structures under the Chiefs that are also consulted during the planning of projects. These forums are inclusive and, in rural areas and informal settlements, these are often comprised of women due to the impact of migrant labour.
Governance and Accountability	There are established traditional, local government, provincial and national governance structures that enable elections, public representation, decision-making and accountability. These platforms do not discriminate against women, the poor or rural masses; however the current make-up still leans towards a more male-orientated, urban-biased and high class leadership.
Impact and Sustainability	The current scheme does not fully address key accessibility and water quality issues to cope with the expected growth and expansion of the town. The formalisation of the town has not fully incorporated development of informal high density settlement in the periphery of the town and such is leading to social exclusion of the poor. The proposed scheme is therefore designed to respond to major developments such as commercial, industrial and residential developments a through a phased development approach.

In addition to the above findings, information has also been drawn on from both the Cost Benefit Analysis and Support Systems components of the design report to complete the GESI Rating Tool, which is included in **Annex 8**.

Social Recommendations for Project Planning and System Design

Based on preliminary assessment conducted in the area, it is concluded that:

a) The town is still peri-urban with a mix of income groups, most of whom are low-income families who depend on cross-border trading and a limited number of government officials who also occupy formal houses. High income earners, business, commercial and industrial customers are yet to establish

presence largely due to the absence of a reliable water supply and sanitation system. The approved town plans may gradually tip the scales to accommodate a large group of middle income earners.

b) Socio-cultural characteristics indicate a mix of communalism associated with rural life and individualistic lifestyle associate with urban life. Communalistic households, mostly in the poor section of the town, unite to share costs for facilities such as stand pipes and monthly payments and live off limited resources; and the urbanised group is smaller, not yet "emotionally" attached to the town, and mostly consists of civil servants.

c) In the midst of observed and recorded poverty levels in the town, the proposed combination of infrastructure development projects, led by potable water and sanitation, will bring hope for employment and skills development for a majority of poor households in Kazungula and surrounding villages.

d) There is a risk of actual cost of operation and maintenance of a modern WSS system being unaffordable, which will put SWSC resources under pressure in short to medium term because high tariff customers (business, institutions, industry, etc.) will take time to establish and create a constant high water demand to achieve cross-subsidisation.

e) Willingness to pay has been demonstrated; however there are still concerns regarding ability to pay for higher costs especially if tariffs factor capital redemption costs.

f) The town may develop into a largely peri-urban settlement composed of a large portion of poor households.

It is therefore recommended that:

a) A detailed social impact assessment be carried out once the detailed preliminary designs are approved. This study should form part of the compulsory Environmental Impact Assessment Study required by ZEMA.

b) System design must factor the following:

- Basing coverage and demand on more realistic and observed development around town than focusing on ambitious government plans whose realisation depend on a number of variables, most of which are not within control. It is because of this factor that the density of the water and wastewater network is not extended to every street, to reduce recurrent costs
- Achieving affordability for poor communities which may become a large portion of the town's population noting current rapid expansion of non-formal housing;
- Ensuring acceptability of proposed technologies considering socio-cultural factors such as acceptance of shared/communal standpipes and ventilated improved latrines; and
- Ensuring accessibility of water and sanitation to promote spatial growth, human dignity and socio-economic growth.

c) Different options for low cost systems (access and levels of service) be developed to accommodate the dynamics of the poor sections of the town and reduce vulnerability risks of poverty and disease.

Public/Environmental Health Considerations

This section provides an overview of the environmental health issues in Kazungula, and also relevant legislations, which have helped to shape the design of the interventions on the water supply and sanitation in Kazungula.

Legislation

The Public Health Act (1930) (as amended several times between 1930 and 1995) defines notifiable infectious diseases in Zambia as anthrax, blackwater fever, epidemic cerebro-spinal meningitis or cerebro-spinal fever, asiatic cholera, diphtheria or membranous croup, dysentery, enteric or typhoid fever (including para-typhoid fever), erysipelas, glanders, leprosy, plague, acute anterior poliomyelitis, puerperal fever (including septicaemia, pyaemia, septic pelvic cellulitis or other serious septic condition occurring during the puerperal state), rabies, relapsing fever, scarlatina or scarlet fever, sleeping sickness or human trypanosomiasis, smallpox or any disease resembling smallpox, typhus fever, all forms of tuberculosis which are clinically recognisable apart from reaction to the tuberculin test, undulant fever and yellow fever.

The Act requires properties to be kept in sanitary condition. In particular Section IX Sanitation and Housing, Paras 64 to 66, 67 (1) (b) (c) and (e) address the matter of “nuisance”, one variety of which is the discharge of “any noxious matter, or waste water, flowing or discharged from any premises, wherever situated, into any public street, or into the gutter or side channel of any street, or into any water-course, irrigation channel or bed thereof not approved for the reception of such discharge;”. This is of particular relevance to Kazungula where septic tanks and pit latrines erected in the flat riparian plain of the Zambezi River regularly flood and discharge their contents around the surrounding dwellings and streets during times of heavy rainfall.

Similarly, PART XII, PREVENTION AND DESTRUCTION OF MOSQUITOES, para 84 (b) and(c) provides for any open, unscreened, water collecting container harbouring immature stages of Mosquitoes to be classified as a “nuisance” and dealt with accordingly. This is again a relevant issue for Kazungula as the proximity to side channels and pools of the Zambezi River and the standing water following heavy rains provide significant (relatively clean and still) water bodies for mosquitoes to breed in.

Other infectious diseases that are common in Southern Africa and that can be expected to occur in Kazungula (but are not necessarily notifiable) include Malaria and Schistosomiasis (aka Bilharzia). Both of these diseases have linkages to water in that Anopheles mosquitoes (the vector for Malaria transmission) breed in relatively clean still water, and Schistosomiasis is a "Water Based" disease in that it relies on aquatic host snails (Genus Biomphalaria and/or Bulinus in Southern Africa) to complete its life cycle in between infecting humans. The transmission cycle is completed when infected people urinate or defecate into water containing the snails

The Public Health legislation is written from a clearly command-oriented point of view and prescribes duties and penalties on all relevant parties, but no guidance on how to avoid such problems or where advice on dealing with them can be obtained.

Health Data availability

During the visit to Kazungula 6-9th May 2014, several discussions were held with the Study team and the Health Inspector at the Kazungula District Administration, and the MoH Port Health Surveillance Officer. This was in an attempt to gather statistics on the disease prevalence in the area. All conversations produced only anecdotal information, with no numbers and no historical data. Both officials interviewed referred the study team to the District Disease Surveillance Officer in Livingstone for the data sought. The following information was obtained during this visit and subsequently, also gleaned from the officials contacted, and the internet.

Disease Quantification

Diarrhoeal Diseases

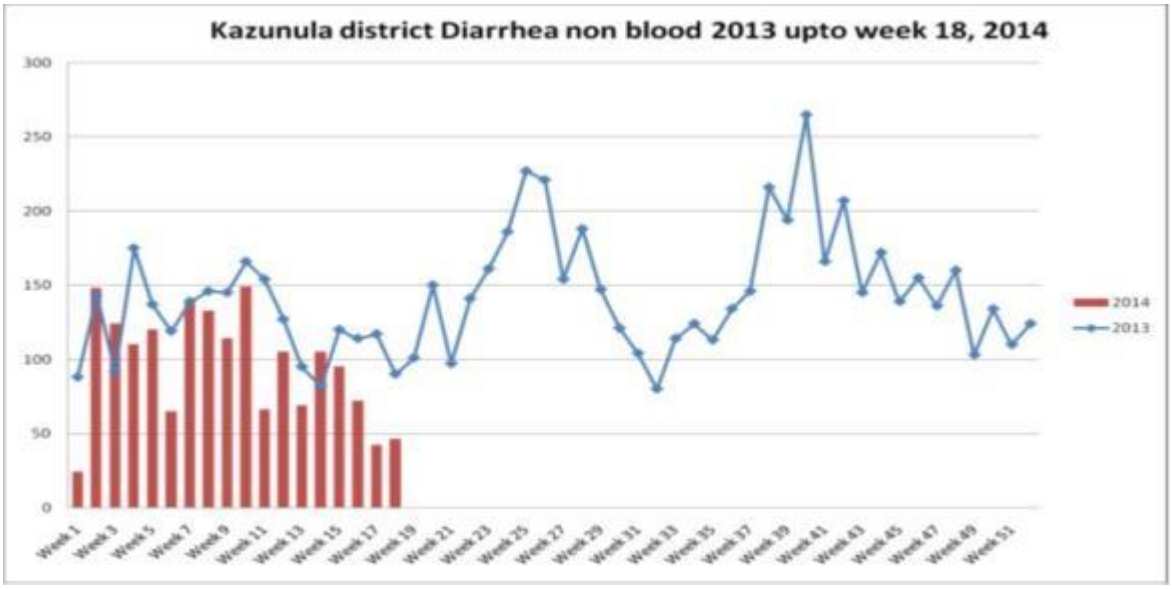

Figure 3: Kazungula district diarrhoeal incidence in 2014

These figures, while relating to the whole District, can be read as typical for Kazungula town. Diarrhoea is the primary initial indicator of many diseases, particularly the faecal-oral diseases as described by Cairncross and Feachem such as cholera, dysentery, enteric or typhoid fever (including para-typhoid fever) and also the (occasionally) water-washed condition diphtheria. The figures show a fairly consistent incidence from 2013 to 2014 (as far as the information available) and average around 100 cases per month.

Malaria

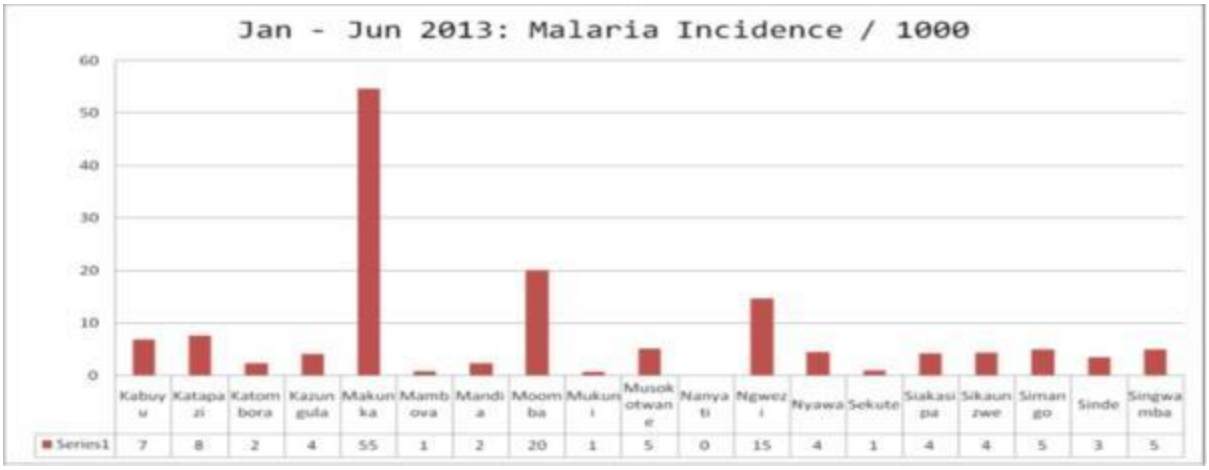

Figure 4: Kazungula District Malaria Incidence

These figures show that the town of Kazungula itself has relatively few cases of Malaria (approx. 4/1000 population) as compared to Makunka and Moomba elsewhere in the District. This might indicate that the primary water body available to the Anopheles Mosquito for egg laying flows at too rapid a rate for larvae to proliferate and hatch near the town.

Infant and Under-5 Mortality rates

No specific data for Infant Mortality Rate (IMR) and Under-Five Mortality Rate (U5MR) was available for Kazungula Town, but a search of data on the internet revealed a country-wide situation as follows:

- IMR Zambia increased from 99 to 110 per 1000 live births between 1980 and 2005.
- U5MR Zambia increased from 121 to 162 per 1000 live births between 1980 and 2005.

These figures are a cause for concern as both the IMR and the U5MR have increased over the 25 year period monitored, indicating a general reduction in the overall health of the population. In the absence of any specific data concerning IMR and U5MR for Kazungula we can take these figures as representative of the situation and state that the situation is deteriorating. It can also be confidently stated that much of the Infant Mortality and Under-Five Mortality can be ascribed to the faecal-oral diseases, of which Diarrhoea is the most common symptom. This situation is endemic in poor communities around the World and can be expected to be positively impacted by the provision of reliable water and sanitation systems, especially when accompanied by public health promotion activities such as the “Hand washing with soap” campaigns.

Considerations for Public Health Related Interventions in the Project

Diarrhoea

As stated above the incidence of diarrhoeal episodes can be expected to reduce significantly with the provision of a safe and reliable water supply, provided it is accompanied by the provision of appropriate sanitation facilities at household level and at public venues such as markets, schools and clinics. The proposed water supply system for Kazungula will achieve its part in this instance, being comprised of raw water intake from the Zambezi River, filtration and chlorination. However, one key issue at Kazungula is the flooding and overflowing of pit latrines and septic tanks in the lower part of the town adjacent to the river, during periods of heavy rainfall. This opens the opportunity for many instances of diarrhoeal episodes via the exposure of residents and visitors to the polluted standing water through which they must pass.

The sanitation interventions should therefore promote technical options for domestic sanitation that are less vulnerable to surface water flooding. It is recommended that KDC and RDA investigate surface water drainage options in high risk areas. It should be noted that pragmatic options will need to be considered for the improvements of public health conditions in the low-lying area, considering the District Council hopes to relocate the population from this area.

A public health promotion exercise should be instigated in concert with the local health authorities on the dangers of faecal contamination and the benefits of frequent hand washing.

Malaria

The low incidence of Malaria in the area does not warrant any large scale intervention as part of this project. Spraying of insecticides around residences and public venues during the breeding season should be adequate to keep the disease in check. The side pools of the river (and any maturation ponds included in the sewage treatment process) may also provide breeding sites and these should be monitored (by the health authority) and spraying commenced should larvae be detected. If the local health authority is not already doing this then they should be encouraged to do so in terms of their already existing legislation.

Schistosomiasis, IMR and U5MR

Without specific information on the incidence of Schistosomiasis it is not possible to recommend any specific interventions. However, the provision of the improved water supply and sanitation facilities will address two of the four responses normally required for Schistosomiasis control. The additional public health messages, and screening/treating of infected people, is anyway the responsibility of the Department of Health. The IMR and U5MR can be expected to improve following the infrastructure interventions. Unfortunately the data on these issues is not available for Kazungula specifically but the project can rest assured that it will definitely not make these statistics worse and, from documented evidence globally, will most likely improve them.

Population Size and Future Projections

Context

Kazungula is a recently proclaimed urban area stemming from a historical rural settlement and sparsely populated border post. In this regard, population projections for the border town largely depend on the potential consequences of the local authority's own vision and planning. The current spatial plans have laid the ground for promotion of urbanisation and economic development, and these plans are expected to have a positive influence on future population numbers. Assumptions incorporated into population projections take into account the planned infrastructural, economic and government developments. It is however difficult to ascertain the potential socio-economic growth of the town except for intentions and consequent pronouncements by government.

In the case of Kazungula as a new town without adequate infrastructure to support and sustain the local authority (and national government's) plans, population growth estimates must incorporate adjustments to national projections which focus on year-on-year historical analysis. These adjustments relate to possible migration patterns and changes in quality of lives which directly affect mortality and birth rates. In this regard, socio-economic developments proposed for Kazungula can be treated as an exogenous variable affecting population trends but not affecting the relationships within the population growth model. Migration assumptions in the demographic projections must be adjusted to account for expected economic growth. However, economic growth is enabled by availability of base social infrastructure and services.

Population Census, Current Estimates and Growth Projections

Zambia 2010 Population Census

The 2010 population census recorded population in the Kazungula District at 104,731. The average household size for Kazungula district is **5.2** people per household. The 2010 population census indicated that **3,093** people stayed in urban areas of Kazungula. Kazungula Town falls in two wards - Sikaunzwe and Mandia. The two wards include rural areas (villages). According to the 2010 population census, Sikaunzwe had 1536 households and Mandia had 2074 households. Note that there are slight discrepancies between different census documents.

Between 2000 and 2010 urban population growth rate in Zambia was 4.3%. Total population growth (urban and rural) for Southern Province was 2.8%, and for the Kazungula District **4.3%**. Applying these two historical growth rates to the Kazungula Census 2010 population (3,093), gives an estimated 2014 population of between 3,454 and 3,660 respectively.

The Zambian Central Statistics Office has not published population growth projections. The United Nations however estimates annual population growth in Zambia at 2.25% between 2010 and 2030 and 0.923% average annual growth between 2010 and 2060.

Local Authorities' Population Estimates

According to Kazungula District Council Strategic Plan, only 5% of the Kazungula District population stays in urban areas. The Kazungula Town is the only town (urban area) in the district. Using this indication, it can be assumed that over **5,000** people were staying in Kazungula town in 2013.

Relying largely on the local health clinic records, the local authorities (KDC and the District Commissioner) estimate the population size in the town in 2014 between **4,500 and 5,500,** translating into a 100% growth between 2010 (+/-2,500) and 2014. It is clear from these figures that there has already been an explosive increase in population size, leading to the development of a "shanty town" on the outskirts of the planned town zone.

Southern Water and Sanitation Company Planning Information: Population Projections

SWSC used information from NIS[5] to estimate population growth in Kazungula town between 2012 and 2017[6]. It estimates that Kazungula town will have approximately 3,035 people and 506 households (at 6 people per household) by 2017. This figure is already below current estimates of the KDC and the District Commissioner's office and clearly does not factor the economic and rural-urban migration. The NIS projections used by SWSC used an annual (year-on-year) growth rate of about 2.9%.

Current, Planned and Future Developments Impacting on Population Growth

Kazungula Bridge Project

The Kazungula Bridge Project, started in September 2015, with completion in 2019, is arguably a key catalyst in developing Kazungula into a town. Its impact on the population will be both immediate and long-term.

The bridge project will have an immediate impact on the current population size of Kazungula when migrant labour from the nearby towns and countries ascend into the area to search for work. Between 500 and 1200 workers are expected to be employed in construction work for four years. In addition, the number of small traders will also increase to serve the labourers. Traders and construction workers are likely to bring a few people to stay with (spouse, children, etc).

Most of the labourers and traders will stay in the "shanty town" section of Kazungula, whilst others will hire accommodation in more formal houses in the town. Others, especially those from the nearby village of Mambova, will choose to stay in the new village (Lumbo) on the border of the town.

[5] Full title for the abbreviation "NIS" has not been established
[6] SWSC Reviewed Business Plan 2012-2017

In the long-term, the bridge will facilitate better trade between Southern African countries such as Botswana, Zambia, Zimbabwe, Congo, South Africa and Namibia. Although the amount of time spent by trucks at the border will reduce tremendously, a better border facility and route will facilitate more trade traffic and given the distances between towns, Kazungula will still benefit as a “stop-over”.

Town Development and Government Housing Development Project

About **238** plots have been reserved to move/accommodate residents staying in the unplanned section of the town (south-eastern side). These stands are being sold cheaply (approximately K2000) however there are residents who will still continue to stay in the "shanty town" due to a variety of reasons[7].

Four thousand **(4,000)** houses have been approved for construction to accommodate civil/public servants and the general public interested in moving into town. These will be funded through government sources and 2,000 houses will be sold to low-income, middle-income and high-income residents. This project is expected to begin in the near future after final approval in May 2014, and has been factored into designs of the water and sewerage system.

The bridge project has resettled a portion of Kazungula to a new section of Mambova village (Lumbo) where **38** houses have been built for the resettled community.

Extension of the town to include the "modern village" of Makalanguza (current unplanned settlement) which is part of Kazungula Town. The proposed designs capture the needs of both communities.

Tourism and Commercial Development

The Kazungula District Council has planned, reserved and sold a number of sites for the development of what it calls “river front’ lodges. The development of these sites is currently inhibited by a lack of reliable potable water supply and sanitation system.

The availability of suitable and acceptable (international standards) lodging establishments will propel tourism into the area. The precinct, with Zambezi River as a central attraction, is already a high tourism area, although only Botswana benefits at this stage due to the developed infrastructure of Kasane Town.

There are possibilities of extending the protected area between Kazungula and Livingstone to provide an avenue for supporting eco-tourism in the area. The growth of tourism and its impact on settlement patterns, economic development and population growth remains

[7] (i) Affordability limitations (most residents are unemployed); (ii) housing regulations (all houses/house plans in planned plots must meet certain building standards to be approved by the District Council); (iii) sense of entitlement demonstrated by some residents of the "shanty town/modern village" do not believe that they must be forced to buy land, which is essentially theirs; (iv) unwillingness to disintegrate community (communal structures and organisation) which is emerges when members feel that a sense of community may disappear when they get integrated into a formal town setting; and (v) expected influx of job seekers when the bridge and housing projects begin.

Government Services

Kazungula District Council was established as part of government's efforts to decentralise governance. The Kazungula Town is planned to serve as central administrative zone for localised government services such as primary health and basic education. In this regard, government will be investing in new office facilities in the town to accommodate public officials. Already there is a new hospital under construction in addition to new public schools. Half of the planned government-funded housing project will be reserved for government officials.

Other Factors Impacting on Population Growth

It is assumed that the current population growth rate cited in the census calculates birth and death rates using national and regional indicators and trends. The one particular factor that may affect mortality rate in Kazungula is the effect of a high concentration of truckers and contract workers in the next five years, which will likely increase the rate of HIV/AIDS infections.

Brief Comparative Assessment with Border Towns of Similar Character in Same Vicinity

It is useful to consider similar border town development cases in assessing factors which are likely to contribute to rapid population growth for Kazungula town. Indications of a similar trajectory will bring population growth projections closer to reliable planning figures. Kasane Town (Botswana), Katima Mulilo (Namibia) and Sesheke (Zambia) share similar location characteristics with Kazungula and therefore provide good cases for establishing a possible spatial development and demographic pattern for Kazungula town factoring similar triggers such as:

- Formalising the area as a formal town (in terms of land ownership, administration and allocation; town planning; and development of bulk connector infrastructure)
- Establishing the town as an administrative centre for the district
- Creating opportunities for commercial and industrial development

Kasane Town, Botswana

Kasane town serves as an administrative centre for Chobe District, and is located a few kilometres (± 15 kilometres) from the Kazungula Bridge. Its population was 9008 according to the 2011 Botswana Population Census. The town has established facilities for government, commercial, tourism and light industrial activities. Tourism is the main economic driver for the town, and due to high demand the town has an airport. The possible impact of the new bridge on population growth is yet to be assessed.

Katima Mulilo, Namibia

Katima Mulilo was formally established as a town in 1999, and now boasts a population of approximately 30,000. It also serves as an administrative centre. Completion of a bridge linking Zambia and Namibia to facilitate movement of goods via Walvis Bay created a boom resulting in mushrooming of shanty towns and rapid growth of rural areas close to the urban area.

Sesheke, Zambia

Sesheke is the administrative centre for the district and shares the bridge with Katima Mulilo. The town has experienced a high rural-urban migration since 2004, and the 2010 Population Census recorded its population at 16,276. Its population size is currently estimated to have reached 20,150 (2014). New lodge and tourist facilities have created a growing tourism industry which is a revenue base for the town.

Population Growth Assumptions and Projections

a) The various estimates of the current Kazungula population vary significantly. As stated the SWSC population estimate seems to be too low. Utilising the 2010 Census data, the population based on the Kazungula District historical growth (2000 – 2010) would be at least 3,660. Due to the rural – urban movements, it can be expected that the Kazungula Town growth rate has actually been far higher than the district growth rate. To achieve the Kazungula District Council estimate of between 4,500 and 5,500, the annual growth rate (2010 and 2014) would need to have been between 10 % and 15.5% respectively.

b) Three projection scenarios are presented:

- Low Scenario: Using linear growth rate of about 4.3% per year (Kazungula District growth between 2000 and 2010). This excludes economic migration, rural-urban migration, and relocation of district level government officials to Kazungula. The 2014 starting population for this model is the census population using Kazungula District historical growth rate (3,660 people).
- Medium Scenario: This scenario incorporates the migration of people into Kazungula to work, establish businesses, seek employment or relocate from a rural area to the town. The 2014 starting population is the District Council high estimate of 5,500.
- High Scenario: The scenario assumes peak migration periods triggered by the construction of the bridge and proposed government housing scheme. The 2014 starting population is the District Council high estimate of 5,500.

c) Given complexities of accurately projecting the rate of economic migration and urbanisation over the period 2010 and 2030, some more definite calculations were used to estimate the planned population size using known variables such as number of residential plots and housing units planned for the town.

d) Key assumptions guiding growth patterns and estimates regarding town size and number of water consumption units are as follows:

- Construction and occupation of new housing units will take some time and will be affected by other factors, the most primary being the availability of potable water and sanitation and other human settlement services, in addition to availability of government funding. The projections have spread the time to achieve full occupation over a period of more than fifteen years (beyond 2030). The current town plan has capacity for approximately 4,500 houses (4000 through new government housing project, 238 high density low income plots, small holdings and existing privately owned houses) excluding the unplanned section. At full occupation, factoring household size increasing over a period of 25 years, over 30,000 people will be staying in the formal houses alone, in addition to those remaining in the shanty town sections and small holdings.

- Maternity and mortality rates will remain stable over this period and therefore a normal growth rate similar to national and district trends is expected. This rate is between 2.9% and 3.7%

- There will be peak periods, first between 2015 and 2020 in response to the bridge project and resultant high demand for accommodation, then second between 2025 and 2030 driven relocation of government officials and occupation of government houses. These will be followed by a more organic or gradual than exponential growth driven largely by expansion of government services and the development of tourism, industrial and commercial sectors. This development, however, remains largely dependent on commitment and levels of public and private investments to grow the town.

e) The Zambian Government's decentralisation programme, in this instance establishing the town as an administrative centre for the district thereby bringing in government services closer to people, will further support the establishment of a new fledging town in Kazungula. There seems to be a deliberate effort to direct the development of the town using pro-active planning approaches instead of reactionary (post-fact) approaches of addressing migration trends. In this instance, government is promoting urbanisation and establishment of spatial capacity to absorb possible rural-urban migration over time.

f) Trends in similar border towns in the vicinity show that population growth is directly attributed to significant triggers such as bridge construction and establishment of these towns as administrative centres for their respective districts. The three cited cases – Sesheke, Katima Mulilo and Kasane experienced exponential population growth within periods of about ten years, and population sizes are between 15,000 and 30,000. Another similar trend is the proliferation of shanty towns on the outskirts of the formal towns and a remarkable growth of rural villages in the immediate vicinity of the towns.

The table and graph below give population numbers and growth patterns projected for Kazungula town between 2010 and 2030, based on the three population growth scenarios.

Table 3: Population Growth Estimates - SWSC Kazungula Town Service Area

	2014	2015	2020	2025	2030
Low Scenario: Historical district growth rates (4.3%), no account for migration	3,660	3,817	4,712	5,816	7,178
	The scenario represents the low bound of the population. However, due to growth factors that will significantly impact on the influx of people to Kazungula, this scenario is unlikely transpire.				
High Scenario: High net migration projection (economic migration and rapid urbanisation)	5,500	7,500	11,742	15,896	25,000
	This is the figure recorded and used as 2014 baseline. It's the most reliable estimate backed by clinic records.	In addition to normal growth at 3%, the start of bridge construction will attract more activity in the town increasing migration. 600 new traders, builders, rural to urban migrants and government officials expected to come (based on average annual	Bridge construction no longer impacting on service demand. Improved (reliable) water supply triggers formal housing development mostly by private investors to accommodate construction workers and about 2,000 government scheme houses are completed in time	Bridge construction is complete and traffic volumes increase. Border operation accelerates movement in and out of town, government services and improved infrastructure accelerates housing development	Government completes its housing scheme providing for capacity of more than 20,000 people in formal houses; improved water, roads and other services trigger commercial, industrial and tourism development

	2014	2015	2020	2025	2030
		rate for past five years) 1200 construction workers to come for bridge construction (Bridge project plan estimates about 1200 job opportunities to result from construction)	to accommodate border workers, police, health and local authority workers. Projected growth includes growth rate at 3% plus continued migration/relocation of about 600 people per year.	Normal growth reaches around 3%. Migration continues at a rate of 600 people per year	
Medium Scenario: Medium net migration projection	**5,500**	**7,500**	**9,433**	**12,467**	**22,300**
	This is the figure recorded and used as 2014 baseline. It's the most reliable estimate backed by clinic records.	In addition to normal growth at 3%, the start of bridge construction will attract more activity in the town increasing migration.	Bridge construction no longer impacting on service demand. Improved (reliable) water supply triggers formal housing development mostly by private	Bridge construction is complete leading to out-migration for job seekers. Traffic volumes increase. Border operation accelerates movement in and out of town and	Access to water and sewerage improves attracting constant rural-urban migration and relocation of government workers. Commercial and

	2014	2015	2020	2025	2030
		600 new traders, builders, rural to urban migrants and government officials expected to come (based on average annual rate for past five years) 1200 construction workers to come for bridge construction (Bridge project plan estimates about 1200 job opportunities to result from construction)	investors to accommodate construction workers, and to a limited extent by government to relocate government workers. Only a few government houses are built to accommodate hospital and border facility staff. Movement of people seeking employment reduces as bridge project is complete.	trading reduces dramatically. Growth rate stabilises to 3% with low in-migration due to limited economic opportunities	tourism developments occur attracting further housing development in the area Population growth continues at a stable 3%. Migration rate reaches an average of 1500 new residents a year (2024-2030), largely composed of government and retail sector workers

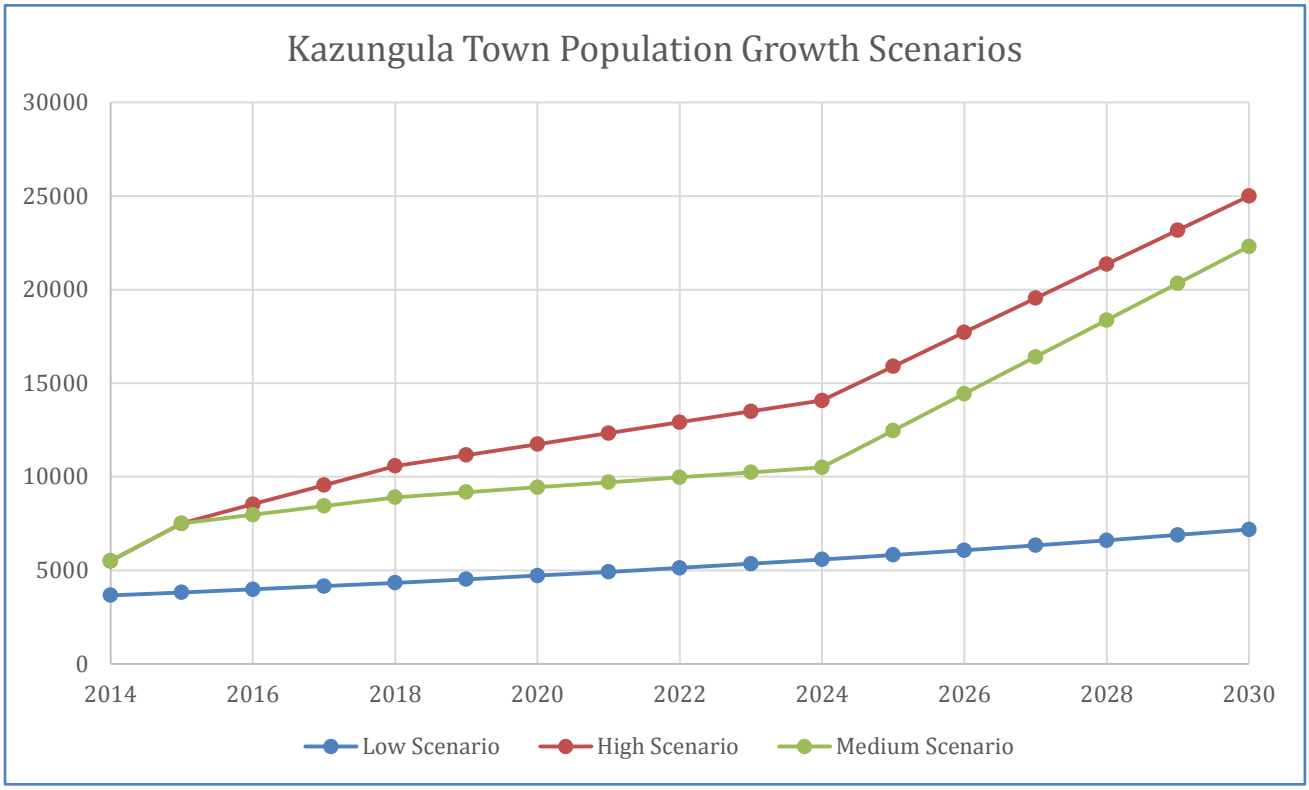

Figure 5: Population projections for Kazungula Town

Analysis, Implications for Water Supply and Sanitation Project and Conclusions

a) Future population growth in Kazungula is expected to increase rapidly in the immediate-to-medium term (2015 to 2030), not due to a high birth rate but as a result of high in-migration into the town triggered by envisaged economic development (tourism, border trading, commercial and industrial developments, construction projects), planned human settlement development (government housing development and rural-urban migration) and proposed infrastructure to enable decentralisation of government services. This growth has a lot of inter-dependencies which may see growth constrained to half of what the local authority and national government are planning for. A more certain trend that will continue for a while is the expansion of the unplanned section of the town and high occupation of the town by poor rural-to-urban migrants.

b) Industrial, commercial and tourism developments are expected to drive growth and in-migration between 2030 and 2060. This development is very uncertain given the position of Kazungula in Zambia's development vision.

c) It is assumed that the Medium Scenario projection is the most likely scenario, and it is on this that the design figures for the water supply and sanitation system have been designed. The actual population growth should be monitored to allow sufficient planning time to upgrade the system in a phased approach.

Table 4: Option Analysis of Proposed Technical Solutions from a Socio-Economic Perspective

Criteria / Options	Affordability	Acceptability	Appropriateness	Accessibility to poor households
Piped water supply with house connections	The current residents of Kazungula are paying for the supply and the cost-recovery rate is acceptable. An improved supply – assurance and quality – may increase the rate even higher based on customer satisfaction levels. However, there remains a possibility of a high increase in the cost of operation and maintenance, and the risk of this cost not being covered by current tariffs and revenue streams in the first fifteen to twenty years before the maturity of commercial and industrial developments (to enable cross-subsidisation)	The level of service proposed will maximise cost recovery through metering each house connection and potentially establishing kiosks or shared/communal standpipes for those in the unplanned sections. This allows for differentiated levels to cover different income levels and preferences. The system will not differ from what is currently provided for in the town and nearby villages.	The technologies proposed are appropriate for a new urban settlement such as Kazungula town. They offer choice in regards to levels of service, and will be easy to use by the consumers. Shared/communal taps will only be appropriate in the high density unplanned section(s).	The provision of drinking water to poor households on the periphery of the planned sections of town will minimise the risk of households using unclean river water and alleviate all the burdens of collecting water from unsafe sources. This will particularly benefit women and children.
Reticulated Sewerage System for non-domestic customers	The system will be affordable for non-domestic users such as government, commercial entities,	Most non-domestic users prefer a government/utility run sewerage system as it reduces capital and	The reticulated system is acceptable for non-domestic users and high-income	Poor households are being safe-guarded from high costs by not extending this

Criteria / Options	Affordability	Acceptability	Appropriateness	Accessibility to poor households
	tourism establishments and industries, plus higher income households.	operation and maintenance costs (shared)	households.	service to the poor sections of the community.
Solids-free sewerage system for low-to-middle income households	The system is the least costly option relevant for a new/developing town. Unlike the full reticulation system, the capital redemption costs (connection fees) will be lower. The costs of desludging septic tanks will be minimal given the expected intervals between sludge disposals.	This has not been tested; however most households in the formal/planned sections of Kazungula already use septic tanks. The introduction of a solids-free system, elevates the level of service in terms of creating a mechanism of disposing liquids safely (instead of disposing into the underground)	It has not been established if a similar system exists in Zambia. The main areas of concern in regards to appropriateness is users' responsibility to empty and dispose solids.	Poor households will be able to choose between upgrading to a ventilated pit-latrine or a solids-free piped system based on what they can afford.
Communal Ablution Blocks	The communal blocks are cheaper to maintain than individual connections. The operation and maintenance system can also be sub-contracted to a local private provider to avoid system failure.	This needs further investigation. Ablution blocks are currently only used at the border gate, free to all. A few areas may be identified for installation – the market places, border post (to augment), bus terminus, and potentially high	Already used as part of institutional sanitation. Cultural acceptability is not an issue, however broad social acceptability for domestic multi-household use has not been assessed in full.	Whereas these may suit poor households in dense settlements, the costs of running the blocks may dissuade poor households from using them. What may be further explored is building the costs into costs

Criteria / Options	Affordability	Acceptability	Appropriateness	Accessibility to poor households
		density residential areas		of running the total system and encourage poor households to use the blocks.
Ventilated Improved Pit-latrine	VIPs are very low cost in terms of maintenance	The system is already used in the town and the new settlement (relocation village).	VIPs are generally acceptable for low-income areas where piped sewage may be costly or difficult to construct and manage.	Poor communities already use unimproved systems. There is a need to accompany VIP introduction with health and hygiene awareness.

Social Assessment Recommendations

Based on the social assessment, the following recommendations in regards to project development and system design are made:

- The water supply and sanitation system must be designed to ensure universal access and to support current growth trends instead of planned growth based on settlement plans. Drinking water and sanitation must be provided to areas where settlement growth is happening and where new residents are likely to go in the next few years.
- Sanitation system should follow the same route priority areas as the water supply.
- Only sections accommodating government institutions (border, offices, hospital, etc.), formal housing for government officials and commercial development should be considered for connection to a piped sewerage network.
- The implementation of the project must factor in an incremental development with the first phase focusing on improving what is existing (immediate), followed by implementing a new modern system, together with developing the required institutional and revenue capacity to operate and maintain the system.
- It is assumed that the Medium Scenario population projection is the most likely scenario, and it is on this that the design figures for the water supply and sanitation system have been designed. The actual population growth should be monitored to allow sufficient planning time to upgrade the system in a phased approach.
- Noting that migration patterns will bring in a mixture of low income families and middle-to-high income families, the water system must be designed to cater for different income groups (options for incremental levels of service, shared/communal facilities, etc.). The system must be designed to ensure accessibility and affordability by poor people who are likely to remain a majority of the population of Kazungula.

Technical Assessment

This section of the report details the current context of the water and sanitation system, and the potential improvements that could be made. It begins with a review of the water resources available for the water supply system, and also considerations of flood risk in the area.

Hydrological and Water Resources Review

The Kazungula Catchment area

The Zambezi River basin is divided into three major sections (the division of Zambezi used in this report is based on the delineation and nomenclature used by GRDC (2007)[8] and HYDRO1k (2001)[9]), namely:

- Upper Zambezi, a sub-catchment that stretches from its headwaters in Northern Zambia and the highlands of Angola to the Victoria Falls. A flow gauging station (ZPG25) measures flow at Victoria Falls. Kazungula town is located just upstream of the Victoria Falls, and the catchment area that contributes flow at Kazungula is given in **Figure 6**. The Upper Zambezi is made up of the Kabompo, Lungue Bungo, Luanginga, Cuando and Barotse major sub-basins;
- Middle Zambezi which covers the area from the Falls to the Cahora Bassa Dam in Mozambique, and
- Lower Zambezi downstream of the Cahora Bassa gorge in Mozambique to the outlet of the river in the Indian Ocean.

The aim of this segment of the study is to provide a comprehensive description of the existing water resources of Kazungula Town, assessing their adequacy for the water supply needs of the town. It is undisputed that the primary source of water for Kazungula is the Zambezi River and that any other (possible) sources would be supplementary. This conclusion derives from the magnitudes of flow of the Zambezi that passes Kazungula and would therefore (notwithstanding international protocols and national legislation) be available for abstraction to meet local domestic and industrial uses.

The catchment map, in **Figure 6**, shows an outline of the Upper Zambezi catchment area that contributes the flow at Kazungula Town and is a source of water (located close to the outlet of the basin). The red triangles indicate locations of flow measurement. ZPG25 is a few kilometres downstream of Kazungula at Victoria Falls on the Zambezi River.

[8] *Global Runoff Data Centre (2007): Major River Basins of the World / Global Runoff Data Centre. Koblenz, Germany: Federal Institute of Hydrology (BfG)*
[9] *US Geological Survey, USGS (2001) HYDRO1k Elevation Derivative Database, http://eros.usgs.gov.*

Figure 6: Outline of Upper Zambezi Catchment and Google Earth Imagery of Kazungula Town

The town of Kazungula is located in 'Zambezi 9' sub-catchment of the Upper Zambezi and is at the confluence of the Zambezi and the Chobe (Cuando sub-catchment) rivers. The abstraction works at Kazungula are thus located just past the confluence. Although the majority of the flow past Kazungula would be from the larger Zambezi River, which originates and flows through a wetter area than the Chobe, it is still necessary to assess the contribution of each of these rivers at Kazungula.

Estimating the water resources of Kazungula

The complexity of current approaches to water resource management poses many challenges. Water managers need to solve a range of interrelated water dilemmas, such as balancing water quantity and quality, flooding, drought, maintaining biodiversity and ecological functions and the supply of water services to people. It is a sad fact in southern Africa as a whole that water availability is highly variable both spatially and temporally with low runoff coefficients of less than 9% conversion of mean annual precipitation (MAP) to mean annual runoff (MAR) known to be prevalent across large parts of the region (FAO, 2003)[10] including the Upper Zambezi. With predictions of water scarcity conditions, caused by rapid population growth, expanding urbanization, increased economic development and climate change (Rosegrant and Perez, 1997)[11], water could become a limiting resource in the sub-catchment.

Thus, the reliable quantification of hydrological variables such as rainfall and streamflow is a prerequisite for mutually beneficial, cooperative and sustainable water resource management, planning and development. Reliable quantification demands and implicitly highlights the importance of historical observed data of hydrological variables (especially streamflow) in water resource assessments and studies. Data are also required when assessments are needed beyond the gauged circumstances, e.g. flood predictions, hydrological impacts of anticipated future land use or climate change. There are a number of runoff stations in the Upper Zambezi (see **Figure 6**) where historical observations of flow are available and can therefore be

[10] Food And Agriculture Organization Of The United Nations (FAO), Review of World Water Resources by Country, 2003.
[11] Rosegrant, M.W., Perez, N.D. (1997). Water resources development in Africa: A review and synthesis of issues, potentials, and strategies for the future, International Food Policy Research Institute.

used to estimate the water resources available at Kazungula. However, the quality and quantity of these observations in the Upper Zambezi are less than optimal and are thus barely adequate. The other problem with the observations is that the gauging stations have different lengths and periods of observations, making it difficult to find a common period long enough for assessments. To alleviate the problem of data paucity and to supplement the available information, hydrological simulation models have become standard tools for the generation of data and have been used extensively in the SADC region, and as a result, water resource decision making has been heavily dependent on their results.

For this exercise, a revised semi-distributed version of the Pitman model (Pitman, 1973)[12] that incorporates surface and groundwater interactions (Hughes et al., 2006)[13] was used. The choice of a coarse-scale Pitman model is premised on the understanding that in water resources studies where storage-yield determinations and medium to long-term resource estimation and planning based on monthly data are the primary target, a monthly input model is quite adequate. The Pitman model includes explicit routines to simulate interception, infiltration excess surface runoff, soil moisture (or unsaturated zone) runoff, groundwater recharge and drainage to stream flow, evaporative losses from the unsaturated zone as well as the groundwater storage (in the vicinity of the river channel).

The Pitman model is driven by monthly rainfall time series and evaporation demand.

Available Rainfall data

The availability of observed rainfall data for the Upper Zambezi sub-catchment (indeed for the whole Zambezi catchment) is inadequate, and it was necessary to use global data sources that have a more extensive coverage. One of these sources is the Climatic Research Unit (CRU) database (CRU TS 2.0) developed at the University of East Anglia (Mitchell and Jones, 2005)[14]. The data-set comprises 1200 monthly grids of observed climate, for the period 1901-2000, and covering the global land surface at 0.5 degree resolution. This CRU data set is a compilation of local data which are homogenised through an iterative procedure. Figures below compare the CRU and available (and accessible) data for the Upper Zambezi sub-catchment. Comprehensive monthly comparative analysis (maximum, minimum, mean and standard deviation) of the CRU data against observed data for the whole Zambezi catchment was performed by Tirivarombo (2012)[15] and the conclusion was that the CRU data set was comparable to local observations (with R^2>0.7). Therefore the CRU data was used to drive the Pitman model in this exercise. The estimates of potential evapotranspiration demand were obtained from the International Water Management Institute (IWMI) database[16].

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[12] Pitman, V., (1973). A mathematical model for generating monthly river flows from meteorological data in South Africa. Report No. 2/73, Hydrological Research Unit, Univ. of the Witwatersrand, 1973.
[13] Hughes, D. A., Andersson, L., Wilk, J. & Savenije, H. H. G. (2006) Regional calibration of the Pitman model for the Okavango River. *J. Hydrol*. **331**, 30–42.
[14] Mitchell, T.D. and Jones, P.D. (2005). An improved method of constructing a database of monthly climate observations and associated high-resolution grids. Int. J. Climatol. 25: 693 – 712.
[15] Tirivarombo, S. (2012). Climate variability and climate change in water resources management of the Zambezi River basin, Rhodes University Doctorate Thesis.
[16] www.lk.iwmi.org/WAtlas/AtlasQuery.

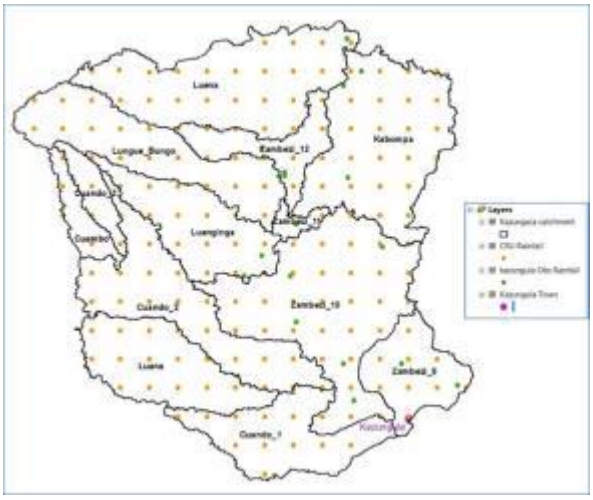


Figure 7: Available data vs CRU rainfall for the Upper Zambezi (Kazungula) catchment

Figure 7 provides an illustrative example of the available observed rainfall data (limited) versus the 0.5 degree resolution of the CRU database.

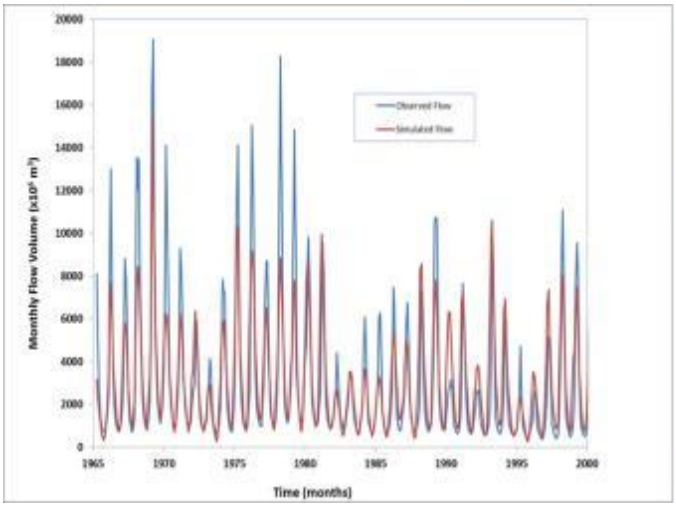
Modelling Kazungula Flows

The Pitman model was setup for the Upper Zambezi using CRU rainfall for the period 1901 to 2000 with minimal calibrations being carried out at some of the available gauging stations for relevant periods. The two lower most gauges on the Chobe (1291200) and Zambezi (1291100) are used to estimate the contributions of these sub-systems to water flow at Kazungula. The flow generated in 'Zambezi 9', the sub-catchment in which Kazungula is located, was also estimated for purposes of determining source of water and design and development of relevant plans for protection of these sources if possible.

Results of Modelling

Figure 8 and **Figure 9** show the modelling results at 1291100 (Zambezi river) and 1291200 (Chobe river) respectively. **Figure 8** is a time series comparison of the observed and simulated flows at the gauging station, while **Figure 9** shows a flow duration curve of flow simulation results at the station near the outlet of Chobe River. These two stations could be used to provide information on how much water flows into 'Zambezi 9' from their respective subsystems.

In **Figure 9** the two curves shows the simulated (blue graph) and observed (black graph) flows.



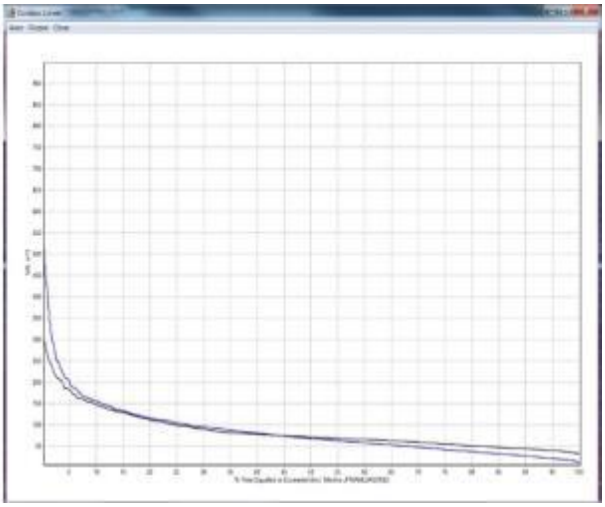


Figure 8: Observed and simulated monthly stream flows for Zambezi 10 (Gauging station 1291100)

Figure 9: Flow duration curves (Gauging station 1291200) Cuando sub-system - Chobe River

The figures above present the statistical analysis of the flows at these two stations. These statistics are a reflection of the performance of the model in the sub-catchment. The table shows the results for the three most important components of flow – the high flows, the medium and low flows and total water balance. The first is measured by the coefficients of determination (R^2) and the Nash-Sutcliffe coefficient of determination (CE), the second is measured by the same indices but with the flows values transformed by taking their natural logarithms. The last component is measured by the percentage difference between the means of the observed and simulated flows, is taken for both normal and natural log-transformed values and is a measure of bias.

Table 5: Modelling results at/near the outlets of the sub-catchments contributing to flow at Kazungula

Sub-basin (flow station)	High Flows		Low Flows		Total water balance (%bias)	
	R2	CE	R2 (ln)	CE (ln)	Normal values	Ln values
Cuando 1	0.516	0.510	0.662	0.611	4.9	11.8
Zambezi 10 (1291100)	0.763	0.761	0.838	0.828	-1.1	2.4
Zambezi 9	No Obs	No Obs	No Obs	No Obs	No Obs	No Obs

Note, 'No Obs' - indicates that there are no observed data to compare with in Zambezi 9.

The mean monthly flow delivered at Kazungula from upstream sub-catchments is 85 x10^6 m^3 (MAR = 1 020 x10^6 m^3) and 3 030 x10^6 m^3 (MAR = 33 360 x10^6 m^3) from Chobe and Zambezi respectively (**Table 6**). The local incremental flow generated by the Kazungula sub-catchment (i.e. Zambezi 9 only) is about 116 x10^6 m^3 (MAR = 1 392 x10^6 m^3) per month. Thus the total flow at Kazungula which is available for abstraction is a mean monthly flow of 3 231 x10^6 m^3 (MAR = 38 772 x10^6 m^3). The Zambezi 9 does not generate a lot of flow in spite of its size. While the Zambezi and many of its main tributaries are perennial

rivers that portray seasonal cycles in high and low flows (Mazvimavi and Wolski, 2006)[17], Bäumle et al. (2007)[18] contend that most of the rivers in this area (like the rest of the Southern Province) are non-perennial. It is prudent to note that while these figures could be used for planning purposes, they are however slightly high. This is because the estimation of water use in the basin was not known and therefore only very low default values were used. Therefore, the water resources available would be less than the ones given here. It is impossible to give an estimate of a factor of reduction at the time of writing. It should also be emphasised that the amount of water available for abstraction could be affected by international obligations (riparian law) and the need for environmental protection of downstream ecosystem and ecosystem services (Phiri, 1999)[19].

Table 6 also shows the minimum, maximum and expected flow level equalled or exceeded 50% and 90% of the time. These figures are a measure of the flow regime of the system that supplies water at Kazungula. The figures are comparable those given in Bäumle et al. (2007).

Table 6: Analysis of flow in the Upper Zambezi, the catchment area of Kazungula

Sub-basin (Flow Station)	Monthly Min Flow (x10^6 m^3)	Monthly Mean Flow (x10^6 m^3)	Monthly Max Flow (x10^6 m^3)	Equalled or exceeded 50% of the time	Equalled or exceeded 90% of the time
Chobe (1291200)	28	85	160	70	27
Zambezi_10 (1291100)	800	3030	6500	2396	785
Zambezi_9 (Kazungula)	1000	3231	6600	2500	1000

Adequacy of the Zambezi as a Water source

Accurate information is required to assess the adequacy of the Zambezi system as a water source for Kazungula both in the current time and for the future. Unfortunately, Zambia's "current water resources use cannot be accurately determined since comprehensive water use data is generally not adequate due to poor data records kept by different users as well as the inadequate regulatory capacity to monitor the various water uses. The last comprehensive water use survey was carried out by the Water Resources Master Plan Study 1993 – 1996 which requires updating (Bäumle et al., 2007).

The estimate of the projected Kazungula abstraction is 2.5 Ml/day (0.9 x10^6 m^3 per annum) to meet 2030 demand requirements. Based on the derived water availability figure (38 772 x10^6 m^3 per annum) this means

[17] Mazvimavi, D. and Wolski, P. (2006). Long-term variations of annual flows of the Okavango and Zambezi Rivers. Physics and Chemistry of the Earth Journal, Vol. 31, 944-951
[18] Bäumle, R., Nkhoma, J., Silembo, O. (2007): Hydrogeological Map of Zambia, Southern Province, Department of Water Affairs, Zambia & Federal Institute for Natural Resources; 1st ed.; Hannover - Lusaka.
[19] Phiri, Z. (1999). Water Law, Water Rights and Water Supply (Africa) – Zambia, DFID.

that **the Upper Zambezi system is capable of supplying the requisite water requirements of Kazungula,** even when considering environmental requirements, international obligations and uncertainty of analysis.

Estimating impacts of extended droughts

Chibuye (2008)[20] outlines the various droughts that have occurred in the Zambezi in the past. These have occurred in 1946-47, 1965-1966, 1972-1973, 1981-1983, 1986-1987, 1991-1992, 1994-1995, 2001-2002, 2004-2005 and 2008. Through the use of the Standardised Precipitation Index (SPI) over 6 monthly periods for the whole Zambezi catchment, Tirivarombo (2012)[21] noted the drought periods for the Upper Zambezi sub-system (**Table 7**).

Table 7: Severe and extreme SPI6 droughts in the Kazungula catchment area (1901 – 2002)

Sub-basin	Year starting from October		Total
	Severe drought	Extreme drought	
Kabompo	1921, 1930, 1932	1972, 1981, 1994	6
Upper Zambezi	1918, 1942, 1976, 1995	1914, 1945	6
Luanginga	1948, 1972, 1982, 1985, 1995	1904, 1981, 1984,1994	9
Barotse	1902, 1915, 1923, 1930,1964	1972,1981, 1994	8

These periods coincide with the periods of lower flows in the system. The lowest simulated high flows in Zambezi 9 (Kazungula basin) are 3 000 $x10^6$ m^3 (in 1972-1974), 2 900 $x10^6$ m^3 (1981-1983) and 2 550 $x10^6$ m^3 (in 1995-1996). This analysis should form the basis of assessing the resilience of the Upper Zambezi sub-catchment for the supply of water to the Kazungula.

Taking the lowest maximum flow over the 100 year period of simulation, it can be stated whether the Kazungula water supply is under threat from extended drought periods that would occur in the area. This is premised on the same climatic conditions being maintained in the catchment. However, should climate change (as is expected) additional analyses based on projected and expected climate changes in the catchment would need to be undertaken to identify impacts of such changes on the water resources of the catchment and the elasticity of the water resources under changing climatic conditions.

Flood Risk Assessment

Over the last 2 decades, the Zambezi River Basin has experienced extreme floods (1999-2000; 2005-2006 and 2007-2008). While flooding in some areas, such as the Barotse Plains is a regular event providing vital water for irrigation and replenishing soil fertility, the frequency, timing, intensity and duration of the floods are changing in the Basin. Thus human occupancy of flood plains as is the case in Kazungula is a risk. The

[20] Chibuye, H. (2008). Zambezi River basin – Key features and challenges from climate change. Transboundary Water Cooperation –Climate Change Workshop.
[21] Tirivarombo, S. (2012). Climate variability and climate change in water resources management of the Zambezi River basin, Rhodes University Doctorate Thesis.

stakes are high – the population wins only if the losses from floods (loss of life and assets) are less than the benefits (cheaper land and fertile soils) gained from settling in the floodplain. Because of the increased frequency and magnitude of the floods in that part of the Zambezi River Basin, which is immediately downstream of the high rainfall Upper Zambezi sub-catchment, the odds over the long run are against winning. It is therefore important that a flood risk assessment of the floodplain in Kazungula be carried out as part of the detailed design. Information is needed on the current settlement patterns, modelled flood levels and topographic levels within the flood plain as well as those of the Kazala 'Island' (a site of higher ground on the flood plain), the site of the proposed Wastewater Treatment Plant. The flood risk assessment should also consider flooding from other sources, including storm water drainage in order to minimize the negative environmental and socio-economic impacts of flooding on the Kazungula communities and those living downstream.

Exploring alternative sources of water – groundwater potential

Bäumle et al. (2007)[22] state that most of the rural areas in Zambia are dependent on groundwater as a source of water. It was therefore necessary to assess the potential of groundwater as a possible alternative source of water for Kazungula both from a quantity and quality perspective. However, a reliable quantification of the groundwater resources of Kazungula was not possible due to the limitations of available data regarding in particular climate (e.g. evapotranspiration), groundwater recharge, groundwater flow dynamics and aquifer geometry (e.g. layering, vertical and lateral extensions). This section had to rely therefore on available qualitative description and typical range of borehole yields and hydraulic characteristics of the identified aquifer system from literature review and personal communication rather than hard evidence.

The geology of the Kazungula District is dominated by the Kalahari Group which consists predominantly of unconsolidated and semi- consolidated clastic deposits of gravel, sand, silt and clay. Due to this heterogeneity in the aquifer system it is difficult to quantify the local groundwater potential. Although the Upper Zambezi catchment is underlain by major groundwater basins of local shallow aquifers where recharge rates are quite high (Figure below), Kazungula is at the edge of a major groundwater basin and lies in an area of local and shallow aquifers of limited groundwater potential. It is likely that the aquifer in Kazungula is composed predominantly of clays that are less transmissive. The low regional groundwater gradients also limit the flow of groundwater towards Kazungula (**Figure 10** and **Figure 11**). This would imply that the potential to successfully use groundwater on a large scale to the extent that it would be regarded as an alternative to the Zambezi surface flow is very low.

The overall groundwater quality in Kazungula with respect to the chemistry is generally good. However, there is a threat of groundwater contamination due to poor sanitation in the town where access to improved sanitation is generally poor with on-site sanitation in the form of traditional pit latrines being the commonest means of excreta disposal. Groundwater vulnerability to this source of pollution is exacerbated by the geology of the area and the shallow water table.

[22] Bäumle, R., Nkhoma, J., Silembo, O. (2007): Hydrogeological Map of Zambia, Southern Province, Department of Water Affairs, Zambia & Federal Institute for Natural Resources; 1st ed.; Hannover - Lusaka

Therefore the conclusion reached is that the potential of groundwater in Kazungula District is limited and should not be considered as an alternative sustainable source for the bulk supply of water for Kazungula.

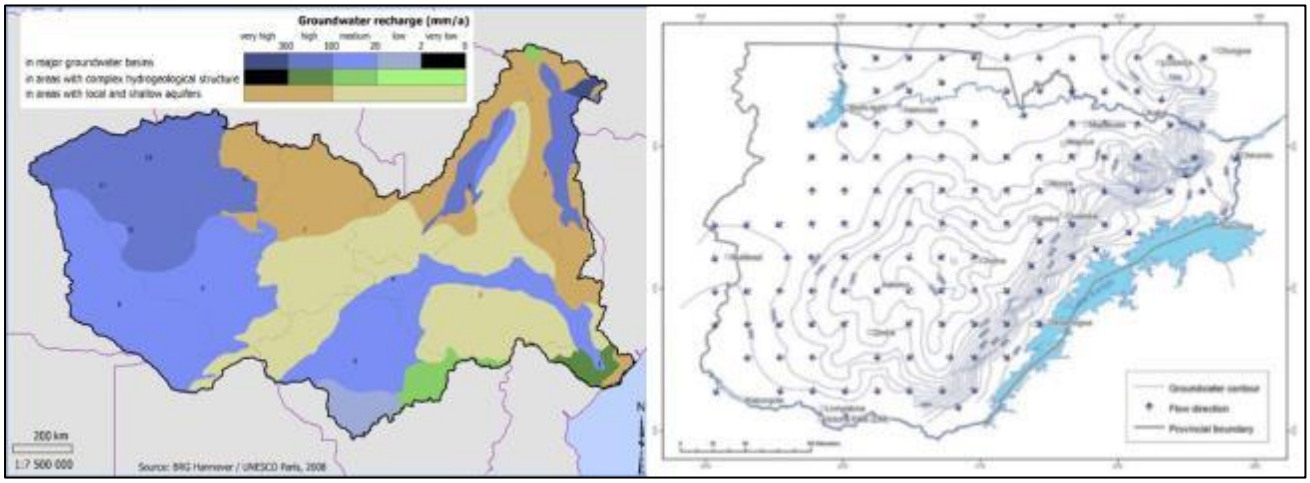


Figure 10: Estimates of recharge rates in different aquifers in the Zambezi basin

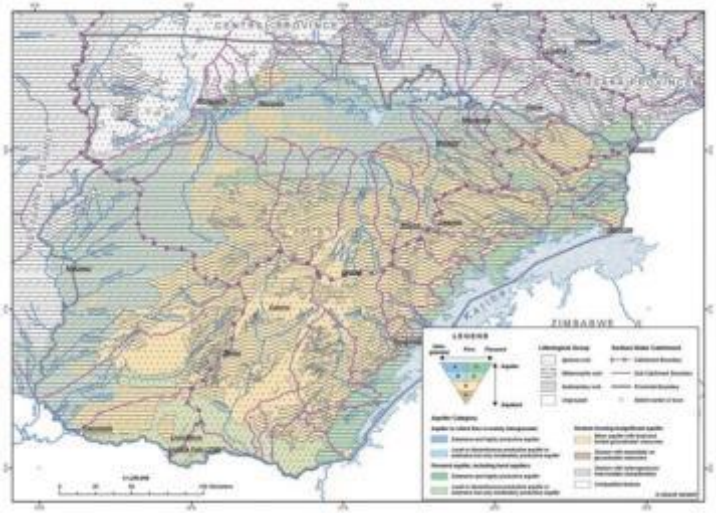


Figure 11: Lithology and potential of groundwater systems in the Southern Province

Water Resources Conclusions

The Zambezi River is an adequate supply for Kazungula and will continue to be so for the foreseeable future. Based on the hydrological analysis and water resources estimations in this report there is no logical reason for Kazungula to find and alternative source of water. Surface water should be used preferentially to groundwater since the groundwater potential is very low.

Existing Infrastructure

Water Supply Infrastructure

The existing water supply system in Kazungula is a straightforward, conventional design suitable for a small urban community. The system comprises of the following basic components:

i. A floating intake on the Zambezi River and raw water pumping main.
ii. A Water Treatment Plant / Works (WTW)
iii. A ground level storage reservoir with a chlorination system.
iv. A gravity fed distribution system supplying over 90% of the treated water to Kazungula Town.
v. A high level distribution zone supplied from an Over Head Tank (OHT) with booster pumps at the Water Treatment Plant / Works (WTW), supplying a small high level area.

The existing water supply system has inadequate capacity to meet current and future demands and will require upgrade and expansion to meet current and 2030 demands. The suppressed demand is significant with frequent shortages and high customer dissatisfaction.

A detailed description of the water supply system and WTW is contained in **Annex 2**. The description contains photographs of the various components and therefore the photos are not repeated in the report.

The water supply service indicators as provided by SWSC at the Livingstone kick-off meeting on the 7 May 2014 are given in **Table 8** (note that some of these indicators may not be current).

Table 8: Current water supply service levels and SWSC targets for Kazungula

Indicator	Current	Target	Remarks
Hours of Service	0 to 15 hours/day	24/7	The majority of poor communities receive less than 4 hours/day.
Coverage	100%*	100%	*Most persons have access to piped water but poor communities have to walk long distance to gain access. Given the low numbers of standpipes, large numbers of users utilise the water points, meaning long queues. Significant areas of the town lack pipe networks. Therefore coverage based on government and international definition is likely to be below 100%.
Distance to access	0 to 2km	100m	The number of legal standpipes is low.

Indicator	Current	Target	Remarks
Service Level: Standpipe Yard House	 32% 60% 8%	 - - 90+%	Data on proportions of users per service level was difficult to obtain.
NRW	55%	30%	Bulk metering needs to be improved to increase accuracy of results.
Metering	69%	100%	SWSC is implementing a Government funded program to increase the number of meters.
Water Quality	Current water treatment facility bypassed, with no filtration and only basic chlorination. Not regularly tested	National Standards	Target is Full 4-Stage Treatment.
Min Pressure	Zero	10m	Target achievable following implementation of Phase 1 interventions.
Water Distribution	Approximately 10km of distribution pipes, focussed mainly in the South and East of the town	100% coverage	Implementation of all phases will provide service coverage across the town, and enable house connections to all residents who want it. 50+km of pipes to be laid. Phased service provision will follow defined demand zones.

Bulk Pipe Network and Distribution

The SWSC reports that the Kazungula water reticulation network is fairly new, with uPVC and PE the predominant materials, although there is also a small number of GI pipes. The water distribution network is reportedly in good working condition. Although Non-Revenue Water (NRW) is pegged at 40-50%, the main reason for the NRW is the current coverage of water meters on connections (only 70% connections).

There was very little recorded information showing the existing SWSC infrastructure in Kazungula and record drawings were prepared by the study team. It was not possible to confirm the exact pipe details, but an

approximation of the pipe network was developed for the Feasibility Study by CRIDF and SWSC. During the course of any construction work, the exact position and pipe details should be captured on a GIS system to provide 'as-built' data to the system operators and planners.

The approximate distribution system is provided on drawing SWSC/KWS/KDC001/R 'Existing Water Supply System', attached in **Annex 4**.

Sewerage Infrastructure

There is no existing public sewerage system. There are some on-site sanitation solutions, pit latrines (of varying levels of improvement), a small number of septic tanks, but many practice open defecation.

There is a Communal Ablution Block (CAB) at the Market.

Kazungula School has a sewerage system for the school attendees, which has a pond treatment system.

Some photos are included in **Annex 2**.

Town Planning

There was a scarcity of drawing information showing how KDC envisaged Kazungula town would grow and develop. This information was essential to the CRIDF team in order to design the future water and sanitation systems. In conjunction with KDC Officers and the KDC Strategic Planners, a drawing of the Kazungula 'Town Plan' was prepared showing the various development zones and land use planning. The Town Plan is provided on drawing SWSC/KFS/KDC0013 'Kazungula KDC Land Use Zones', attached in **Annex 4.**

Although more detailed planning will be required to implement the Kazungula 'Town Plan', the drawing provides a high level concept that future planning can be based on. It is important that the 'Town Plan' is enforced to ensure the efficient development of infrastructure.

Option Analysis

Water Supply

The water supply interventions in Kazungula will be phased over time and incorporate anticipated changes in socio-economic trends in the town. Priority interventions within the immediate measures will focus on increasing the water supply production and distribution to the poor, maximising where possible the existing assets.

Options Analysis for Water Supply

The design, development and selection of the preferred water supply system design has been an iterative process considering the important parameters in an integrated way. The highest priority objective throughout has been to ‘provide the public with improved, affordable and sustainable water services’. Different water supply options and levels of service can be introduced at different phases.

The criteria/standards/principles of the primary stakeholders have also been considered and have been factored into and assessed through a qualitative analysis shown in the tables below.

The analysis of the options divided the infrastructure into basic components and then assessed Options for each component against the following parameters:

i. Capital Cost
ii. Operational Cost
iii. Appropriate Technology
iv. Level of Service provided
v. Sustainability
vi. Institutional Suitability
vii. Affordability
viii. Social & Health issues
ix. Access for the Poor
x. Environmental & Climate Resilience
xi. Economic Development potential
xii. Trans boundary matters

Table 9: Water Supply Option Analysis for Kazungula

Criteria Ranking: 1 Poor - 5 Excellent

	DESIGN OPTION	Cap Cost	Ops Cost	Appropriate Technology	Level of Service	Sustainability	Institutional Suitability	Affordability	Social & Health	Access for the Poor	Environmental & CR	Econ Dev	Transboundary	SCORE	REMARKS
WATER SOURCE – Use raw water abstracted from the Zambezi River															
1	Surface Water [Zambezi River]	4	3	5	5	5	4	4	5	5	4	5	4	53	Highly preferred
2	Ground Water	2	3	2	2	2	2	2	2	5	4	2	2	30	Not preferred, unproven yield, possible quality issue.
WATER INTAKE – Use a floating intake															
3	Fixed bankside	2	3	1	3	3	4	4	3	4	4	3	5	39	Not preferred
4	Floating intake	4	3	5	5	5	5	4	5	5	5	5	5	56	Highly preferred, Climate Resilient
WATER TREATMENT PROCESS – Use a new conventional Water Treatment Plant (WTW), however rehabilitate the existing WTW in the Immediate Measures, but plan to re-locate and construct a new WTW with appropriate 4-stage design in future project phases.															
5	Expand Existing WTW	3	3	2	3	3	4	3	4	4	4	3	4	40	Complexity of pressure

	DESIGN OPTION	Cap Cost	Ops Cost	Appropriate Technology	Level of Service	Sustainability	Institutional Suitability	Affordability	Social & Health	Access for the Poor	Environmental & CR	Econ Dev	Transboundary	SCORE	REMARKS
															filters, not appropriate tech. Elevation is too low.
6	New Conventional WTW	2	4	5	5	4	5	3	5	4	4	5	4	50	Meets all criteria.
7	New Package Plant	4	2	2	4	3	2	4	3	3	4	3	4	38	Not Appropriate tech.
8	Basic 'safe' WTW (SSF + CL_2)	5	5	4	3	3	5	5	4	5	5	2	4	50	Produces 'safe' water. WTW can be upgraded.
GROUND LEVEL STORAGE - Use 24 h Steel Reservoir															
9	12, 18 and 24 Hour storage								.						24 h minimum storage especially considering reliability of electricity supply. Capital cost could be an affordability issue.
10	Steel or Reinforced Concrete														Construction material to be selected primarily on capital cost. The high capital cost for the supporting

	DESIGN OPTION	Cap Cost	Ops Cost	Appropriate Technology	Level of Service	Sustainability	Institutional Suitability	Affordability	Social & Health	Access for the Poor	Environmental & CR	Econ Dev	Transboundary	SCORE	REMARKS
															infrastructure of Reinforced Concrete makes this option undesirable to stakeholders
OVERHEAD TANK [OHT] - Continue to use existing OHT at WTW and Market in Immediate Measures, relocate WTW and storage to higher elevation site in future phase.															
12	Relocate existing OHT														Lowest capital cost option.
13	Pumped supply														Low cost alternative to OHT but operationally complex
14	New High Level Storage with 2, 4, 8 and 12 hour options														Most desired but highest capital cost option.
15	Relocate WTW and ground storage tank to higher elevation														Need to consider this option based on the pressure supply in each of the zones – from an operational cost perspective not ideal to pump total water volume to

	DESIGN OPTION	Cap Cost	Ops Cost	Appropriate Technology	Level of Service	Sustainability	Institutional Suitability	Affordability	Social & Health	Access for the Poor	Environmental & CR	Econ Dev	Transboundary	SCORE	REMARKS
															new high level WTW.
DISTRIBUTION NETWORK - Use ring main gravity flow															
16	Branch Main, Gravity Flow	3	2	3	4	4	3	3	5	4	4	4	4	43	
17	Ring Main, Mechanised	2	2	2	5	2	3	2	2	2	4	3	3	32	
18	Ring Main, Gravity Flow (A) - New infrastructure utilising demand and pressure zoning	3	4	5	5	5	5	3	5	5	4	5	4	53	Preferred. Supports distribution management and sustainability.
19	Ring Main, Gravity Flow (B) - using existing infrastructure	5	3	3	3	3	4	5	3	3	4	3	3	42	

The preferred option for each component was then summarised in **Table 10**, which constitutes a 'Preferred Design'.

Table 10: Preferred design option for the water supply system

	Component	Preferred Qualitative Solution/Design	Remarks
1.	Water Source	Option 1. The Zambezi River	This is the existing source, which is prolific, high quality and satisfactory.
2.	Water Intake + Raw Pipeline	Option 4. Climate Resilient Floating Intake	This is the existing method of abstraction and is satisfactory. Relocation to be funded by the Bridge Project
3	Water Treatment Plant	Option 6. A new water treatment plant of conventional design [similar to Livingstone].	To be located on a new site at the highest elevation in Kazungula. Land to be secured from KDC.
4.	Ground Level Storage	Option 9. 24 hour capacity including existing reservoir.	Capacity to be increased on a phased approach, with the ultimate objective to provide 24 hour capacity. Affordability versus reliability of supply to be considered before upgrading storage capacity.
5.	High Level Storage	Option 15. Relocate WTW and ground storage to higher elevation	Continue to use existing OHT at WTW and Market in Immediate Measures, relocate WTW and storage to higher elevation site in future phase. Need to consider this option based on the pressure supply in each of the zones – from an operational cost perspective not ideal to pump total water volume to new high level WTW.
6.	Distribution System	Option 18. Ring Main, Gravity Flow (A) – New Infrastructure utilising demand and pressure zones	Provides best performance of all Options. All design criteria is achieved especially levels of service and sustainability. Distribution network zones to be constructed to match the town development and growth. The distribution system development to match revenue growth with priority delivery to the zones occupied by the poor.

The preferred design will be implemented in a phased approach to suit the actual rate of growth of Kazungula up to 2030. The proposed phased approach will be discussed in the 'Implementation Plan' section.

The water supply system design will be based on the Livingstone system, which is appropriate technology because SWSC is already familiar with the technology and operation / maintenance. Some of the reasons for basing the Kazungula design on Livingstone include:

- Both towns use the same raw water source, the Zambezi River.
- Livingstone is 70km from Kazungula and falls into the same operating division of SWSC as Kazungula.
- Given SWSC's current institutional stage of development it is also considered important to have consistent, appropriate and familiar technology within the utility.

The most significant technical/commercial departure from the Livingstone water system is the design of the future Kazungula Distribution system. The design has been configured to enable modern distribution management practices to be utilised including the use of Distribution Network Improvement (DNI) zones to achieve 'water balances' and income correlation, leading to efficient water management – assisting with the primary goal of 'sustainability'.

The proposed design is climate resilient due to the preferred floating intake design and the emphasis on minimising non-revenue water.

The early phases of the water system places high emphasis on providing services to the poor communities, the under-served communities and the border crossing related infrastructure. The areas in close proximity to the new border post and bridge will provide commercial opportunities, which is a revenue source for SWSC. The construction of water supply kiosks and ablution blocks provide access to safe water and sanitation for the poor. The ablution blocks will include solar lighting to provide safe facilities at night.

The operation and maintenance of the proposed system will be low cost and consistent with the infrastructure/processes in Livingstone, utilising 'appropriate' technology. The design philosophy of 'Low Mechanical Content' (LMC) should be incorporated throughout the designs for both the water supply and sewerage projects.

Most of the expertise support required to operate, e.g. laboratory services, will be provided by existing personnel in Livingstone with only a small number of SWSC operatives based in Kazungula.

Sanitation Infrastructure

Currently most of the institutions have on-site latrines or septic tanks, e.g. there is a basic toilet block at the border post. Facilities are inadequate in the market and to cater for the long queues that back up from the border post. This also results in open defecation, posing considerable health and safety risks to the population.

Most of the Kazungula population uses pit latrines, some ventilated, but many unimproved. Some households do not have any facilities, and practice open defecation.

In terms of public health, a priority for Kazungula is to prevent open defecation. A major sanitation issue in Kazungula arises during heavy rains, when surface water flows into the low-lying areas, and floods the pit latrines.

The design, development and selection of the preferred sanitation system design was undertaken in a similar manner to the water supply system, i.e. using an iterative process considering the important parameters in an integrated way. As with water supply, the sanitation interventions in Kazungula will be phased over time, and incorporate anticipated changes in socio-economic, especially demographic, trends in the town.

The same options analysis used for selection of the water supply was used for the sanitation.

Options Analysis for Sanitation

The highest priority objective throughout has been to 'provide the public with improved, affordable and sustainable sanitation services'. Different sanitation options can be introduced at different phases. **Table 11** provides the results of the options analysis, while **Table 12** discusses the affordability, acceptability, appropriateness and accessibility of different sanitation technology options.

Table 11: Sanitation Option Analysis for Kazungula

SANITATION DESIGN OPTION		Cap Cost	Ops Cost	Appropriate Technology	Level of Service	Sustainability	Institutional Suitability	Affordability	Social & Health	Access for the Poor	Environmental and CR	Econ Dev	Trans-boundary	SCORE	REMARKS
1.	Conventional Gravity Sewer	2	4	4	5	4	4	3	4	5	4	4	5	48	Preferred solution for institutions, but high capital cost. Can use phased implementation with different service level scenarios.
2.	Grinder Pump pressure sewer	3	3	1	3	2	2	2	3	1	3	3	3	29	Non Preferred. Inappropriate technology, high customer cost and maintenance.
3.	Septic tank Effluent Gravity (STEG)	4	2	3	3	3	2	3	3	4	2	2	3	34	Non Preferred. Operationally complex.
4.	Vacuum sewer	2	2	2	3	3	2	3	4	3	3	2	3	32	Non Preferred. Inappropriate technology.
5.	Simplified/small bore gravity sewer	3	3	4	4	4	4	4	3	4	3	3	4	43	Preferred solution for domestic discharge, low capital cost. Phased implementation with different service level scenarios.

SANITATION DESIGN OPTION		Cap Cost	Ops Cost	Appropriate Technology	Level of Service	Sustainability	Institutional Suitability	Affordability	Social & Health	Access for the Poor	Environmental and CR	Econ Dev	Trans-boundary	SCORE	REMARKS
6.	Improved Pit latrines & Septic Tanks	5	5	4	2	4	3	4	3	5	3	2	2	42	Preferred solution for households including women in the interim before a well-established sewerage network, and for households that cannot afford sewerage. Familiar technology to households, although requires them to upgrade their domestic facilities to a hygienic level. Capital and O&M costs borne by the households.
7.	Public Toilet Facilities Owned by SWSC / Council, leased to private operator	4	3	4	3	3	4	3	4	4	4	3	4	43	Preferred solution for public areas and cater for demand from low-income / high density areas that do not have domestic facilities. Solar lighting make facilities safe to use at night especially for women and children.

Table 12: Details (Affordability, Acceptability, Appropriateness, Accessibility) of Options

Options	Affordability	Acceptability	Appropriateness	Accessibility to poor households
Reticulated Sewerage System for non-domestic customers and higher-income areas	The system will be affordable for non-domestic users such as government, commercial entities, tourism establishments and industries.	Most non-domestic users prefer a government/utility run sewerage system as it reduces capital and operation and maintenance costs (shared)	The reticulated system is acceptable for non-domestic users and high-income households.	Poor households are being safe-guarded from high costs by not extending this service to the poor sections of the community.
Solids-free sewerage system for low-to-middle income households	The system is the least costly option relevant for a new/developing town. Unlike the full reticulation system, the capital redemption costs (connection fees) will be lower. The costs of desludging septic tanks will be minimal given the expected intervals between sludge disposals.	This has not been tested; however some households in the formal/planned sections of Kazungula already use septic tanks. The introduction of a solids-free system, elevates the level of service in terms of creating a mechanism of disposing liquids safely (instead of disposing underground)	It has not been established if a similar system exists in Zambia. The main areas of concern in regards to appropriateness is users' responsibility to empty and dispose solids.	Poor households will be able to choose between a ventilated pit-latrine and a solids-free piped system.
Communal Ablution Blocks	The communal blocks are cheaper to maintain than individual connections. The operation and maintenance system can also be sub-contracted to a local private provider to	Ablution blocks are currently only used at the border gate, free to all. A few areas should be identified for installation – the market places, close to institutions and low-income areas. Communal ablution	Already used as part of institutional sanitation. Cultural acceptability is not an issue, however broad social acceptability for domestic multi-household use has not been assessed	Whereas these may suit poor households in dense settlements, the costs of running the blocks may dissuade poor households from using them. What

Options	Affordability	Acceptability	Appropriateness	Accessibility to poor households
	avoid system failure.	facilities within residential areas are not a common technology in Zambia, so there is need for awareness creation and arrangements for effective maintenance. The ablution facilities will have lighting at night to reduce safety issues of users, particularly for women and children. The facilities will also target the passing visitors, increasing hygiene measures for cross-border flows, a key component of transboundary disease prevention.	in full.	may be further explored is building the costs into costs of running the total system and encourage poor households to use the blocks.
Improved Pit-latrines and other on-site options (septic tanks)	Improved pit latrines are very low cost in terms of maintenance. Households would need to raise the capital cost to upgrade their facilities to a basic hygienic standard.	The system is already used in the town and the new settlement (relocation village).	Improved pit latrines are generally acceptable for low-income areas where piped sewage may be costly or difficult to construct and manage.	Poor communities already use unimproved systems. To achieve a basic level of sanitation without material subsidy will require a strong behaviour change programme and potentially complimentary activities around

Options	Affordability	Acceptability	Appropriateness	Accessibility to poor households
				sanitary enforcement and private sector development to provide products and services to enable latrine upgrading.

Priority interventions will focus on the provision of public ablution blocks in key areas of the town, together with a behavioural change programme to promote the (household financed) upgrading of domestic toilets, and install and enforce by-laws on open defecation. Over time, a phased sewerage network and wastewater treatment facility is proposed, to be progressively expanded in the town.

It is unclear the latest government position regarding subsidy for domestic sanitation for small towns. This needs to be investigated further during detailed design. The common approach in Zambia seems to be non-subsidy approaches for domestic facilities, while the utilities and local authorities provide public and communal infrastructure (e.g. ablution blocks, sewerage network etc.). This approach is followed in this Feasibility Study.

Options Analysis for Wastewater Treatment

The design, development and selection of the preferred Wastewater Treatment system design has been an iterative process considering the important parameters in an integrated way. The highest priority objective throughout has been to 'provide the public with improved, affordable, environmental and sustainable wastewater services'.

The criteria/standards/principles of the primary stakeholders have also been considered and have been factored into and assessed through a qualitative analysis shown in **Table 13**.

The analysis of the options divided the infrastructure into basic components and then assessed options for each component against the following parameters:

1. Capital Cost
2. Operational Cost
3. Appropriate Technology
4. Level of Service provided
5. Sustainability
6. Institutional Suitability
7. Affordability

8. Social & Health issues
9. Access for the Poor
10. Environmental & Climate Resilience
11. Economic Development potential
12. Trans boundary matters

The sanitation options for Kazungula were presented above, which highlighted domestic upgrading, together with a conventional sewerage network with sections of small bore sewerage for the lower-income areas. The table below further investigates the options for the components of the sewerage system.

Table 13: Wastewater Option Analysis for Kazungula

Criteria Rankings: 1 Poor - 5 Excellent

	DESIGN OPTION	Cap Cost	Ops Cost	Appropriate Tech	Level of Service	Sustainability	Institutional Suitability	Affordability	Social & Health	Access for the Poor	Environmental & CR	Econ Dev	Transboundary	SCORE	REMARKS
SEWAGE TREATMENT PROCESS – Use facultative lagoons															
1	Constructed Wetlands	3	2	2	4	3	2	4	3	4	2	2	2	33	None. Preferred. Not climate Resilient.
2	Activated Sludge	3	4	2	4	4	2	3	4	3	3	3	3	38	None. Would provide high quality effluent. Inappropriate technology.
3	Aerated Ponds	2	2	2	4	4	2	2	4	2	3	3	3	33	None. Preferred. Inappropriate technology.
4	Rotating Biological Contactor	2	2	2	4	4	2	2	4	2	3	2	3	32	None. Preferred. Inappropriate technology.
5	Stabilization Ponds / Facultative Lagoons	3	5	4	4	4	4	4	4	4	4	4	4	48	Preferred option. Reliable straightforward operation. Similar technology to Livingstone STW. Appropriate technology. Climate Resilient. Land is available at Kazala Island.

6	Trickling Media Filters	2	2	2	4	3	2	3	3	3	3	3	3	33	None. Inappropriate technology.
FINAL EFFLUENT DISCHARGE LOCATION – Discharge to wetland															
7	Discharge to Zambezi River	2	4	4	4	4	4	3	4	4	2	2	2	39	None. No additional polishing step if STW was not performing adequately.
8	Discharge to wetlands adjacent to lagoons.	4	4	4	4	4	4	4	3	4	4	3	4	44	Preferred solution. Some agricultural and environmental benefits.

Therefore the preferred option, which constitutes a 'Preferred design', is Option 5 – Stabilization Ponds, combined with Option 8 - Discharge into the adjacent wetland, which will provide polishing of the effluent prior to flow into the Zambezi River.

Due to the expected low initial connectivity to a wastewater system during the first number of years of the project, it was found to be not viable when constructed in a single phase. Consequently it is proposed to construct the new infrastructure in Phases.

A consultative approach was used during the selection of the appropriate wastewater treatment technology, which included the concerns and aspirations of the primary stakeholders and this has also been factored in to the selection of the preferred designs. All of the components of the sanitation system fit together into a 'comfortable', multi-technology design which has been approved in principle by the main stakeholders. A full conventional waterborne sewerage was considered, but was found not to be viable due to unaffordability.

Engineering Assessment and Outline Design

Project Phasing

Initially it was proposed to construct the required infrastructure to meet 2030 demands in a single investment. The subsequent Cost-Benefit Analysis (CBA) showed that this was not viable so a phased approach has been adopted enabling investments to be made as the town grows and providing some flexibility if the population growth differs from the predicted. The scope and design was therefore adapted to match the costs of the project for both water supply and sanitation, due to the relatively small (but growing) poor population to support the investment. The phased approach will allow the full design to be achieved, but is linked to the growth in demand.

The Feasibility Study looks at the period until 2030 and has phased the project into Immediate Measures, Phase 1 (2020), Phase 2 (2025) and Phase 3 (2030). The study recommends that sanitation improvements are carried out in the same phases, to match the implementation of improved water supply. It should be noted that the dates linked to the phases are the dates when the infrastructure will need to be in place to meet the demand. Therefore to meet these dates, probably more than two years for planning, funding and construction needs to precede the demand / phase date.

The Social Assessment recommends that the Medium Scenario population projection is the most likely scenario, and should be used for the design of the water supply and sanitation system. The actual population growth should be monitored to allow sufficient planning time to upgrade the system in a phased approach, i.e. although the phasing has currently been linked to implementation years, it may be necessary to implement earlier or later based on actual population growth (or increase in water demand).

It is therefore relevant to link the phasing to population numbers as shown in **Table 14.**

Table 14: Population and Phasing

	2014	2015	2020	2025	2030
		Immediate	Phase 1	Phase 2	Phase 3
Medium Scenario: Medium net migration projection	5,500	7,500	9,500	12,500	22,300

Although the phasing will be based on these years / population figures combination, based on practicality it may be beneficial to provide certain bulk infrastructure in excess of the current phase.

The overriding project objective is to provide infrastructure supported by institutional strengthening that facilitates the delivery of improved, reliable and sustainable services to Kazungula.

Water Supply

From the start of the study it was clear that there was potential to produce more water from the existing assets leading to improved services and increased revenues in the short term, with a lower capital cost. Therefore maximising the existing water supply assets and integrating with a new design for the future has been a high priority for the Feasibility Study.

Distribution Network Improvement (DNI) Zones

The use of Distribution Network Improvement (DNI) Zones is an important component of this project to improve management of the system. SWSC are implementing similar distribution managements systems in Livingstone.

The main purpose of the DNI Zones is to allow for efficient water management. By dividing a large water supply area into smaller demand areas (DNI Zones), each demand area can be analysed (revenue, water balances and non-revenue water) and isolated separately, which allows for simpler problem identification and quicker speed of resolution. High water loss or non-revenue water can be easily pinpointed and investigated.

Each DNI Zone has a bulk flow meter, which thereby allows comparison to the total water supplied to the consumers (summation of the consumer meter readings versus the total supplied into the DNI Zone read from the bulk meter reading).

Using the developed concept Town Plan for Kazungula, KDC and SWSC, supported by CRIDF, developed a Water Supply Master Plan. The Water Supply Master Plan used the land use categories (commercial, administrative, industrial, low / medium / high cost residential) to define DNI Zones. The typical DNI Zone was selected based on similar land use category, water demand, level of service and pressure characteristic.

The Water Supply Master Plan, showing the proposed DNI Zones, is provided on drawing SWSC/KFS/KDC0001 'Proposed Distribution Network Improvement (DNI) Zones', attached in **Annex 4.** For

Kazungula, 13 DNI zones have been proposed for the water network and implemented in accordance with stakeholder priorities.

Poor communities have been identified by KDC in DNI Zones 1, 4, 5 and 6 and improved services will be targeted towards these communities.

Water Demand

The water demand by phase was calculated to allow the water supply system to be designed. The calculated water demand is presented in **Table 15**.

Table 15: Water demand calculations

Water Supply	2014	2015	2020	2025	2030
POPULATION	**5,500**	**7,500**	**9,500**	**12,500**	**22,300**
DOMESTIC DEMAND					
Standpipe @ 30 l/c/d - % of population	32%	45%	45%	51%	50%
Total number of standpipe users	1,760	3,380	4,520	6,410	11,150
Number of users / standpipe (typical)	250	250	250	250	250
Number of standpipes (estimate)	7	14	18	26	45
Total Standpipe Demand (m^3/d)	**52.8**	**101.4**	**135.6**	**192.3**	**334.5**
Yard @ 50 l/c/d - % of population	60%	47%	42%	35%	30%
Total Number of yard tap users	3,300	3,530	4,030	4,380	6690
Number of users per yard tap (people / household)	5.2	5.2	5.2	5.2	5.2
Number of yard taps (estimate)	635	679	775	842	1,287
Total Yard Tap Demand (m^3/d)	**165.0**	**176.5**	**201. 5**	**219.0**	**334.5**
House Connection @ 100 l/c/d - % of population	8%	8%	10%	14%	20%
Total Number of house connection users	440	600	950	1,720	4,460
Number of users per house connection	5.2	5.2	5.2	5.2	5.2

Water Supply	2014	2015	2020	2025	2030
Number of House Connections (estimate)	85	115	183	331	858
Total House Connection Demand (m³/d)	**44.0**	**60.0**	**95.0**	**172.0**	**446.0**
Total Domestic Demand on Piped Supply (m³)	**261.8**	**337.9**	**432.1**	**583.3**	**1,115.0**
INSTITUTIONAL AND COMMERCIAL DEMAND					
Institutional @ 5% to 10% Total Domestic Demand	5%	4%	7%	9%	10%
Institutional Demand (m³/d)	13.1	13.5	30.8	54.6	111.5
Commercial @ 5% to 12% Total Domestic Demand	5%	7%	6%	10%	12%
Commercial Demand (m³/d)	13.1	23.6	32.4	62.7	133.8
Border @ 5% to 12% Total Domestic Demand	5%	4%	10%	12%	12%
Border Post Demand (m³/d)	13.1	13.5	46.4	69.9	133.8
Hospital @ 5% to 7% Total Domestic Demand	7%	7%	5%	5%	5%
Hospital Demand (m³/d)	18.3	23.6	21.6	29.1	55.8
Fire @ 4% to 7% Total Domestic Demand	7%	7%	4%	5%	5%
Fire Demand (m³/d)	18.3	23.6	18.9	29.1	55.8
Total Institutional and Commercial Demand (m³/d)	**75.9**	**98.0**	**150.2**	**245.7**	**490.6**
Total Demand on Piped Water System (m³/d)	337.7	435.9	582.3	829.0	1,605.6
Peak Day Factor 1 to 1.4	1	1	1.3	1.3	1.4
Total Peak day Demand (m³/d)	**337.7**	**435.9**	**756.9**	**1,077.7**	**2,247.8**
Estimated Physical Losses	30%	25%	18%	14%	12%
Total Production Required (m³/d)	**439.0**	**544.9**	**893.2**	**1,228.6**	**2,517.6**

Water Supply Components and Design Parameters

Table 16 provides a breakdown of the proposed water supply components and Design Parameters per project phase. This table has been updated based on further work undertaking after completing the original Feasibility Study report, which resulted in additional considerations:

- Aligning of the Phase 1 scope of the project to potential funding from the SADC Regional Fund for Water Infrastructure and Basic Sanitation (RFWIBS), which will possibly amount to £2.2 million grant funding.
- Refinement of the bridge relocation scope.

Each of these aspects were discussed in CRIDF reports, which are included in **Annex 7**:

- Funding Alignment
- Relocation of Intake Study

Since funding is not yet secure for any portion of the work, all components can be expanded or contracted to suit actual demand or future funding. The funding of future phases should therefore be analysed and prioritised accordingly.

Table 16: Water Supply Component per Phase

Component	Current Situation	Immediate Measures	Phase 1	Phase 2	Phase 3	Remarks
INTAKE	Located at bridge site, vulnerable to contamination. Pumping 16 hrs / day. Potential to increase production. SWSC has duplicated pump and pipe to treatment plant.	Funding of intake relocation by the bridge project to be secured (SWSC). Refurbish the electrical supply to existing intake.		Review Pump Capacity. Relocation of abstraction point upstream, locate on floating pontoon, 2 x 60 m^3/hr pumps (Phase 3 capacity).		Resilient to flood and drought conditions
RAW WATER PIPELINE	SWSC has duplicated the pipe to the treatment plant and therefore current capacity is sufficient for 24 h supply.	N/A	N/A	6.7 km raw water transmission from new intake to new WTW site. 250mm Pipe. Funded by bridge project.		Designed for 2030 Flows
WATER TREATMENT PLANT	Non-functional Water Treatment Plant / Works (WTW). Raw water receives drip-	Rehabilitation of existing WTW (filtration, chlorination). Rehabilitation to	Upgrade treatment plant to 1.25 Ml/d to meet Phase 2 demand.	Relocation of WTW to higher elevation site. New plant capacity 2.5 Ml/d to meet phase		Flocculation, Clarification, Filtration and

Component	Current Situation	Immediate Measures	Phase 1	Phase 2	Phase 3	Remarks
	feed chlorination only.	include modifications to improve the treated water quality and to increase the treatment capacity. Secure land for future treatment plant (SWSC). Provide bulk metering at WTW.		3 demand, 4 stage treatment (flocculation, settlement, filtration, disinfection).		Chlorination.
WATER QUALITY	Reasonable, problems during high turbidity periods.	Safe, potable water	NWASCO Standards	NWASCO Standards	NWASCO Standards	
STORAGE RESERVOIR	285 m³ ground tank, 20 m³ Over Head Tank (OHT) at WTW, 50 m³ OHT at market site. Total storage approx. 3555 m³. SWSC has connected market OHT.	Convert existing 285 m³ tank into rudimentary settling tank. Proved 2 x 300 m³ ground storage tanks.	Provide an OHT at the proposed future WTW site, with booster pump station at the existing treatment works.	Relocate and reuse existing storage as required when moving site of WT". Add additional storage to raise to 1.25 Ml (24hr storage for phase 2 demand).	Add additional storage to raise to 2.5ML (to meet 24hr phase 3 demand)	24 Hour Storage using existing and new infrastructure

Component	Current Situation	Immediate Measures	Phase 1	Phase 2	Phase 3	Remarks
BULK RING MAIN		Priority pipework to reduce Non-Revenue Water (if required)	6,530m	5,585m	6,000 m branch main laid to connect northern areas	250mm uPVC or Polyethylene Pipe. Gravity Supply to DNI's
DNI ZONES		Not Formed, although priority network expansion in zones 4, 5 and 6. Provide bulk metering at WTW.	1(part) 4 and 5. Provide bulk meter positions for all DNI's.	1(part), 2, 3, 6 and 8.	9, 10, 12 and 13	Total of 13 confined DNI Zones with Bulk Meter.
SECONDARY DISTRIBUTION	Limited, antiquated distribution network, not covering all areas	3,000 m pipe extension and standpipe / kiosk construction to priority poor communities using 'self-help' contributions.	26,266 m laid in various diameters to the above DNI's to achieve target service levels	13,768 m laid in various diameters to the above DNI's to achieve target service levels	10,272 m laid in various diameters to the above DNI's to achieve target service levels	uPVC or Polyethylene Pipe. Poor Communities Prioritised. Includes for standpipes, kiosks, domestic connections.

Conceptual designs were developed based on the proposed phasing, which are shown on the following drawings in **Annex 4**:

- SWSC/KWS/KDC001/R – Existing Water Supply System
- SWSC/KWS/KDC002/R – Phase 1
- SWSC/KFS/KDC005/R – Phase 2
- SWSC/KFS/KDC006/R – Phase 3

These conceptual designs have been discussed with SWSC and with the primary stakeholders. There has been broad agreement for the concept designs from the stakeholders.

It is proposed to construct a new Water Treatment Plant during Phase 2. The water treatment works processes will be changed to be identical to the 'four stage processes at Livingstone, i.e. Flocculation, Clarification, Filtration and Disinfection, with the existing pressure filters being replaced with rapid gravity filters. At that stage, there is potential for SWSC to relocate the existing pressure filters to another, more appropriate location. It is expected that using a technology similar to Livingstone will assist SWSC to improve the service to customers and will be more cost effective.

By agreement between KDC and SWSC on a 'land swop' basis the WTW will be relocated to a higher elevation so as to afford a gravity supply to the majority of Kazungula customers. The land swop has to be formally ratified.

During the CRIDF site investigations it became apparent that the existing SWSC river intake was adjacent to the abutment of the proposed new bridge. Preliminary discussions were arranged between RDA and SWSC regarding the re-location of the river intake. After completion of the original Feasibility Study, the relocation of the intake was reviewed. Various options were identified and investigated. Negotiations for the relocation of the intake and raw water pipeline are ongoing between SWSC and RDA and it is anticipated that the Bridge project will fully contribute towards the capital cost of the relocation.

The trunk main system will be a conventional gravity fed Ring Main, constructed in phases according to priority supply areas. The Ring Main will feed the DNI Zones through a single bulk meter per zone enabling distribution management techniques to be utilised. The distribution management will be supported through the institutional strengthening program. The distribution management will enable SWSC to achieve its NRW targets and increase revenues. The Secondary Distribution pipelines in the DNI's are laid in the priority DNI's for each phase to ensure meeting the coverage targets at the predicted service levels [standpipes, yard connections, house connections] and at the same time maximising the use of the existing network. The existing Secondary Distribution pipes will need to be isolated and incorporated into the new DNI Zones.

All customers will be metered. It is a SWSC target to achieve 100% metering. Current level of metering is about 70%. The financing of the metering will be by SWSC and a Government of Zambian funded program. Domestic customers will have the choice of three levels of service, House Connections, Yard Connections and Standpipes / Kiosks. It is expected that over time that customers will migrate to higher levels of service and this has been taken into account in the demand calculations. The proposed Communal Ablution Blocks (see Sanitation design) will also be utilised as water kiosks.

The water supply system design is flexible to accommodate different population growth rates and different demand rates. The proposed phases can be accelerated or slowed according to the actual water demands. Commercial and Tourist demands have been predicted using reasonably conservative growth rates. The early phases will meet the demands of bridge construction and bridge operation with obvious revenue benefits for SWSC. Later growth rates in commercial demands and tourism are less predictable but can be accommodated in the phased approach.

The future WTW will ideally be constructed using reinforced concrete structures, as in Livingstone, although final material selection should be based on cost and appropriate technology considerations. The pipelines are most likely to be uPVC or Polyethylene. All of the infrastructure will be designed to be climate resilient. The most climate sensitive component is assessed to be the river intake. This will be designed as a floating intake and capable of functioning through flood and drought conditions.

The entire project will be implemented to SWSC technical specifications.

Immediate Measures - Water Supply (IM1)

The Immediate Measures phase is designed to maximise the existing assets. To increase water production and improve service levels through a combination of small investments and revised operating procedures. The immediate measures focus on increasing the abstraction and storage capacity to provide 24 h supply to the current population, and rehabilitate the existing water treatment works to ensure adequate quality of water supplied. It also includes basic repairs of the existing network and approximately 3 km network expansion and standpipe construction, particularly focused on the low-income areas (DNI Zones 4, 5, and 6).

The schematic layout in **Figure 12**, provides an overview of the Kazungula system and the work categorised as Immediate Measures (IM1). Item 1, the relocation of the intake, is discussed below and SWSC has already re-connected the OHT at the market (Item 5).

Immediate Measures – Relocation of Intake (IM2)

During the Feasibility Study it was noted that the proposed upstream Kazungula Bridge would potentially have an impact on the water quality abstracted from the river by the existing intake. The Feasibility Study recommended relocation.

Further work was undertaken regarding the relocation of the intake and the detailed report, 'Relocation of the Intake Study' can be found in **Annex 7**. It is still recommended that the intake be relocated, but to minimise the capital expenditure the relocation is no longer prioritised as Immediate Measures (IM2). It is proposed to review the changes in water quality once the bridge is operational, with only mitigation measures being implemented immediately. It is still proposed that funding for this work should be sought from the Kazungula Bridge project by SWSC.

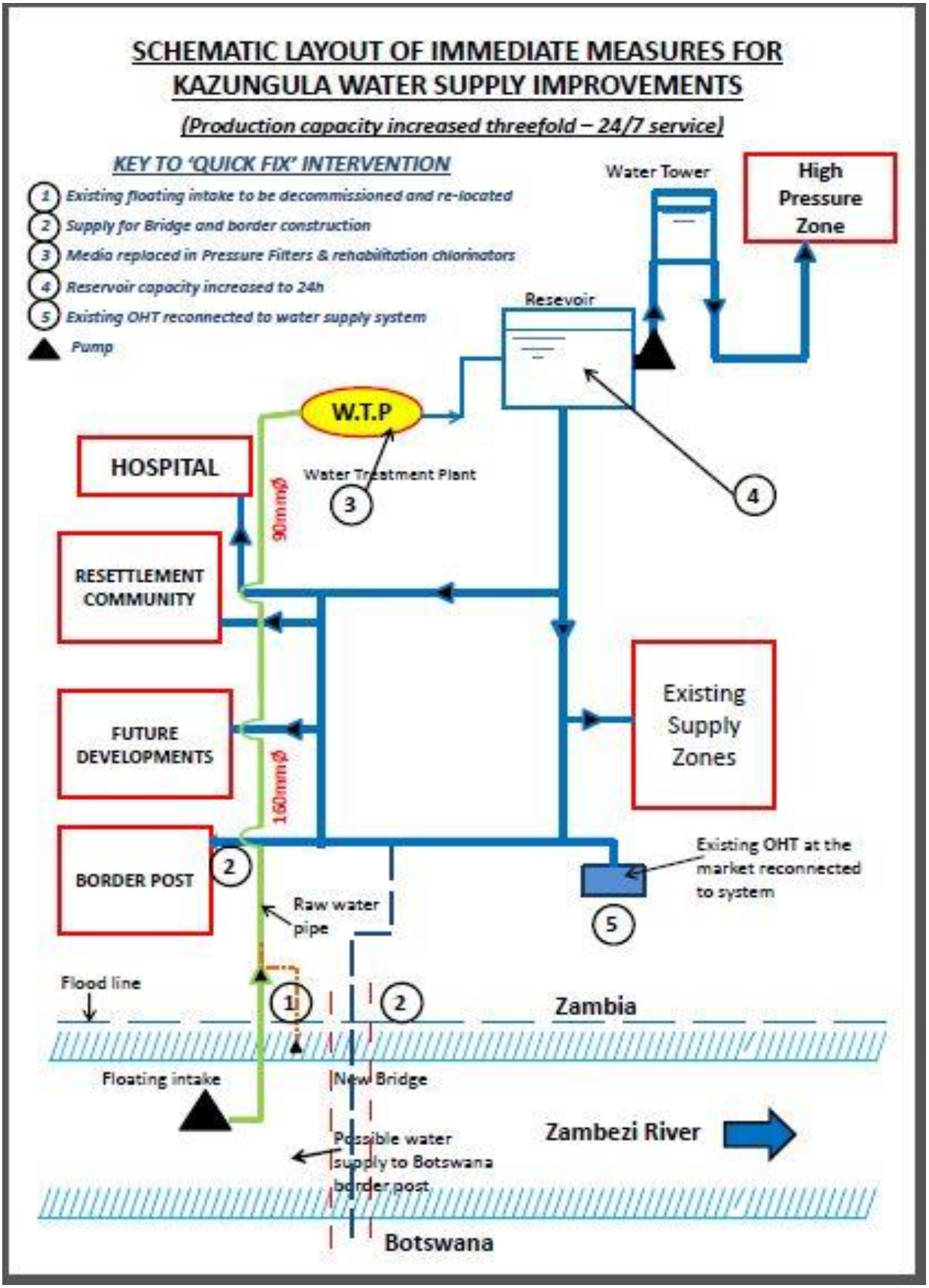


Figure 12: Immediate Measures Schematic

Phase 1 Water Supply (2020)

Phase 1, as refined in the 'Funding Alignment' report (**Annex 7**), includes the following proposed infrastructure (refer to drawing SWSC/KWS/KDC002/R in **Annex 4**):

- The design has been configured to enable modern distribution management practices to be incorporated including the use of DNI Zones to achieve 'water balances' and income correlation.
- Phase 1 (as a follow on from the Immediate Works) will target improved services towards poor communities in DNI Zones 1, 4, 5, and 6 (identified by KDC/SWSC), including some 'self-help' from the communities.
- Construction of main sewer line and treatment works, serving institutions and public facilities and limited network in residential areas.
- Ongoing behavioural change campaign linked with sanitary enforcement and sanitation marketing (particularly for new residents)
- The SWSC commercial improvements are fully harmonised with the infrastructure designs and linked through institutional strengthening, like linking the billing to DNI / Non-Revenue Water (NRW) management.
- Provision of services to allow for the relocation of residents from an informal settlement in DNI 7 to DNI 11. Therefore water supply to DNI 11 is allowed for in the revised Phase 1 infrastructure. This will be a critical aspect in line with the proposed new WWTW being located in DNI 7, where the current informal settlement is.

The following is the detailed scope for this work:

- Establishment of the Distribution Network Improvement (DNI) zones:
    - Zone off-take, meter, and zone isolation of existing reticulation for DNI 1, 3, 4, 5, 6, 10 and 11.
    - Zone off-take and isolation valve for DNI 2, 8, and 9, allowing for future connection as development in these areas is planned and implemented.
- Minor upgrade to the Existing WTW
    - Increase storage capacity to 24 hr of daily demand by duplicating existing 600 m^3 storage tank (600 m^3 storage tank provided as part of the Immediate Works).
    - Revise pipework, valves as required to cater for the 1,230 m^3/day capacity (Phase 2 demand).
    - Note the capital expenditure should be minimised due to the long term plan of relocating the treatment works.
    - Selection of the type of storage tank should be based on the ability to relocate the tank to the new treatment works when constructed.
    - Review and improvements to the sludge handling system.
- High Level Water Storage at proposed future WTW site
    - Booster pipeline from WTW to High Level Water Storage situated at the proposed future WTW site

  - Return gravity main supplying DNI 1, DNI 8, DNI 10 and DNI 11 (Ring Main 2 – with metered cross connection to Ring Main 1).
- Bulk Gravity Ring Main
  - From WTW supplying DNI 3, 4, 5, 6 and 7.
  - Additional pipeline to DNI 11, to allow for the relocation of the informal settlement in DNI 7, enabling the supply to the hospital and in future DNI 8.
- Secondary Distribution and Connections
  - Allowance in the Feasibility Study for 26,000 m of distribution pipelines, with varying diameters. This work includes replacement of old pipes, installation of new pipes and re-routing of existing network to isolate zones.
  - Confirm metering for commercial, institutional and administrative buildings.
  - Remove illegal connections and repair leaking connections.
  - Provide opportunity to the community to obtain metered connection to the new / existing network through self-help / self-payment.
  - Provide water supply kiosks for DNI 4, 5 and 6 – to provide access to water between 250 and 300 m from every household, would require approximately 11 kiosks.

Phase 2 Water Supply (2025)

The focus of Phase 2 interventions includes relocating the Water Treatment Plant, providing treatment capacity for Phase 3 demand, increasing storage, construction of the western branch of the ring main, and extend the distribution network particularly to DNI zones 1, 2, 3, 6 and 8.

Phase 3 Water Supply (2030)

The focus for Phase 3 would be to construct the branch main supplying the northern DNI Zones in the town, particularly zones 9, 10, 12 and 13.

Sanitation and Sewerage Outline Design

Following the sanitation options analysis, the sanitation system was conceptualised and designs were developed. Options were considered for the Sewage Treatment, the Sewerage system and the phasing of the services to the various communities. Supporting Institutional Strengthening is recommended to ensure the desired performance and compliance with all requirements including Environmental conditions. These designs were discussed with SWSC and with the primary stakeholders. There has been broad agreement for the conceptual designs from the stakeholders.

Initially it was proposed to construct the new infrastructure to meet 2030 demands in one single investment using a conventional gravity flow sewerage network as desired by the primary stakeholders. The subsequent CBA showed that this was not viable so a phased approach has been adopted enabling investments be made as the town grows and providing some flexibility if the population growth fluctuates from the predicted. The phased approach will enable the ‘ideal’ design to be achieved as the growth in population justifies it.

A short term improvement is proposed in the 'Immediate Measures' phase whilst the Phase 1 improvements are being procured and implemented. The 'Immediate Measures' proposes the construction of 5 Communal Ablution/Toilet Blocks in the vicinity of the bridge / border post (to service the border crossing population), other highly traffic areas and in the poorer communities. This will provide sanitation improvements in the most urgently required locations. Initially this system will be connected to septic tanks.

A basic (primary) conventional sewerage system is proposed for Phase 1 which will collect effluent principally from the institutional and commercial sources to include the 'One Stop' border post and the new regional hospital. This will provide the central basic system that can be expanded in the future if the population growth and situation justifies it. The proposed sewerage system follows closely the design of the existing sewerage system in Livingstone using a predominantly gravity collection network flowing to facultative lagoons for treatment.

The preferred Sewage Treatment option by the stakeholders and supported by CRIDF is for Facultative Lagoons. Land for the Facultative lagoons was identified and agreed during a field visit of stakeholders [SWSC, KDC, RDA, ZEMA and CRIDF] on the 24th June 2014. The Facultative Lagoons will be similar conceptually to the Lagoons used in Livingstone but with design improvements.

It is proposed to place the Phase 2 and 3 Facultative Lagoons on Kazala 'Island', to the east of Kazungula. The number of lagoons will be constructed to match the wastewater flows. Considerable effort was made with the primary stakeholders to identify suitable sites for the sewage treatment facilities but the only option available for the full development was Kazala Island. Kazala Island is high ground in a flood plain some 2 km from the Zambezi. The land is reported to not flood and the flood plain is reported to be dry and accessible throughout most years. The land is long and narrow, suitable for lagoons in a chain formation. Access was gained in June 2014 by vehicle along a motorable track. This location will however require a more detailed study and special attention to ensure that it is climate resilient. The location is however considered feasible using conventional engineering methods. The land around Kazala Island is used for animal grazing and it considered feasible to dispose of the treated effluent to the land to improve year round grazing. The alternative is to discharge the treated effluent to the Zambezi through a 2 km gravity pipeline. ZEMA in principle were receptive to both the STW location and disposal of effluent methods but of course all subject to more thorough investigations.

It will be necessary to pump the wastewater to Kazala Island, due to a low lying area between Kazungula and the island. A large sewage pump station requires a pump sump to provide storage during power failures and maintenance. Depending on the reliability of the system, the pump sump capacity could range between 8 hours and 24 hours. Therefore a pump sump will be required to the south of Makalanguza, an informal suburb of Kazungula. For this reason, during Phase 1, it is proposed to instead construct Facultative Lagoons south of Makalanguza to meet the wastewater flow for Phase 1. These Facultative Lagoons constructed under Phase 1, will then be converted to the required pump sump for Phase 2 and 3, when new Facultative Lagoons will be constructed on Kazala Island.

Therefore the intention for sanitation is a mixture of public ablution blocks, upgraded domestic on-site facilities, and a hybrid conventional and small bore sewerage system.

Wastewater Flows

Table 17 details the estimated design flows for the sewerage system, linked to the different phases. The estimate for the wastewater flows has assumes that all the water supplied to the Intuitional and Commercial properties (including the Border Post and Hospital) returns to sewer, while the wastewater return form residential properties is shown in the table as a percentage of the supply to the properties with house connections.

Table 17: Flow calculations for the sewerage system

Wastewater Source	Phase 1	Phase 2	Phase 3
Institutional and Commercial Return	131.3 m³/d	216.6 m³/d	434.9 m³/d
Domestic Return %	30%	45%	60%
Domestic Return	28.5 m³/d	77.4 m³/d	267.6 m³/d
Total estimated wastewater flows	**124.9 m³/d**	**210.6 m³d**	**702.5 m³/d**

Typically Facultative Lagoons require approximately 3 days of retention time, if including an anaerobic pond an additional day of retention would be required. Based on 4 days of retention, the Phase 1 Facultative Lagoons will need to have a volume of about 500 m³. When converting this into a the future Phase 2 and 3 pump sump, this would provide 17 hours of storage, which is more than sufficient to be used as a pump sump. The sump will provide some pre-treatment of the waste even when acting as a pump sump.

A 'Step by Step' Implementation Program, has been developed for SWSC to assist the development planning up to 2030. The Implementation Plan is included in the 'Project Implementation Plan' section of this report. The initial proposal showed a single stage development to meet 2030 requirements. This however was found not to be financially viable and so the scope of works were modified and the implementation is now proposed to be carried out in Phases that it can be flexibly implemented in accordance with the actual rate of growth of Kazungula. The border town is unique in its location at the intersection of four countries and at the site of the new bridge across the Zambezi offering many transboundary opportunities. The impact of the new bridge on Kazungula has widely varying population growth predictions which is partly why the phased approach to the water and sanitation systems is recommended.

Table 18 provides and overview of the various proposed sanitation interventions per phase.

Table 18: Overview of Sanitation Interventions per Phase

Component	Immediate Measures	Phase 1	Phase 2	Phase 3	Remarks
Domestic & Public Sanitation Facilities	Develop behavioural change programme and sanitation marketing for user financed upgrading of their domestic facilities Construction of 5 public ablution blocks	Behavioural change programme and sanitation marketing for user financed upgrading of their domestic facilities	Behavioural change programme and sanitation marketing for user financed upgrading of their domestic facilities	Behavioural change programme and sanitation marketing for user financed upgrading of their domestic facilities	The behaviour change campaign would also cover aspects of promoting yard and domestic connections to the water and sewerage network, compliance on bill payment, and utility-customer communications The sanitation marketing may require partnering with an experienced NGO together with KDC and the local health authority.
Sewage Treatment Facultative Lagoons	-	Two Lagoons constructed to meet projected Phase 1 flows in the Makalanguza area. Irregular shaped lagoons to suit location. Earth Embankments protected by Gabion	Four Lagoons on Kazala Island to meet projected Phase 3 flows.		Requires Climate Resilient and Environmental detailing. Location proposed by SWSC and KDC. Final effluent to Zambezi River or surrounding grazing land.

Component	Immediate Measures	Phase 1	Phase 2	Phase 3	Remarks
		Mattress.			
Primary Sewerage Network	_	14,415m of conventional gravity sewer pipes from Institutions and Border Post to Lagoon.	Extension of 10,854m of conventional gravity sewer pipes. To commercial and tourism areas.		uPVC Pipes. Various diameters. 90+% of effluent estimated to flow by gravity.
Small Bore/Simplified Sewerage Network				20,576m of small bore uPVC sewers collecting from residences in DNI areas 4, 5 and 6.	uPVC Pipes. Various diameters. 90+% of effluent estimated to flow by gravity Introduced into high density/poor communities as a progression from latrine solutions.
Submersible Pumping Station in Makalanguza area	-	-	Below ground pump station (utilising Phase 1 Facultative Lagoons as the pump sump). 2x 30l/s pumps		Station constructed in low area of the town. Requires detailing to be climate resilient. Location proposed by SWSC and KDC. The final location of this station may need to be further reviewed to ensure minimal environmental impact, health risks and climate resilience

Component	Immediate Measures	Phase 1	Phase 2	Phase 3	Remarks
Final Effluent		ZEMA consent Standards	ZEMA consent Standards	ZEMA consent Standards	Discharge to River or adjacent grazing land.

Conceptual designs were developed based on the proposed phasing, which are shown on the following drawings in **Annex 4**:

- SWSC/KWS/KDC003/R – Immediate Measures
- SWSC/KWS/KDC004/R – Phase 1
- SWSC/KFS/KDC010/R – Phase 2
- SWSC/KFS/KDC011/R – Phase 3

These conceptual designs have been discussed with SWSC and with the primary stakeholders. There has been broad agreement for the concept designs from the stakeholders.

Domestic effluent will be treated predominantly by 'on-site' methods, however the flexible sewerage design will be able to incorporate a small bore or simplified sewerage system for low cost / high density domestic areas.

Immediate Measures -Sanitation (IM1)

The Immediate Measures for sanitation in Kazungula provides for the construction of 5 Community Ablution Blocks (CAB's). The purpose of the Ablution Blocks is to provide early sanitation relief at the Border post, market, commercial areas, and potentially to the poorer communities of the town. The effluent from the Ablution Blocks will be treated in on-site septic tanks (in Phase 1 they will be connected to the primary sewerage network).

The Ablution Blocks will be approximately 15m x 6m in plan. It is proposed that each block will house 10 toilets, 5 Showers and 6 hand basins, with facilities for laundry.

The locations of the Ablution Blocks will be selected through consultation with SWSC and KDC.

It is expected that the facilities could also serve as water kiosks, and may provide other services (small vendor facility). They are expected to be owned by SWSC, and may be leased to private operators, financed by user fees. For the residential areas, there may be consideration to cross-subsidise the service from water and/or sewerage revenues. Therefore location, ownership and management arrangements will need to be further clarified.

Phase 1 Sewerage Intervention (2020)

The focus for phase 1 would be to construct the mainline gravity sewer to connect the main commercial and institutional customers, together with the required Facultative Lagoons for treatment of the wastewater.

The detailed scope includes:

- Bulk Sewerage
    - Construction of 14,415 m of conventional bulk sewerage, serving institutions and public facilities (and limited residential connections). During detail design, utilising simplified sewerage should be considered to reduce the cost of the infrastructure.
    - Provision of connections for commercial, institutional and administrative buildings.
    - Connection of the main CAB's to the sewerage.

- Implementation of a behavioural change campaign linked with the sanitary enforcement and sanitation marketing (particularly for new residents). The behavioural change campaign should include design and construction standards of on-site disposal facilities.

- Wastewater Ponds
  - Construct wastewater ponds on the south western side of Kazungula, adjacent to the Makalanguza informal settlement (that will be moved to DNI 11). This site is on the banks of the Zambezi River, where the final effluent can be disposed. The Phase 1 ponds will in future provide pre-treatment, balancing storage and pump sump for the required pump station required under Phase 2, to pump the wastewater to Kazala Island.
  - The bulk of the population will still utilise on-site disposal, therefore future phases need to include the handling and disposal of the septic tank and VIP septage (faecal sludge).

Phase 2 Sewerage Intervention (2025)

The focus of Phase 2 would be to extend the conventional sewerage network to commercial, tourist, high cost residential areas and residential properties with a water connection inside the house. During this phase the sewage treatment plant, will need to be established on Kazala Island, with a pump station in Makalunguza, together with modification to the Phase 1 lagoons to change their purpose to a pump sump.

Phase 3 Sewerage Intervention (2030)

The focus of phase 3 will be to extend simplified/small bore sewerage network into residential areas, for access to sewerage services by all categories of customer, particularly high density areas.

Technical and Engineering Design Parameters for the Sewerage System

Public Ablution Blocks

A total of 5 communal ablution blocks are proposed, that would each contain ten toilets, five showers, six hand washing basins and laundry facilities. The ablution blocks would also serve as water kiosks, selling water to surrounding households. The ablution blocks would include solar lighting to provide safe access at night.

Domestic Sanitation

For the lower income areas, and particularly for the initial phases of the project before the sewerage network is established in all areas, sanitation interventions would focus on promoting and enforcing basic, hygienic on-site sanitation options such as Ventilated Improved Pit latrines and where applicable septic tanks. The project would take a ‘no-subsidy’ approach for domestic toilets, applying the principle that the community can build their own houses and can therefore build their own toilets as a form of ‘self-help’ contribution. The non-subsidy approach is common across Zambia. To encourage the population to construct/upgrade their toilets to minimal hygienic levels, the behavioural change programme would educate and demonstrate improved sanitation technologies, and also detail how to achieve hygienic (e.g. Ventilated Improved Pit) latrines. The detailed design activity

during financial closure would further investigate the most appropriate mechanism to promote and enable domestic sanitation upgrading, looking into options around demonstration models, and potentially looking into local manufacture of sanitation products such as slabs, netted ventilation pipes and hygienic superstructures through the local private sector, to meet domestic demand for sanitation upgrading. Technical options and products would be promoted appropriate to the different areas of the town, including technical options that prevent surface water inflow to pits for the low-lying areas. These may include slightly raised pits and slabs, with impermeable above-ground pit walls.

A suitable implementing partner would need to be identified during Financial Closure that has a strong track record of sanitation promotion and sanitation marketing in peri-urban Zambia. They could then partner with SWSC and the District Council's Environmental Health officers to undertake the behavioural change, sanitation marketing and sanitary enforcement activities.

Given that some of the domestic toilets are filling and there is limited space for some households to construct replacements, whilst outside the scope of this project, the council and/or SWSC may want to look into options to mobilise/aggregate community demand for a vacuum truck to undertake pit emptying.

Mitigating Flooding of Pit Latrines

Whilst outside the scope of this project, it is recommended that the District Council works with residents in the low-lying areas to develop basic prevention mechanisms to reduce the surface water inflow and flooding of pit latrines during heavy rains. One option to consider could include instigating basic storm water drainage channels along the roads to divert the flood water away from the low lying area. The requirement for storm water drainage is identified in the District Council strategic plan. This study strongly endorses the requirement for storm water drainage for social, health, environmental and economic purposes/benefits.

Sewerage Collection

A new sewerage system has been proposed for Kazungula town which incorporates the use of both conventional sewer collection system and simplified sewerage or small bore collection system. The collection system has optimised gravity flow to reduce operational costs and to increase reliability.

The conventional sewer collection system has been adopted for all institutional infrastructures, whilst the simplified sewer collection system is proposed as appropriate for the high and medium density residential zones.

The conventional gravity collection system proposed is the favoured option by KDC and SWSC and has been evaluated by this study as the preferred design for all institutional infrastructures.

The population that is targeted for simplified sewerage is low income and lacks individual ability to manage and maintain any system; therefore the simplified sewer collection system with multi household connections is most appropriate for the town. Simplified sewer systems provide an economical way to upgrade existing sanitation facilities (or lack thereof) to a level of service comparable to conventional sewers. Because of the lower costs of construction and maintenance and the ability to function with little water, simplified sewers will be used where a conventional sewerage system would be inappropriate. Simplified sewers therefore offer an opportunity of

improving sanitation in areas which otherwise might not be upgraded. The system makes use of the favourable gradient and topography of Kazungula town to convey effluent into the conventional system.

Figure 13 provides a schematic for a Simplified Sewerage. This schematic shows the main elements, i.e. small diameter pipes, buried at shallow depth, with an interceptor tank (or baffled box), which gives the property owner the responsibility of removing large objects from the wastewater stream before it enters the collector main.

An alternative to the Simplified Sewer is the Small Bore system, which includes a septic tank between the household and the collector main. This type of system is also called a no solids system, which has the advantage of fewer blockages. However, the main disadvantage of this type of system is the large number of septic tanks required, which all require periodic emptying.

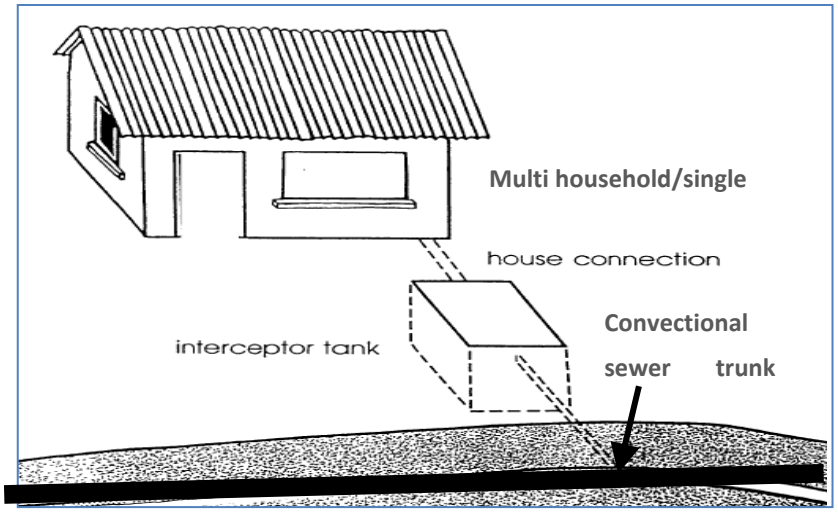


Figure 13: Schematic Representation of a Small Bore Sewer

System pipeline sizing

Pipeline sizing for gravity pipelines shall be determined on the basis of the design flow rate using the "Manning" formula to determine the velocities in pipes.

The Manning's equation in SI units; $\mathbf{v = 1/ n R^{2/3} S^{1/2}}$

Where: v = velocity of flow

n = manning's roughness coefficient (0.013 used)

R = hydraulic radius

S = slope

Using 0.6 m/s as the minimum velocity to achieve self-cleansing of the pipe, the minimum slope can be calculated per pipe diameter. The results of this calculation are provided in **Table 19**. However, typically a minimum pipe diameter of 150 mm is utilised, together with a minimum slope of 1:200 (or 0.5%).

Table 19: Sewerage pipe diameters and gradients

Pipe diameter	Minimum slope
200	0.33
250	0.24
300	0.19
375	0.14
450	0.11
525	0.092
600	0.077

For high density areas, Simplified Sewerage collection pipelines should be considered due to the lower cost and suitability of this technology to installation in unplanned areas. The required gradients for simplified sewerage is shown in **Table 20**.

Table 20: Simplified Sewerage Gradients

Pipe diameter	gradient
100	0.67
150	0.4
200	0.33
300	0.25

In all cases provision should be made for adequate access (manholes and rodding eyes) to allow for maintenance activities.

On-site Sanitation Options

The lower income / poor communities that choose not to connect to the sewerage network will be mobilised and enabled to upgrade their on-site facilities to be more durable, hygienic, and in low-lying areas, less vulnerable to surface water flooding. These facilities could in future be upgraded and connected to the sewerage network.

A range of upgrading options would be proposed to the households, and they would be encouraged to upgrade to a level they felt they could afford, and aspired to reach. The Department of Health would work together with the implementing agent undertaking the promotion campaign (e.g. a suitable NGO) to suggest minimal design features to achieve to be deemed 'acceptable'. Care must be taken not to prescribe standards that inhibit the poor from accessing. Such minimum standards could be based on definitions such as: 'barriers to fly breeding /

exiting the pit; basic hand washing facilities within 5 meters (e.g. tippy tap); impermeable slab. In flood risk areas, additional features could be recommended.

Community members would be sensitised on the design features of the Ventilated Improved Pit latrine, which would be the 'target' to which promoters of upgrades are working towards.

The local private sector could be trained on the production/supply/installation of basic sanitation items, such as slabs, vent pipes (with fly nets), toilet seats, and even products like pre-fabricated superstructures.

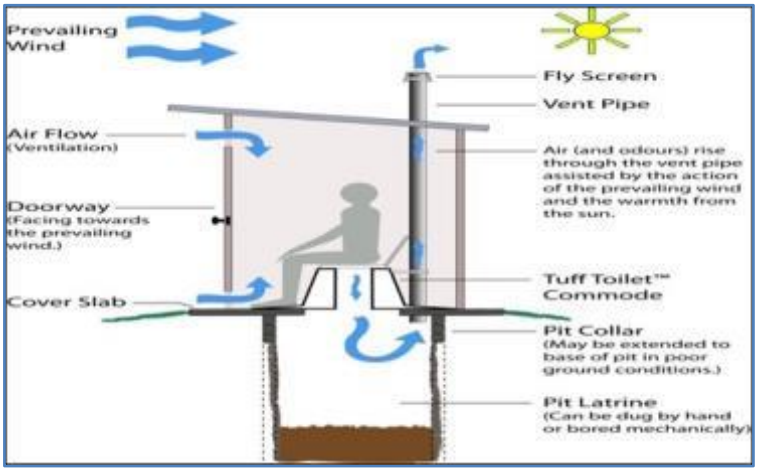


Figure 14: Diagram of the principles of the VIP toilet

Materials and Installation for both Conventional and Simplified Sewerage Systems

Sewer lines and pipe fittings shall consist of polyvinyl chloride (PVC) solid wall plastic sewer pipe. Flexible joints are proposed to reduce the effects of deferential settlement, with all joints to remain watertight under working conditions. Material approval should be under the authority of the SWSC.

The depth of cover will depend on the levels of the connections to the system, the gradients at which the pipes are to be laid and the ground levels. Pipes need to be protected from damage and if the proposed bedding class gives too little cover (or too much, when the pipes could be damaged by the weight of backfilling) for one combination of cover, pipe strength and pipe bedding, it may be possible to choose another combination. Alternatively special protection can be provided.

Location of sewer lines

The sanitary sewer lines should not be constructed within the floodline as plotted so as to be a climate resilient system. KDC and SWSC reserve the right to access sanitary sewer line locations. Preliminary proposals are that the sewer sanitation lines be parallel to property lines (or centrelines) or as close as possible to parallel. The Convectional gravity sewer system is designed in a manner to facilitate the future extension and includes diameter oversizing and extra depth. In addition, where the location of the sewer lines is unavoidable in the flood plain, the pipeline is to be protected from floatation during the detailed design stage.

Where simplified sewer system will be in use, the small bore plastic pipe (minimum diameter of 100 mm) which are trenched into the ground at a depth sufficient to collect the wastewater from most connections by gravity. Unlike conventional sewers, small bore sewers are not necessarily laid on a uniform gradient with straight alignment between manholes or cleanouts. The sewer may have an inflective gradient; that is to say, the sewer may have dips so that sections of it remain full under static conditions. Also, the alignment may curve to avoid natural or manmade obstacles. The objective in the design and construction of small bore sewers is to utilize to the maximum extent the energy resulting from the difference in elevation between the upstream and downstream ends.

The sanitary sewer lines location shall not interfere with other proposed or existing utilities. Sewer installations near water pipelines shall be in accordance with Public Health criteria for the separation of water mains and wastewater sewers.

Lift stations and inverted siphons

Although lift stations and inverted siphons should be avoided whenever possible, the terrain of Kazungula, the land made available for sewer treatment and the floodline has located the Sewer Treatment Plant at a higher location therefore the need arises to pump part the sewer discharge. The lift station is to be located at the lowest point along sewer transmission trunk main conveying effluent from the Market, Hospital and low lying residential areas of Kazungula town. The proposed design gravitates effluent from other areas to the sewer treatment plant directly. The pumping station design would include stand-by pumps and a generator to minimise the risk of pumping station failure. The system would be designed to overflow at a predetermined location to minimise social, health and environmental impact in the event of a ‘catastrophic’ failure.

Proposed, two submersible pumps will be used at the facility with 100% standby generators and all flood proof. The pump regime should ensure that the effluent does not become septic. Walls of Pumping Station sump to be high - above the flood level to prevent pollution or flooding.

Manholes, Cleanouts and Vents

The sizing of manholes shall be based on the diameter of the sewer line(s) connected to the manhole. The proposed spacing is not to exceed 150m. Manholes are located at change of grade, change in line size and change in line direction. A special consideration shall be made for water tight manholes in the event that construction of the system cannot be avoided in the flood plain.

In the case of the simplified system, cleanouts are preferable to manholes because they cost less and can be more tightly sealed to eliminate most infiltration and grit which commonly enter through the lids and walls of manholes. Also, they can be easily concealed to prevent tampering. They function as flushing points during sewer cleaning operations. The sewers must be ventilated to maintain free-flowing conditions. Vents within the household plumbing are sufficient, except where inflective gradient sewers are installed. In such cases, the high points of the sewer should be ventilated either by locating the high points at connections or by installing a clean out with a ventilated cap.

Interceptor tanks

In the simplified sewer system, the interceptor tank is a buried watertight tank with baffled inlet and outlet. It is designed to detain the liquid flow for 12 to 24 hours and to remove both floating and settleable solids from the liquid stream. Ample volume is also provided for storage of the solids, which are periodically removed through an access port. The capital costs of the inceptor tanks are to be borne by the households, and are not included in the capital cost of this project.

Typically, a single-chamber septic tank is used as an interceptor tank each household is usually served by its own solids interceptor tank. In many instances this may be the optimal solution, but consideration should be given to the feasibility of connecting more than one household to each interceptor tank. This is likely to be a lower-cost solution in many situations, especially in high-density, low-income urban areas. **Figure 15** is a typical interceptor tank, for a household of **6 people**, producing **70 litres/person/day** to be desludged every **3 years**.

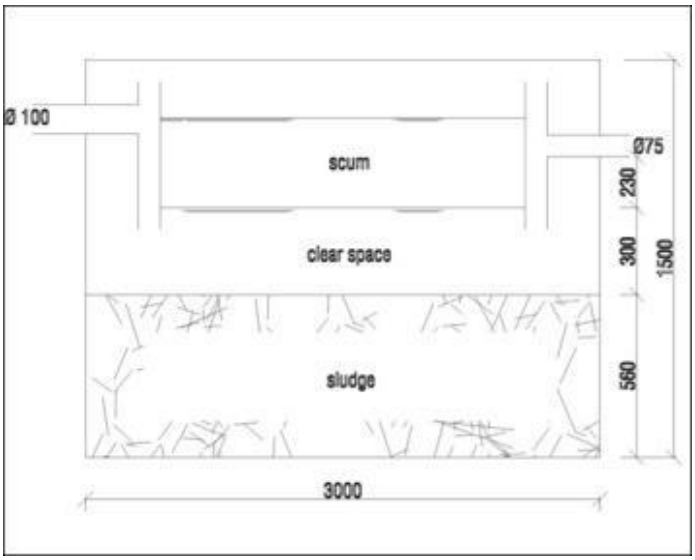


Figure 15: Typical Interceptor Tank Design

Climate Change Risk Assessment (CCRA)

Scope of Review

The scope of this Climate Resilience Risk Assessment (CCRA) review includes the following project components and outcomes.

Climate risk screening on the following project components:

- Refurbishment of existing water treatment works, including increase storage capacity
- Distribution network upgrade and extension
- Water zoning and non-revenue water reduction
- Sanitation facilities for cross border population (communal ablutions building)

Identification of resilience benefits of the following project outcomes:

- Provision of a reliable water supply system
- Water zoning and non-revenue water reduction
- Provision of water and sanitation facility for the cross border population (communal ablution building)

Climate Vulnerability Mapping and Tool Indicators

Table 21 presents the level of the climate vulnerability indicators for the Kazungula Water Supply project area according to the climate vulnerability assessment tool. For some indicators a range is presented, which reflects the differences in vulnerability amongst sites. Further guidance on the meaning of the indicators is presented in **Annex 6**.

Table 21: Kazungula WSS - Climate Vulnerability Indicators (from website[23])

Indicator	Outcome
Future risks to people	4. Moderate
Water risk under climate change	5. High
Climate change pressure	5. Very High
Baseline risks to people	3. Medium
Resilient population	3. Medium
Population density	105 (people per km²)
Household and community resilience Groundwater stress	0.46 Moderately less resilient
Groundwater stress	No data
Upstream storage	No major reservoirs
Drought severity	3. Medium to High (30-40)
Flood FREQ MINM	
Seasonal variability	5. Extremely High (>1.33)
Inter-annual variability	2. Low to Medium (0.25 to 0.5)
Baseline Water Stress	1. Low (<10%)
CRIDF Basin	ZAMBEZI

[23] The CRIDF Climate Vulnerability Assessment is available online at: http://geoservergisweb2.hrwallingford.co.uk/CRIDF/CCVmap.htm

Regional Climate Projections

The project falls within Region 1 (refer **Annex 6**), and the expected impacts associated with this region are presented in **Table 22**.

Table 22: Kazungula WSS - Climate projections for project area

Climate change trend / parameter	Impacts	
	By 2025	By 2055
Precipitation variability	Continuing trend of seasonal and Interannual variability in precipitation. A transition zone between areas where the annual rainfall is more likely to increase (to the north) and more likely to decrease (to the south). Any changes are most likely (but not definitively) in the range −10% to +10%. The possibility of increased rainfall rises with higher emissions.	Continuing trend of seasonal and Interannual variability in precipitation, decreased winter rainfall and increased aridity, in combination with wind gustiness, drying out of seasonal wetlands/pans and ephemeral rivers. Variability in particular at boundary with southernmost extent of intertropical convergence zone (ITCZ). A transition zone between areas where the annual rainfall is more likely to increase (to the north) and more likely to decrease (to the south). Any changes are most likely (but not definitively) in the range −10% to +10%. The possibility of decreased rainfall is higher than around 2025. Water supply is challenged by increased temperatures (and associated evaporation), and more erratic rainfall patterns, leading to vulnerability of perennial river systems and decreased level of the groundwater table.
Temperature variability	Continuing trend of increased mean annual air temperature (MAAT). Likely increase of MAAT by 0.5°C to 1.5°C, but lower/higher values cannot be excluded; some increase in length of warm spells and reduced frequency of cold periods.	Continuing trend of increased MAAT, aridity trend will reinforce decreased humidity especially under more erratic seasonal precipitation regimes; increased heatwaves; increased thunderstorm activity, heatwaves. Likely increase of MAAT by 0.5°C to 3.0°C, but lower/higher values not excluded; almost certain increase in length of warm spells and reduced frequency of cold periods.

Climate change trend / parameter	Impacts	
	By 2025	By 2055
Extreme events	More erratic precipitation and temperature regimes, resulting in some likely increase in extreme flood/drought events.	More erratic precipitation and temperature regimes, resulting in an increased likelihood of extreme flood/drought events, both in severity and duration. This will have a multiplier effect in increasing vulnerabilities to other risk events and thus result in wider likely impacts.
Agriculture	Food insecurity arising from political instability across the region and challenges to both food production and supply, climatic instability.	Increased overall drying trend and decreased winter rains result in decreased food production in total and land surface degradation and soil erosion due to increased aridity and soil moisture loss. Deforestation and loss of biodiversity an increasing issue. Aridification and spread of sand dunes in Sahelian areas. Rain-fed agriculture will be likely less reliable in many areas and irrigated agriculture will become more significant, but this poses problems for famers' access to technology, investment and training (including provision of GM seeds).
Health	Pockets of different disease types as a result of site-specific water/air/pollution, amplified by incorrect water, agricultural and land management practices, and mining wastes. Low nutrition/health in some areas due to food insecurity.	Widespread health effects due to food/water insecurity, availability of potable water, water contamination by runoff, and low water quality due to biological diseases, pollution/sewage runoff into rivers, and wastewater and groundwater contamination due to poor sanitation in informal settlements and due to industries such as mining.

CCRA Results

Climate Risks

The project comprises of a number of physical infrastructure components that were identified and screened at a high level against a series of relevant climatic threats for the area such as flooding, drought and fire. A summary of the outcome of the process in terms of climate risks is presented in **Table 23** along with a series of risk management options.

Table 23: Kazungula WSS - Climate Risk Matrix

Project component	Flood	Drought	Fire	Risk mitigation options
Provision of a reliable water supply system	**Medium**: • The raw water is abstracted from the Zambezi River and therefore flooding could have an impact. However, the existing intake is off the main river channel (lower water force, less debris and sediment) and floats on the water (no impact from rising water levels) – it therefore a resilient solution. • Flooding could impact the distribution network by causing pipes to 'float'. • Flooding could impact above ground infrastructure	**Medium**: • Prolonged drought can impact on the water levels in the Zambezi River, which could impact the abstraction of raw water. However, the existing intake floats on the water and has the ability to be moved further out into the river.	**Medium**: • Fire can have an impact on the intake, which is in an area with many reeds. • It could also have an impact on the above ground infrastructure like the treatment works and communal ablution blocks. • A reliable water system has a positive benefit, because the water can assist with extinguishing any fires that may result from dry / hot conditions	• CRIDF are currently reviewing the intake position to determine whether there is a position that will improve water quality and access. Will include the risk aspects identifying as part of the CCRA. • Design of above ground infrastructure will consider the possibility of high rainfall events and flooding, and ensure that suitable drainage is provided. • Any distribution pipes that are potentially in a flood risk area will be suitably designed against flotation. • Construction materials will be selected to be fire retardant. • Position of above ground infrastructure to consider the proximity of natural flammable materials.

Project component	Flood	Drought	Fire	Risk mitigation options
Water zoning and non-revenue water reduction	**Low**: • Flooding is unlikely to impact this project component.	**Low**: • Drought is unlikely to impact this project component. • Water zoning and reducing non-revenue water will reduce the impact of drought significantly.	**Low**: • Fire is unlikely to impact this project component.	No mitigation required
Provision of water and sanitation facility for the cross border population (communal ablution building)	**Medium**: • Flooding could damage the communal ablution building. • Flooding of the septic tank is possible, which could result in spillage of contents. • Flooding over the septic tank could also result in flotation.	**Low**: • Drought is unlikely to impact the communal ablution buildings.	**Medium**: • Fire could destroy or damage the communal ablution building.	• Design of above ground infrastructure will consider the possibility of high rainfall events and flooding, and ensure that suitable drainage is provided. • Construction materials will be selected to be fire retardant. • Position of above ground infrastructure to consider the proximity of natural flammable materials. • Possible flotation of the septic tank should be considered in design.

Resilience benefits

The project delivers a series of outcomes that enhance the resilience of project recipients to climate change. An overview of the project's outcomes along with a list of resilience benefits that the project delivers are presented in **Table 24**.

Table 24: Kazungula WSS - Climate Resilience Benefits Matrix

Project component	Livelihoods	Safety	Health	Governance	Gender	Education	Environment
Reduced water losses	**Medium**: Additional water for productive uses and consumption. Can lead to lower tariffs or at least improved maintenance due to higher economic sustainability	**Low**: No significant benefits	**Medium**: Less stagnant water caused by leaks. Lower risk of contaminants entering leaking pipes.	**High**: More efficient use of source, less lost revenue due to water loss	**Low**: No significant benefits	**Low**: No significant benefits	**Low**: No significant benefits
More reliable water supply	**Medium:** reduced risk of non-supply or utilisation of alternative supplies	**Low**: Some benefit due to higher visibility of kiosks and shorter time in risk areas.	**Medium**: Improved volume / supply of water for hygiene purposes	**Low:** No significant benefits, but improved customer relationship due to higher customer satisfaction	**High**: Women typically collect water for the entire family, a reliable supply aids in time management	**High**: Children are also responsible for water collection – reduced uncertainty equals better time management for	**Low**: No significant benefits

Project component	Livelihoods	Safety	Health	Governance	Gender	Education	Environment
						studies	
Improved water quality - reduced incidence of waterborne disease	**Medium**: Reduced time and cost dealing with health issues - providing more time for productive activities.	**Low**: No significant benefits	**Medium**: Reduced time and cost dealing with health issues - providing more time for productive activities.	**Low: No significant benefits**	**High**: Women typically collect water for the entire family, reduced time allows time for other activities	**High**: Children are also responsible for water collection – reduced time equals more time for studies	**Low**: No significant benefits
Improved revenue stream, system management and customer satisfaction	**Medium**: An improved water supply system will provide the consumer with value for money	**Low**: No significant benefits	**Low**: No significant benefits	**High**: An improved system will boost revenue and willingness to pay	**Low**: No significant benefits	**Low**: No significant benefits	**Low**: No significant benefits

CCRA Conclusions

The Track 1 CCRA shows that the project brings a number of high resilience benefits to the project recipients especially in relation to governance and livelihoods, gender and health. The review also identified a number of risks in relation to the associated infrastructure and risk-mitigating actions which if implemented will improve the resilience of the project itself to climate change risks.

Flood

The existing flood risk in the area is medium to high and is likely to intensify with future climate change impacts. The infrastructure that is at risk of flooding (communal ablution blocks and water treatment works) should be designed to firstly manage stormwater run-off and secondly minimise the impact of flooding.

Drought

Drought is a known and recurrent issue in the area and is likely to intensify with climate change. This could impact water abstractions from the Zambezi River and this in turn could have systemic implications for the water supply of the project area. An ongoing study is reviewing the current intake position and will consider the impact of climate change on potential relocation or mitigation modification.

Engineering Cost Estimate

The construction costs have been estimated for the recommended works to refurbish, improve and expand the water supply and sanitation system in Kazungula town. This section provides a summary of the estimated costs, with Bills of Quantities (BOQ) per phase included in **Annex 3**.

Water System Investment Costs

Table 25 provides a summary of the Immediate Measures estimated costs, while **Table 26** provides the estimated cost for Phase 1, 2 and 3. **Table 27** is a summary of the estimated costs for the water supply system upgrade for all phases.

Table 25: Estimated Cost of Immediate Measures – Water Supply

Item	Description	Immediate (IM1)	Immediate (IM2)
		US$	US$
A	**Water Supply Infrastructure**		
0	Intake and raw water transmission [Funded by bridge project]		436,100
1	Treatment works	87,000	
2	Transmission mains and storage	100,000	
3	Distribution network rehabilitation and expansion	110,000	
	Total	**297,000**	**436,100**

Table 26: Estimated Cost - Phase 1, 2 and 3 - Water Supply

Item	Description	Phase 1	Phase 2	Phase 3
		US$	US$	US$
A	**Water Supply Infrastructure**			
1	Treatment works	132,500	1,950,000	0
2	Transmission mains and storage	168,700	156,000	0
3	Distribution network rehabilitation and expansion	2,029,200	730,000	862,300
4	Contingency and Engineering (10%)	233,040	283,600	86,230
	Total	**2,563,440**	**3,119,600**	**948,530**

Table 27: Summary of Water Supply Estimated Costs

Item	Description	Immediate (IM1)
		US$
A	**Water Supply Infrastructure**	
A.1	Immediate Measures (IM1)	297,000
A.2	Immediate Measures (IM2)	436,100
A.3	Phase 1	2,563,440
A.4	Phase 2	3,119,600
A.5	Phase 3	948,530
	Total	**7,364,670**

Sewerage, Sanitation System and Behavioural Change Investment Cost

Table 28 provides a summary of the Immediate Measures estimated costs, while **Table 29** provides the estimated cost for Phase 1, 2 and 3. **Table 30** is a summary of the estimated costs for the water supply system upgrade for all phases.

Table 28: Estimated Cost of Immediate Measures – Sanitation

Item	Description	Immediate (IM1)
		US$
B	**Sewerage and Sanitation Infrastructure**	
1	Water and sanitation centres	123,000
2	Sewage treatment works	
3	Pumping station and lift stations	
4	Collection pipeline	
5	Education and awareness campaigns	5,000
	Total	**128,000**

Table 29: Estimated Cost of Phase 1, 2 and 3 - Sanitation

Item	Description	Phase 1	Phase 2	Phase 3
		US$	US$	US$
B	**Sewerage and Sanitation Infrastructure**			
1	Water and sanitation centres	55,500	0	0
2	Sewage treatment works	455,700	955,500	0
3	Pumping station and lift stations	0	205,800	0
4	Collection pipeline	472,000	649,000	823,200
5	Education and awareness campaigns	75,000	55,000	40,000
6	Contingency and Engineering (10%)	98,320	181,030	82,320
	Total	**1,156,520**	**2,046,330**	**945,520**

Table 30: Summary of Sanitation Estimated Costs

Item	Description	Estimated Cost
		US$
B	**Sewerage and Sanitation Infrastructure**	
B.1	Immediate Measures (IM1)	128,000
B.2	Phase 1	1,172,720
B.3	Phase 2	2,000,600
B.4	Phase 3	962,000
	Total	**4,263,320**

Combined Investment Costs

Table 31 summarises the combined estimated costs for the water supply and sanitation infrastructure.

Table 31: Combined Estimated Cost for Water Supply and Sanitation

Item	Description	A – Water Supply	B - Sanitation	Total Estimate	Total Estimate
		US$	US$	US$	£
C	**Combined Estimate**				
C.1	Immediate Measures (IM1)	297,000	128,000	425,000	297,500
C.2	Immediate Measures (IM2)	436,100	0	436,100	305,270
C.3	Phase 1	2,563,440	1,172,720	3,736,160	2,615,312
C.4	Phase 2	3,119,600	2,000,600	5,120,200	3,584,140
C.5	Phase 3	948,530	962,000	1,910,530	1,337,371
	Total	**7,364,670**	**4,263,320**	**11,627,990**	**8,139,593**

Operation & Maintenance Plan

The overriding objective is to deliver improved, reliable and sustainable services to Kazungula.

It is widely recognised that Operation & Maintenance (O&M) services are essential for providing improved services and neglect of this discipline will lead to inefficient and poor services and a reduced life of capital assets. Integral to achieving this is an efficient and effective O&M Plan implemented supported by new SWSC business practices.

It is proposed that SWSC continues to manage and operate Kazungula primarily from Livingstone, as it is now doing. This ensures an overarching efficiency and economy by sharing resources and expertise. The majority of O&M services for Kazungula will be provided from Livingstone and the wider resources of SWSC. It is envisaged that only a small SWSC workforce will be based in Kazungula utilizing good communications. The water and sanitation technology proposed for Kazungula is nearly identical to that used in Livingstone.

The entire O&M department is required to be coordinated under an O&M Plan with an adequate O&M budget. It is recommended that the existing O&M procedures are reviewed during the Immediate Measures through the Institutional Strengthening Assessment (described in the subsequent sections).

The review would include:-

i. The O&M organisational structure
ii. The O&M Budget
iii. The O&M Planned Maintenance program
iv. The Operations information system
v. The use and introduction of new and appropriate technology
vi. New and appropriate business processes
vii. Integration with the SWSC Commercial and Operations departments
viii. Training requirements
ix. O&M requirements for future investments, Phase 1, etc.
x. Development of new O&M procedures
xi. Development of a new O&M Plan

The Current O&M Situation

Currently SWSC in Livingstone takes the overall responsibility of the system management and operation in Kazungula. Maintenance and new connections to the system are the responsibilities of a Senior Plumber/Foreman and 3 general hands who are based at the SWSC treatment works. The other SWSC permanent employee in Kazungula is an intake pump operator at the intake pump house. Costs related to the water system are covered by SWSC based in Livingstone, with support from the Kazungula District Council. At the moment there is poor operation and a general lack of maintenance of the distribution infrastructure, for example valve boxes.

The current caretaker is not an administration official, he has a plumbing background, having worked for SWSC and the contractor during construction/installation of the system. For mechanical and electrical

installation, repairs or maintenance related technicians available in the town are contracted by SWSC for the work case by case.

The standpipe and water centre regular maintenance is guaranteed by the KDC and a market representative living near the standpipe having the responsibility of mobilising the users and payments to Council for that purpose.

An operation and maintenance programme of the system is in place and is being used by SWSC.

There is regular monitoring of distributed water quality in the network. Pontoon and Border activities at the intake, along the river are also a potential source of water pollution, although the level of influence is unknown.

For current analysis of water quality additional measurement equipment is required in the distribution network to allow the water supply operator to carry out water consumption data collection in a periodic basis, to guarantee the distributed water quality.

The sewer system will require skilled staff to guarantee maintenance is done correctly and the operation of the system at the level of service designed is efficient.

The technical staff will be required to monitor, maintain and repair timeously all appurtenances along the pipelines in both the conveyance systems. In addition, the small bore conveyance system will require less maintenance (by comparison) but will require sufficient and targeted monitoring. Because the depth of cover for the small bore pipeline is minimal, the Authority will need to ensure no illegal connections.

The waste water treatment ponds if well maintained will not cause pollution to the environment thereby requiring strict adherence to Plant Maintenance practices. The household interceptor tank connections are designed to be desludged every 3 years, but regular checks will be required to ensure the inhabitants and users of the system maintain the infrastructure within their premises. The desludging is the responsibility of the householder and can be carried out by the utility or private contractor.

Lift stations will require regular maintenance and proper operation.

Further information and recommendations relating to sustainability of the water and sanitation systems is captured under the institutional strengthening section later in the report.

Table 32 and **Table 33** and with related **Figure 16** and **Figure 17**, provide annual cost estimates of the operation and maintenance costs of the water and sewerage systems (including the ablution blocks).

Table 32: Water System Operation & Maintenance Costs (US$)

	Immediate Measures	Phase 1	Phase 2	Phase 3
Operational costs	**21,354.05**	**30,303.06**	**73,816.59**	**122,367.22**
Staff Costs	10,538.36	14,954.75	36,428.97	60,389.02
Water Purchase	831.98	1,180.64	2,875.97	4,767.55
Laboratory costs	1,663.95	2,361.28	5,751.94	9,535.11
Electricity costs	3,327.90	4,722.55	11,503.88	19,070.22
Chemicals	3,050.58	4,329.01	10,545.23	17,481.03
Fuel costs	1,663.95	2,361.28	5,751.94	9,535.11
Other costs	277.33	393.55	958.66	1,589.18
Maintenance costs	**6,378.48**	**9,051.56**	**22,049.11**	**36,551.25**

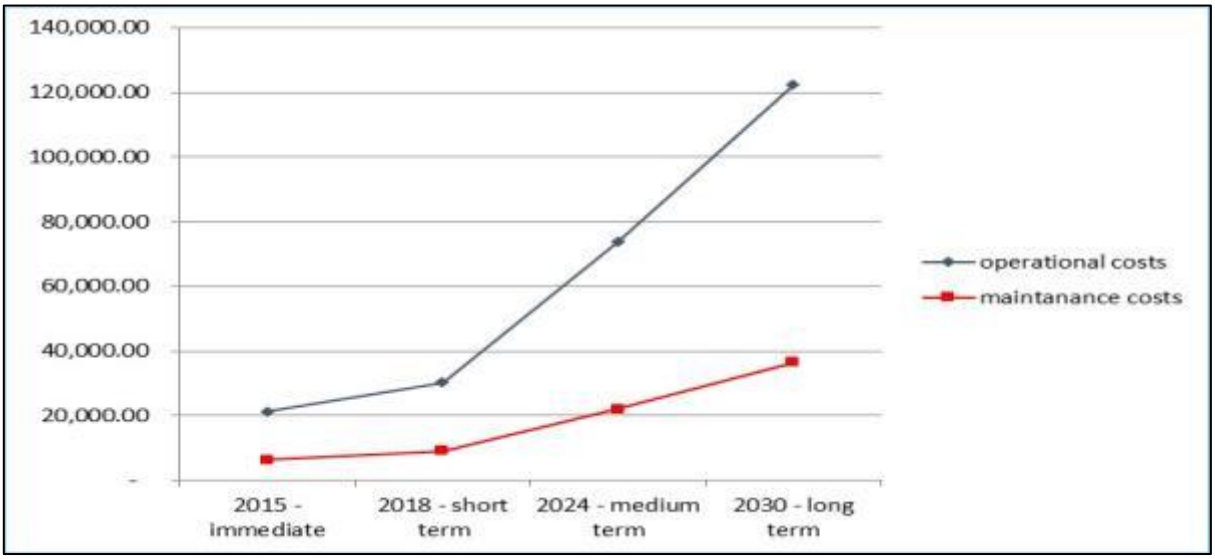


Figure 16: Operation & Maintenance costs of the water system per phase (US$)

Table 33: Sewerage System and Ablution Facility Operation & Maintenance Costs (US$)

	Immediate Measures	Phase 1	Phase 2	Phase 3
Operational costs	**5,069.78**	**16,555.41**	**32,195.60**	**46,141.69**
Staff Costs	3,560.30	7,801.52	13,798.11	23,378.46
Electricity costs	676.66	2,594.80	4,720.41	7,997.69
Chemicals	0.00	2,509.26	3,994.19	6,015.51
Fuel costs	624.61	2,737.37	7,262.17	6,562.37
Other costs	208.20	912.46	2,420.72	2,187.46
Maintenance costs	**3,253.20**	**13,283.50**	**21,913.78**	**36,013.03**

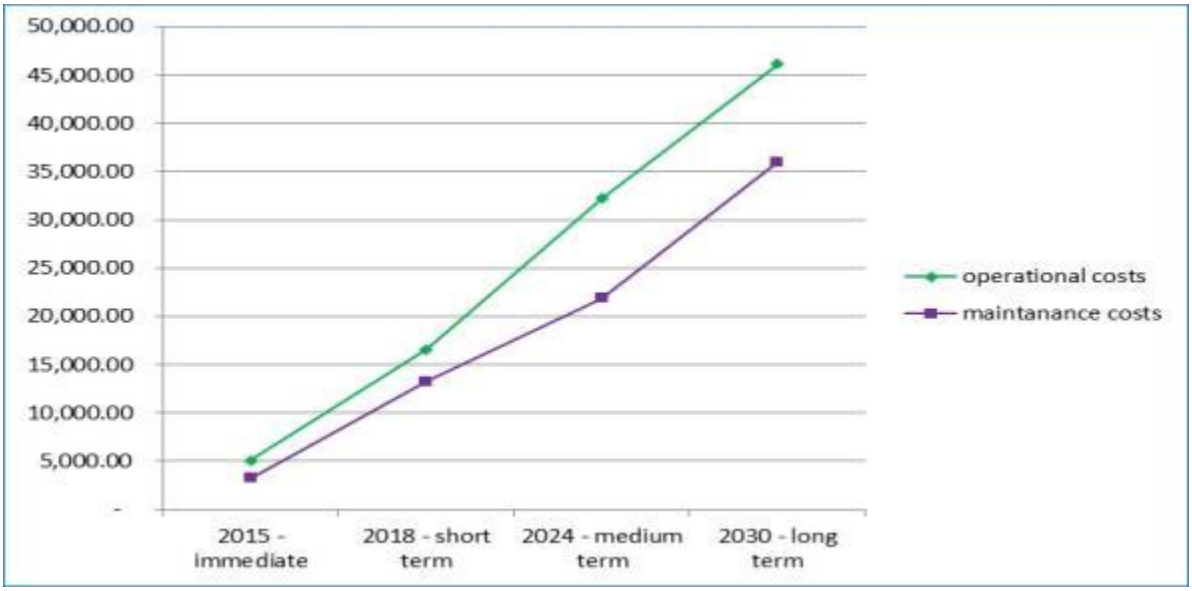


Figure 17: Operation & Maintenance costs of the sewerage system and ablution blocks (US$)

Financial and Economic Assessment

Introduction

The Financial and Economic Assessment aims to determine the financial and economic feasibility of the project as designed. Cost-Benefit Analysis (CBA) is the tool used for this assessment. CBA is a framework for appraising the viability of capital projects by weighing up financial flows, as well as the implicit and explicit positive and negative socio-economic impacts of the investment.

As such, the use of the project CBA is to show both the commercial and social imperatives of project. The CBA is also an invaluable tool for informing and guiding project development so that the project design maximises both the commercial and social imperative of project. In this respect, the project has been redesigned based on the outcomes of a previous CBA which found that despite the clear socio-economic justification for the project, the previous design was highly unlikely to be financially sustainable.

Methodology

A project CBA consists of the following core sections.

1. Purpose and Context
2. Options Appraisal
3. Financial Appraisal
4. Economic Appraisal
5. Sustainability Analysis
6. Risk Assessment
7. Conclusions and Recommendations

The first two sections serve to clarify the demand for and required scope of the infrastructure intervention; preferred technical solution; and hence parameters of the CBA. These two sections are comprehensively described early in the Feasibility Report in the introduction and technical section.

The remainder of this section of the Feasibility Report therefore includes the core assumptions to the CBA, followed by the **financial appraisal** which looks at the financial flows (expenditures and revenues) over the life of the project, to calculate the Financial Net Present Value (FNPV) of the investment, Financial Internal Rate of Return (FIRR) on the project investment, and Financial Benefit-Cost Ratio (BCR). The **economic appraisal** then assesses a wider spectrum of costs and benefits compared to the case of pure profit determination of the financial appraisal. The outcome of the quantitative economic appraisal includes the Economic Net Present Value (ENPV), Economic Rate of Return (ERR), and Economic Benefit-Cost Ratio (BCR) of the project. In addition to these quantitative indicators, a description of qualitative economic impacts, serves to inform an understanding of the expected net socio-economic impact of the project to society.

Based on the results of the financial and economic appraisals, and drawing on a broader understanding of the context, institutional arrangements, and capacity of the project owner, a **sustainability analysis** then provides an assessment of the on-going financial and economic sustainability of the project. Lastly a high-level **risk**

assessment serves to highlight the key risks to the financial and economic viability of the project and discusses associated recommendations for risk mitigation arrangements, before final **conclusions and recommendations** of the CBA are put forward.

Assumptions

Due to the CBA being done early in 2015, the exchange rates, phasing, population and time frames are not identical to the current Feasibility Study, but the majority of the changes will impact the CBA in a positive manner.

Exchange rate

All values in the analysis are presented in American Dollars (US$), with assumed exchange rates, as observed at the time of analysis of:

ZMW 1.00 = US$ 0.15198

US$ 1.00 = ZMW 6.5

US$ 1.00 = GBP 0.6585[24]

Time Frame

The CBA is conducted over a project life of 30 years, from 2015-2045.

The capital investment is phased over 15 years, as per **Table 34**.

Table 34: CBA Project Phases

Phase	Date of Implementation
Immediate Measures	2015
Phase 1	2018
Phase 2	2024
Phase 3	2030

[24] http://www.oanda.com/currency/converter/ accessed 5 Feb 2015

Population

The *Social* section of this Feasibility Report presents projected population figures as shown in the table below. These projections are based on a standard 3% population growth rate between 2014 and 2045; plus in-migration due to town developments of:

- 1,800 people in 2014;
- 250 people per year between 2015 and 2018; and
- Approximately 1,480 people per year between 2024 and 2030.

Table 35: CBA Population[25]

	2014	2015	2018	2024	2030
Population	5,500	7,500	8,900	10,500	22,300

Incremental values

The purpose of the CBA is to determine the viability of the project investments in isolation; i.e. to focus only on those changes to cost and revenue streams that occur as a result of the project, which otherwise would not occur in its absence.

The CBA is therefore based on a with- and without-project basis and hence includes only incremental values for costs and benefits. The without project scenario is assumed to be 'do-nothing' or 'Business as Usual', and hence all costs and benefits (expenditures and revenues) used in the analysis are net of the current level of costs and benefits. Hence the CBA includes:

- O&M costs over and above the level of those occurring in the current situation (assumed to be US$ 1,730 per month)[26].
- Water tariff revenues only for the additional water consumed/billed for, relative to the current situation (assumed to be US$ 2,076 per month).[27]

Discount Rates and Inflation

The discount rate used in the financial appraisal is the real interest rate in Zambia; the most recent estimate provided by the World Bank being 3.7% for the year 2013[28].

The economic appraisal is conducted with a discount rate of 10% and 3.5% in line with the CRIDF CBA guidelines. The CBA uses constant prices.

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[25] Refer to the *Social* section of this Feasibility Report for detail on the calculation and assumptions around the population projections for Kazungula town. These populations are identical, although at different dates.
[26] SWSC March 2014 Budget ("Copy of January 2013 Monthly Report 21")
[27] CRIDF-SWSC general meeting, SWSC Livingstone, 7 May 2014, where it was explained that cost recovery of the Kazungula system from water tariffs was just reaching 120%.
[28] http://data.worldbank.org/indicator/FR.INR.RINR

Conversion Factors

In order to measure economic value, financial (market) prices should be adjusted to correct for market distortions which manifest in financial prices. These adjustments are termed 'shadow pricing' and ensure that economic prices applied to inputs and outputs in the economic appraisal reflect their opportunity cost or real scarcity in society. Shadow pricing is achieved through the application of appropriate 'conversion factors' to financial prices.

To correct for foreign exchange and trade pricing distortions, financial prices of tradable inputs and outputs should be adjusted by a 'standard conversion factor' (SCF). The African Development Bank (AfDB) estimates a 'Standard Conversion Factor' (SCF) of 0.8 for Kazungula in the Project Appraisal conducted for the Kazungula Bridge Project in 2011[29]. This SCF is applied to capital investment costs of the water supply infrastructure and sanitation infrastructure, to determine economic values in the economic appraisal of the CBA.

To address distortions in the market price of labour in the context of high unemployment (such as that in Kazungula) FAO (2002)[30] estimates a conversion factor for unskilled labour in Zimbabwe of 0.4 given high unemployment levels. For analysis of Namibia, look to Barnes (1994)[31] and Humavindu (2008)[32] and adjust the financial prices for semi-skilled and unskilled labour by factors of 0.5 and 0.35 respectively.[33] A labour conversion factor of 0.4 is therefore seen as a credible average for Kazungula, and applied to the staff component of on-going O&M costs in the economic appraisal of the CBA.

Financial Appraisal

The financial appraisal is conducted from the perspective of SWSC which is responsible for the operation and maintenance of the infrastructure, and is the direct recipient of the associated water and sewerage service tariffs and charges. The purpose of the appraisal is to understand the financial return to the project infrastructure investment and the financial viability of the infrastructure in terms of its operational sustainability.

The costs considered in the financial appraisal include the capital investment for the water and sanitation infrastructure, and the operation and maintenance cost for the two systems. The revenue considered includes the expected water tariffs that will be charged to domestic, institutional, commercial and industrial customers for consumption, and sewerage treatment charges from those customers connected to the reticulated system.

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[29] African Development Fund (2011) Project: Kazungula Bridge Project (SADC North-South Transport Corridor Improvement), Project Appraisal Report, AfDB

[30] Savva, P. & Freken, K (2002) "Financial and Economic Appraisal of Irrigation Projects", FAO Sub-Regional Office for East and Southern Africa, Harare, ftp://ftp.fao.org/docrep/fao/010/ai600e00.pdf

[31] Barnes, JI (1994). "Suggested criteria for shadow pricing in the cost–benefit analysis of projects in Namibia". Mimeo. Windhoek: Environmental Economics Unit, Ministry of Environment and Tourism

[32] Humavindu, M.N. (2008) " Essays on the Namibian Economy", Umeå Economic Studies No. 745, Department of Economics, Umeå University, Umeå, Sweden

33 CRIDF (2014) KAZA feasibility report, CRIDF

Project Costs

Capital Investment

The total project investment amounts to Capital (including engineering) of US$11,627,990 plus an estimate of US$150,000 for Institutional Strengthening, i.e. US$ 11,777,990. The capital therefore consists of investments in water supply infrastructure; sewerage infrastructure (including a sanitation behavioural change initiative) and institutional strengthening of SWSC.

The water supply infrastructure investment is the largest component of the project (amounting to US$ 7.4 million) followed by the sanitation investment (amounting to US$ 4.2 million). The institutional strengthening investment (amounting to US$ 150,000) is to ensure that SWSC is in a position to implement and sustainably operate the project infrastructure.

Included in the water infrastructure component is an investment of US$ 436,100 for the relocation of the water intake and associated raw water transmission line. Although it is expected that this investment will be funded by the Kazungula Bridge Project, it is included in the CBA as it is part of the project intervention.

The full project infrastructure, which will only be fully completed in **2030**, is expected to have an economic life of 30 years. The remaining useful life of the infrastructure after 2045 (the time frame of this CBA) is accounted for by a residual value in 2045 included as a 'negative capital investment cost' and is estimated as the expected net project revenue from 2046 to 2060 discounted to 2045.

Table 36: Capital Investment Costs

	Immediate Measures	Phase 1	Phase 2	Phase 3	Total (US$)
Water Supply Infrastructure	733,100	2,563,440	3,119,600	948,530	**7,364,670**
Sewerage Infrastructure (and behavioural change)	128,000	1,172,720	2,000,600	962,000	**4,263,320**
Institutional Strengthening	25,000	60,000	25,000	40,000	**150,000**
Total (US$)	**886,100**	**3,796,160**	**5,145,200**	**1,950,530**	**11,777,990**

Operation and Maintenance Costs

Table 37: Annual Operation and Maintenance Costs (US$)

	Immediate Measures	Phase 1	Phase 2	Phase 3
Water Supply Infrastructure	28,733	39,355	95,866	158,918
Sewerage Infrastructure (and behavioural change)	8,323	29,839	54,109	82,155
Total (US$)	**36,056**	**69,194**	**149,975**	**241,073**

Project Revenues

Income streams included in the CBA are water supply tariffs and sewerage treatment charges associated with water supply and sewerage service provision delivered through the project infrastructure.

Water Supply Tariffs

Projected water supply tariff revenue is based on demand projections, as estimated in the technical section of this Feasibility Report, and summarised in the table below for selected years. Water tariff rates are based on SWSC 2014 approved tariffs.

Domestic demand is based on population growth and the evolution of consumption patterns between standpipes, yard taps and household connections over time. Domestic tariff rates based on the varying levels of consumption assumed for each connection type are based on the SWSC 2014 approved domestic block rates.

Institutional and commercial demand (including that from the border post, hospital, fire fighting, schools, market place, etc.) is estimated for each phase of the project based on the expected developments in Kazungula (these include the Kazungula Bridge Project; Government Housing Project; new Hospital; and new secondary school). An average institutional/commercial tariff of US$ 0.76 is used based on the SWSC 2014 approved tariff rates.

SWSC states that there is currently 100% water supply coverage in Kazungula; however Non-Revenue Water (NRW) is currently at 55%. Projected improvements in NRW reach 30% by 2030 and 15% by 2045, in line with SWSC targets. Projected water tariff revenues included in the CBA are therefore net of the projected level of NRW.

Water demand and water tariff revenue projections

Table 38: Water demand and water tariff revenue projections

Demand	Per unit demand	Tariff rate (US$/m³)	2016	2019	2025	2031	2045
Standpipe (m3/month)	30 l/c/d	0.44	3,215	3,617	4,990	10,037	15,638
Yard tap (m3/month)	50 l/c/d	0.64	5,597	6,028	6,028	10,037	15,638
House connection (m3/month)	100 l/c/d	0.64	1,905	2,679	3,199	13,383	20,850
Potential Domestic Revenue (US$/yr)			**74,471**	**85,819**	**97,450**	**232,482**	**362,200**
Institutional/Commercial (m3/month)		0.76	1,175	1,532	2,304	5,887	5,887
Potential Institutional Revenue - (US$/yr)			**10,711**	**13,887**	**21,010**	**53,684**	**53,684**
Non-revenue water			51%	42%	29%	24%	15%
Total Projected Water Tariff Revenue (US$/yr)			**41,383**	**59,311**	**95,684**	**222,309**	**353,501**

Sewerage Charges

The project's reticulated sewerage system design assumes an 80% flow return rate. As per SWSC's 2014 approved tariffs, a 20% sewerage treatment charge is levied on customers connected to reticulated sewerage systems.[34] Sewerage charge revenues are based on the technical design estimates for required capacity (based on expected demand) in each phase of the project, as shown in table 55 for selected years.

The average water tariff assumed for customers connected to the sewerage system is US$ 0.76, making the effective sewerage charge rate of 20% equal to US$ 0.152/m^3.

[34] This means that 80% of a customer's domestic water consumption is returned into the reticulated sewerage system for treatment. A charge of 20% of the customer's water bill is levied to pay for the treatment of this water.

Table 39: Sewerage charge revenue projections

	IM - 2015	Phase 1 - 2019	Phase 2 - 2025	Phase 3 - 2031
Required capacity (m^3/month)	-	3,743	6,300	21,600
Rate (US$/month)	-	0.152	0.152	0.152
Total Projected Sewerage Charge Revenue (US$)	**-**	**6,827**	**11,490**	**39,393**

It is assumed in the CBA model, that the water supply and sewerage service project-related revenues described above are realised from 2016 onwards (year 1).

Financial Appraisal Results

The results of the appraisal indicate that the project as a standalone entity is not financially viable: at a 3.7% discount rate the FNPV is negative (-US$ 8.3million); and the FIRR (-6.56%) is below the discount rate. These results show that the revenues generated by the project infrastructure are not sufficient to cover the full investment cost over the project life. This is not surprising, given that water and sanitation provision is largely a public good. **Annex 5** contains a full summary of the financial appraisal.

Table 40: Financial Appraisal Results Summary

Indicator	Results (3.7% discount rate)
FNPV (US$)	-8,344,172
FIRR (%)	-6.56%
FBCR	0.24

In terms of the financial sustainability of the project infrastructure however, the projected operational cost-recovery of the infrastructure is positive. Annual operational cash-flows (annual revenues less annual 'O&M costs) have a positive FNPV of US$ 469,110 and BCR of 1.21, implying that over the project life, cost recovery exceeds SWSC's target of 120%. This implies that the project infrastructure will be financially sustainable should external grant/concessional financing be found for the required capital investments.

Table 41 indicates the financial return on the project investment when varying degrees of external grant funding are leveraged. The minimum external grant injection into the project required to achieve a FNPV of zero, and rate of return equal to the discount rate (3.7%) – that is a 'break-even project – is US$ 8,344,172. As clear from the table below, this break-even grant amount is higher that the cumulative capital investments for the Immediate Measures; Phase 1; and Phase 2. An external grant for the entire capital investment (Immediate Measures, and all three subsequent phases) results in a positive FNPV of US$ 1 million and FIRR of 13%.

The FIRR indicator is not suitable for projects with a non-typical distribution of cash-flows[35] (as is the case here where cash-flows alternate between negative and positive values given the phased nature of the capital investment). The FIRR indicators should therefore be viewed with caution in the results, and where the FIRR contradicts the FNPV (such as scenario 5 in the table below) the FNPV indicator should take precedence.

Table 41: Project Funding Scenarios

		FNPV (US$)	FIRR (%)
1	Project alone	-8,344,172	-6.56
2	Including expected Bridge Project contribution to IM (US$ 436,130)	-7,908,956	-6.45
3	Including grant funding for full IM investment (US$ 861,100)	-7,497,246	-6.33
4	Including grant funding for IM and P1 investments (US$ 4,672,260)	-2,839,525	-3.97
5	Including grant funding for IM, P1 & P2 investments (US$ 9,842,460)	-120,208	*2.87*
6	Including grant funding for entire capital investment (US$ 11,777,990)	1,001,572	13.12
7	Break-even grant funding (US$ 8,344,172)	0	3.7

Sensitivity analysis

A sensitivity analysis was conducted on the financial analysis to determine which project parameters have the largest impact on the financial viability of the project (summarised in **Annex 5**).

The sensitivity analysis shows that the only parameter critical[36] to the outcome of the financial appraisal is the capital cost. Even a 30% decrease in capital costs does not result in a viable project (a 30% decrease in both capital and O&M costs also does not result in a viable project). It is therefore concluded that the negative results of the financial appraisal are robust.

The sensitivity analysis however also serves to show the impact of a variation in project parameters on annual operational cost-recovery. The parameters which have a significant impact on operational cost-recovery are O&M costs; domestic water demand; the average domestic water tariff rate; and water supply coverage (which is assumed to be 100% by SWSC at present). A 30% change (for the worse) in any of these parameters shifts

[35] Mackevicius, M. & Tomasevic, V. (2010) "Evaluation of investment projects in case of conflict between the internal rate of return and the net present value methods", ISSN 1392-1258. EKONOMIKA, Vol.89(4) [http://www.zurnalai.vu.lt/files/journals/37/articles/962/public/116-130.pdf]

[36] Critical parameters are seen as those in which a percentage variation in the parameter leads to a larger percentage variation in the NPV of the project.

the operational cost-recovery of the project from positive to negative. These parameters are therefore critical to the sustainable operation of the infrastructure.

Separate Water and Sewerage Schemes

A brief analysis was also made of the water and sewerage investments in isolation of each other, to assess the relative cost recovery of each.

- **Water supply**

The analysis of the water supply scheme alone includes the investment in water infrastructure as well as the investment in institutional strengthening (as this is seen as essential to the operation of the water scheme). Similarly the O&M costs and tariff revenues considered are only those directly linked to the water supply scheme. The results showed that the water supply (and institutional) investment alone is not financially viable, with an FNPV of –US$ 2.67million and FIRR of -0.10%.

The annual operational cash-flows of the water scheme however show a positive FNPV of US$ 1.98million and FBCR of 2.52, indicating operational cost-recovery comfortably above SWSC's120% target.

- **Sewerage and sanitation**

The sewerage infrastructure capital investment is not financially viable alone either, with an FNPV equal to –US$ 4.5million and FIRR undefined (as there are no positive net cash-flows over the project life). The operational cash-flows of the sewerage system also result in a negative FPNV of –US$ 576,719 and FBCR equal to 0.37. This is not surprising given it will be the first reticulated sewerage system in the area, involve significant overhead costs with incremental uptake associated with cultural adjustments in sanitation behaviour.

It is therefore clear that in the project as a whole, water supply infrastructure revenues 'subsidise' the sewerage system charges to meet total O&M costs, and to achieve operational cost-recovery of the entire project.

Economic Appraisal

The economic appraisal is conducted from the perspective of the economy as a whole, to assess whether the project will have a net positive socio-economic impact. As such, the economic appraisal assesses project costs and benefits beyond financial returns alone, and does so at prices equal to their real value to society rather than financial/market prices.

Project Costs

The costs included in the economic analysis are the financial capital and O&M costs adjusted by appropriate conversion factors to account for market distortions, as discussed in the assumptions section. The resultant economic costs are summarised in the following tables.

Table 42: Economic Capital Investment Costs

	Immediate Measures (2015)	Phase 1 (2018)	Phase 2 (2024)	Phase 3 (2030)	Total (US$)
Water Supply Infrastructure	490,610	2,753,870	1,358,499	778,640	5,381,618
Sewerage Infrastructure (and behavioural change)	192,000	1,353,649	1,626,082	749,033	3,920,763
Institutional Strengthening	0	75,000	50,000	25,000	150,000
Total (US$)	682,610	4,172,518	3,034,581	1,552,673	9,452,382

Table 43: Operation and Maintenance Costs

	Immediate Measures (2016)	Phase 1 (2019)	Phase 2 (2025)	Phase 3 (2031)
Total (US$)	25,575	51,922	113,095	178,370

The economic O&M costs are again included in the CBA as incremental values, net of current O&M costs which are also adjusted by the labour conversion factor for the staff component of current O&M costs.

Project Benefits - Quantitative

The economic benefit of the water and sanitation services supplied by the project must be valued in the economic appraisal at its real value to society, as opposed to the market tariffs and charges as in the financial appraisal. The real value of water supply and sanitation is commonly estimated as the maximum Willingness to Pay (WTP) of consumers for the service rather than the market tariff.

WTP is defined such that it includes the full benefit of water and sanitation provision to a consumer – i.e. in terms of health, time savings, productivity, preference of supply, etc. – and is typically assessed through stated preference (contingent valuation) survey methodologies. Such survey methodologies can however be resource intensive and misleading in instances where there is significant asymmetry of information (e.g. if the benefits of clean water are not fully known or understood by the respondent in terms of the impact on their health or productivity, then their perceived WTP will be too low). Moreover, when significant affordability constraints exist, it is very difficult to avoid moral hazard in WTP survey responses.

In this economic appraisal therefore (in the absence of a WTP survey and analysis) the following expected project benefits are quantified and assigned a monetary value in order to estimate the real (economic) value of water and sanitation service provision associated with the project investment:

- Health benefits of improved water supply and sanitation
- Domestic time savings from improved access
- Institutional / commercial time savings from improved access
- Environmental benefits of improved water supply and sanitation

Health Benefits

The sanitation status quo in Kazungula is poor. Few high-cost houses and institutional buildings have pit latrines or septic tanks, from which there is often surface flooding in the rainy season. The majority of the population, including the transitory truckers waiting at the border, use limited unimproved pit-latrines and/or practice open defecation. Although SWSC reports 100% water supply coverage, given limitations in supply capacity and reliability, drinking water is also at times obtained from the river and other surface sources.

The most prevalent diseases in Kazungula and Kasane (across the border) are malaria; diarrhoea and dysentery; bilharzia; upper tract infection; malnutrition; skin diseases; and ear, nose and mouth infections. The prevalence of HIV/AIDs is also very high on both sides of the river, especially around the border post and pontoon site.[37] As indicated in the *Social & public health* section of the Feasibility Report, diarrhoea is the primary initial indicator of many sanitation related diseases, particularly faecal-oral diseases such as cholera, dysentery, enteric or typhoid fever, and the (occasionally) water-washed condition diphtheria. Current figures for Kazungula show a consistent incidence of about 100-150 cases per month between 2013 and 2014 (roughly 2-3% prevalence). National statistics find diarrhoea prevalence in children under five of 17.3% in the Southern Province of Zambia, and is found to be a major cause of morbidity.[38] Exposure to diarrhoea-causing agents is frequently related to the use of contaminated water and to unhygienic practices in the preparation of food and disposal of excreta,[39] and the WHO and SIWI find that improved water supply can decrease diarrhoea morbidity by up to 25%; and hygiene interventions and drinking water quality can reduce the number of diarrhoeal cases by up to 45% and 39% respectively.[40] Moreover, more expensive interventions such as the implementation of advanced types of technologies such as regulated in-house piped water and sewer connections (as planned in the project), can lead to an average global reduction in diarrhoeal cases by around 70%.[41]

The expected imminent increase in the population and concentration of people in Kazungula, as well as cross-border traffic, will further exacerbate the poor sanitation and hygiene situation, with the additional refuse affecting local communities, and finding its way into the river, increasing the risk of potential disease outbreaks

[37] Egis bceom International Egis jmi (2010) " Consultancy services for the Feasibility and Detailed Design of the Kazungula Bridge, Border Facilities and Corridor Studies – Scoping Report for ESIA Study", The SADC North-South Transport Corridor Improvement Study, SADC Secretariat, African Development Bank

[38] Central Statistics Office (CSO), Ministry of Health (MOH), Tropical Diseases Research Centre (TDRC), University of Zambia, and Macro International Inc. (2009) "Zambia Demographic and Health Survey 2007", CSO & Macro International Inc., Calverton, Maryland, USA

[39] Central Statistics Office (CSO), Ministry of Health (MOH), Tropical Diseases Research Centre (TDRC), University of Zambia, and Macro International Inc. (2009) "Zambia Demographic and Health Survey 2007", CSO & Macro International Inc., Calverton, Maryland, USA

[40] WHO & SIWI, " Making Water a Part of Economic Development" , Govt Norway & Sweden as inout into Commission on Sustainable Development (CSD) (2004-2005)

[41] WHO & SIWI, " Making Water a Part of Economic Development" , Govt Norway & Sweden as inout into Commission on Sustainable Development (CSD) (2004-2005)

such as cholera.[42] Indeed, the scoping report for the Bridge ESIA Study found that the negative health impact of the Bridge development is expected to be most severe on the Zambian side of the river, primarily because of the current lack of water infrastructure and sanitation facilities in Kazungula.

The World Bank Water and Sanitation Program (WSP) has calculated the economic costs of poor sanitation in Zambia[43]; it found that Zambia loses US$ 194 million annually – or US$ 16.40 per person annually – due to poor sanitation. These figures comprise of the following costs:

a) The cost of time saved by people practicing open defecation – which falls disproportionately on women – in finding a private location to defecate. Open defecation is a significant problem in Kazungula in particular.
b) The cost of premature death due to illness attributed to poor water, sanitation, and hygiene (predominantly diarrhoea). As indicated above, diarrhoea is a prevalent challenge already in Kazungula.
c) The cost of productivity losses while sick or accessing health care. This again related to further opportunity costs of time.
d) The cost of healthcare treatment for related diseases. This burden can fall directly on households, or places a significant burden on the state in the case of public care.

The economic cost estimate of poor sanitation is used as a basis to estimate the health benefits (or avoided cost) of the project on both the resident Kazungula population and transitory population (traffic) passing through the border town. The following table provides a summary of the estimated health benefits of the project for selected years.

Table 44: Estimated Health Benefits for Selected Years

	2015	2019	2025	2031	2045
Resident population	7,465	9,198	12,463	22,974	34,751
Cost of poor sanitation (US$/capita/yr)	16.4	16.4	16.4	16.4	16.4
Assumed % of per capita cost avoided due to project	0%	75%	80%	90%	90%
Sanitation cost saved (US$/capita)	0	12.30	13.12	14.76	14.76

[42] Egis bceom International Egis jmi (2010) " Consultancy services for the Feasibility and Detailed Design of the Kazungula Bridge, Border Facilities and Corridor Studies – Scoping Report for ESIA Study", The SADC North-South Transport Corridor Improvement Study, SADC Secretariat, African Development Bank

[43] WSP Africa (2012) "Economic Impacts of Poor Sanitation in Zambia" Water and Sanitation Program, World Bank, http://www.wsp.org/sites/wsp.org/files/publications/WSP-ESI-Zambia.pdf

	2015	2019	2025	2031	2045
Avoided sanitation costs – resident population (US$/yr)	**0**	**113,133**	**163,510**	**339,101**	**512,921**
Transitory population (border-post traffic) (vehicles/yr)[44]	130,670	130,670	159,140	159,140	159,140
Cost of poor sanitation (US$/capita/yr)[45]	16.4	16.4	16.4	16.4	16.4
Assumed % of per capita cost avoided due to project	0%	50%	50%	50%	50%
Sanitation cost saved (US$/capita)	0	8.20	8.20	8.20	8.20
Avoided sanitation costs – traffic (US$/yr)	**0**	**1,071,494**	**1,304,948**	**1,304,948**	**1,304,948**

Important to note is that WSP argues that the estimate of US$ 194 million (or US$ 16.40 per person) is also very likely an underestimation of the true cost of the current sanitation situation in Zambia. Some costs which are more difficult and expensive to estimate have not been precisely valued and are excluded from the estimate. These costs – which are also particularly relevant in Kazungula – include:

a) The cost of epidemic outbreaks, of which faecal contamination of the environment is the root cause of an annual average 3,200 cases of cholera affecting Zambia. The economic implications of a cholera outbreak go far beyond the immediate health system response (estimated at US$ 2 million per year in Zambia), to productivity losses, premature death, diversion of expenditure, and losses in trade and tourism. This risk in Kazungula is particularly acute, as the economic implications would likely spread across to neighbouring countries and have a similar impact on their economies.
b) The cost of reduced long-term cognitive development which is a result of early childhood diarrhoea and associated under-nutrition, stunting and wasting.
c) The cost of funerals, which are borne directly by households and are particularly significant in African culture. A study in South Africa found that on average, households spend the equivalent of year's total expenditure on food and groceries on funerals.
d) The cost of water pollution and the adverse impact of excreta disposal on water resources. WSP found that such figures are not available for Africa specifically; however where water pollution affects

[44] Egisbceom International & Egisjmi (2010) " Environmental and Social Impact Assessment VOLUME 2", African Development Bank & SADC
[45] Conservatively assuming one passenger per vehicle

downstream drinking water supply, treatment costs add to the cost of poor sanitation. This cost has been considered for Kazungula in the following 'environmental benefit' subsection below, given the populations and tourism initiatives downstream of Kazungula.

e) The cost of the negative impact of inadequate sanitation on tourism. The sanitation status of a country is one of the key factors that contribute to travel and tourism competitiveness. This is particularly relevant in the case of Kazungula given the surrounding tourist attractions and the option for tourists to visit neighbouring countries on the other side of the river with better facilities. As such the potential positive impact of the project on the tourism sector is considered in the qualitative section on multiplier effects.

Domestic Time Savings

In addition to the time savings mentioned above as a result of avoided illness and time spent finding a private location to defecate; there are expected to be additional savings in terms of the time currently spent collecting domestic water from limited public access points, the river, or other sources.

As per World Health Organisation (WHO) guidance (2004)[46], water collection time saved per household per day for better *external* access is on average 0.5 hours; and water collection time saved per household per day for *piped water* is on average 1.5 hours. The economic appraisal therefore uses an estimated expected savings of 1 hour per household per day on average; given that there will be household and standpipe/communal piped connections.

The WHO estimates the opportunity cost of time to be equal to the relevant minimum wage rate (as published by the World Bank). There is no World Bank data on the Zambian wage rage. However the Zambia Labour Market 2013 Profile[47] indicates the minimum wage in Zambia - determined in 2012 - ranging from US$ 133 (lowest minimum wage) to US$ 275 (highest minimum wage).

The lowest minimum wage from 2012 is used as a conservative estimate, multiplied by the labour conversion factor to attain the real value (opportunity cost) of time in the context of high unemployment.

The table below provides a summary of the estimated domestic time savings of the project for selected years.

[46] http://www.who.int/water_sanitation_health/wsh0404.pdf
[47] http://www.ulandssekretariatet.dk/sites/default/files/uploads/public/PDF/LMP/zambia_2013_final_web.pdf

Table 45: Estimated Domestic Time Savings for Selected Years

	2016	2019	2025	2031	2045
Resident population	7,939	9,198	12,463	22,974	34,751
Households	1,654	1,916	2,596	4,786	7,240
Time saved per household (days/yr)	15.21	15.21	15.21	15.21	15.21
Total time saved (days/yr)	25,154	29,142	39,487	72,792	110,104
Value of time (US$/day)	1.75	1.75	1.75	1.75	1.75
Value of total time saved (US$/yr)	**43,995**	**50,971**	**69,064**	**127,316**	**192,577**

Institutional and Commercial Time Savings

The direct economic benefit of the project on institutional and commercial consumers is expected to include improved labour productivity and better access to water as a fundamental factor of production. Quantification of these benefits in the CBA includes the expected time savings from the alternative of collecting the same amount of water from less accessible sources. This is a conservative approach to avoid any potential double counting of health benefits.

The WHO estimates 1.5 hours per household is saved through piped water connections to collect average daily demand of 120 litres[48]. The CBA therefore uses an estimated time savings of 1.5 hours per day for collection of 120 litres, valued at the higher minimum wage of US$ 275/month.

The following table provides a summary of the estimated institutional and commercial time savings of the project for selected years.

Table 46: Estimated Institutional & Commercial Time Savings for Selected Years

	2016	2019	2025	2031	2045
Water demand (m^3/yr)	35,726	46,322	70,080	179,069	179,069
Time saved (days/m^3)	0.52	0.52	0.52	0.52	0.52
Total time saved (days/yr)	18,607	24,126	36,500	93,265	93,265
Value of time (US$/day)	3.62	3.62	3.62	3.62	3.62
Value of total time saved (US$/yr)	**67,293**	**87,251**	**132,000**	**337,288**	**337,288**

[48] http://www.who.int/water_sanitation_health/wsh0404.pdf

Environmental Benefit

There is currently pollution of the surrounding environment and Zambezi River from open defecation and surface flooding of pit latrines and septic tanks in Kazungula. Such pollution is expected to become significant as the population and concentration of people in Kazungula increases rapidly.

WHO and SIWI[49] argue that immediate and future economic profits depend directly on investment in improved water resources management to maintain ecosystem goods and services – the economic costs of environmental degradation have been estimated at 4-8% of GDP in many developing countries.[50] Moreover, poor segments of the population are disproportionately dependent on natural resources and ecosystem goods and services for their livelihood.[51]

Work carried out for the Zambezi Basin specifically, found that the natural wetlands in the basin have an annual NPV of over US$ 64 million comprising of the value of groundwater recharge; water purification and treatment services; and reduced flood related damage costs.

A portion of the environmental benefit of the project can be quantified by estimating avoided water treatment costs for downstream users, who include small villages and communities, Livingstone town, and various tourism lodges and initiatives along the river and at Victoria Falls, all of whom rely on the Zambezi River for their domestic water supply and economic livelihood.

Krop et al (2008)[52] estimate that US$ 1.00 invested in watershed protection is associated with a savings of between US$ 7.50 – US$ 200 in avoided costs for new treatment and filtration facilities. Given the current and potential level of pollution from surface flooding of unimproved pit latrine and septic tanks, the economic appraisal assumes the sanitation investment (US$ 4.9 million), as an investment in the protection of the Zambezi River and the surrounding environment, and associated avoided treatment and filtration facilities. Using the most conservative estimate of US$ 7.50 savings per dollar investment, and assuming that 50% of this long-term benefit will be realised in 2045, a future avoided cost of US$ 18.4 million is therefore included as an economic benefit of the project in year 2045.

Quantitative Results

The results of the quantitative economic appraisal, as summarised in the table below, the project is economically desirable at both a 3.5% and 10% discount rate. **Annex 5** in the annexure contains a summary of the full economic appraisal.

[49] WHO & SIWI, " Making Water a Part of Economic Development" , Govt Norway & Sweden as inout into Commission on Sustainable Development (CSD) (2004-2005)
[50] WHO & SIWI, " Making Water a Part of Economic Development" , Govt Norway & Sweden as inout into Commission on Sustainable Development (CSD) (2004-2005)
[51] Krop, R.A., Hernick, C. & Frantz, C. (2008) "Local Government Investment in Water and Sewer Infrastructure: Adding Value to the National Economy", US Conference of Mayors, Mayors Water Council Washington, DC
[52] Krop, R.A., Hernick, C. & Frantz, C. (2008) "Local Government Investment in Water and Sewer Infrastructure: Adding Value to the National Economy", US Conference of Mayors, Mayors Water Council Washington, DC

Table 47: Economic Appraisal Results Summary

Indicator	3.5 % discount rate	10 % discount rate
ENPV (US$)	27,528,162	7,595,089
ERR (%)	26.33%	26.33%
EBCR	4.11	2.26

Sensitivity analysis

The sensitivity analysis (summarised in **Annex 5**), indicates that the parameters most critical to the results of the economic appraisal are the health benefit to transitory populations passing through Kazungula, and to a lesser extent capital costs. A simultaneous 30% decrease in the health benefit to transitory populations and 30% increase in capital costs, still results in a project ENPV of US$ 3.3million (at a 10% discount rate), ENPV of US$ 19.3million (at a 3.5% discount rate), and ERR of 15%.

A scenario whereby the entire environmental benefit is excluded was also undertaken, resulting in a 14% variation in the ENPV to US$ 6.5million (at a 10% discount rate) and US$ 21million (at a 3.5% discount rate), and an ERR of 26%.

It is therefore concluded that the positive results of the economic appraisal are robust.

Benefits - Qualitative

In addition to the quantitative benefits, there are significant additional economic benefits which can only practically be described qualitatively. Qualitative economic benefits associated with improved water and sanitation includes the impact on gender, educational outcomes, productivity, economic development, and regional dividends. Elaborated upon in more detail below are those around regional dividends and economic development which are seen to be most poignant for Kazungula.

Economic Development

The extent and speed of infrastructure expansion and economic development in Kazungula will be fundamentally contingent on the supporting water supply and sanitation infrastructure in place. Water supply and sanitation is an enabling factor to economic activity, in that it expands the productive capacity of the economy – both by increasing resources, and enhancing the productivity of existing resources.[53]

[53] Krop, R.A., Hernick, C. & Frantz, C. (2008) “Local Government Investment in Water and Sewer Infrastructure: Adding Value to the National Economy”, US Conference of Mayors, Mayors Water Council Washington, DC

In Kazungula for example, the development of the Bridge, border post, and housing expansion will be constrained by, and limited to the water supply and sanitation system that is available to support it[54]. Similarly, the growth potential of new enterprises in all sectors of the economy will depend on water supply and sanitation as a factor of production. Such opportunities for new enterprises include those in trading; hospitality services; and the provision of roadside services to Bridge users, salaried workers, government officials and the general public – all of which are activities dominated by women. The increase in local economic activity will in turn result in an increase in tax revenues for local government.

In the above context, the economic value of the project consists of both direct and indirect impacts on economic development. Direct value added is the value generated directly in the operations of the infrastructure through the consumptive use of the water resources – in the first 'round' of expenditure. First round expenditure however induces another round of expenditure and value-add in other sectors of the economy, and further rounds after that may follow. These 'backward linkages' create a multiplier effect, so that the overall impact is larger than the direct value add alone. The magnitude of the multiplier effect of water and sanitation investments on national income have been estimated by Krop et al (2008)[55] and WHO & SIWI (2005)[56].

Krop et al (2008) find that the long term multiplier effect of water and sanitation investment on GDP is roughly 6.35 times the original investment – that is, US$ 1.00 investment in water and sewer infrastructure increases private output (GDP) in the long term by US$ 6.35. This estimate was developed through the review of over 300 economic studies. The WHO and SIWI have estimated a multiplier of 3.33; however this multiplier is specific to the effect of investment in household access to safe water supply on GDP only, excluding sewerage systems.

Both Krop et al and WHO & SIWI stress that their economic multiplier estimates for water and sanitation infrastructure vary geographically and by past investment – that is, if public water and sanitation infrastructure is adequate and of high quality, rates of return on further investment will be lower that it would if infrastructure were inadequate[57] - the greatest economic benefits will be felt in countries with the greatest water challenges.[58] Krop et al.'s multiplier is therefore likely to be an underestimation given that it was developed with some focus on more developed states in the United States of America where existing infrastructure is significantly more advanced than that currently in Kazungula.

[54] Already, limited water supply is seen to be delaying the KDC housing development (KDC, 2014). Moreover in terms of the limitations on the tourism sector in Kazungula, 'access to improved sanitation' and 'access to improved drinking water' are both key indicators in the World Economic Forum (WEF) Travel and Tourism Competitiveness Report. In the 2013 Report, Zambia ranked 112/140 and 129/140 in the respective indicators; and based on the current contribution of tourism to GDP, WSP estimated that addressing the sanitation situation in Zambia could lead to an increase in tourism income of US$ 1 million per year.

[55] Krop, R.A., Hernick, C. & Frantz, C. (2008) "Local Government Investment in Water and Sewer Infrastructure: Adding Value to the National Economy", US Conference of Mayors, Mayors Water Council Washington, DC

[56] WHO & SIWI, " Making Water a Part of Economic Development" , Govt Norway & Sweden as inout into Commission on Sustainable Development (CSD) (2004-2005)

[57] Krop, R.A., Hernick, C. & Frantz, C. (2008) "Local Government Investment in Water and Sewer Infrastructure: Adding Value to the National Economy", US Conference of Mayors, Mayors Water Council Washington, DC

[58] WHO & SIWI, " Making Water a Part of Economic Development" , Govt Norway & Sweden as inout into Commission on Sustainable Development (CSD) (2004-2005)

Regional Dividends

The transboundary benefits of the project are due to the location of the border post on the North-South Regional Transport Corridor. The North-South Road Corridor serves more than half of the road transport to/from Botswana, Zimbabwe, Zambia and Malawi – export cargo from these inland countries are transported through this road corridor to the Port of Durban, and trucks with import cargo and South African cargo return to these countries.[59] A road traffic survey and analysis conducted by EGISBECOM in 2010 indicated that a total of 203 vehicles went through Kazungula border each day; and that this is expected to increase to 436 vehicles per day by 2020, in addition to the new rail traffic.[60] The successful operation of the Kazungula border post – of which water supply and sanitation is a fundamental factor – will enable increased and smoother regional connectivity, trade and ultimately regional integration. With a high standard of basic infrastructure, Kazungula will remain a primary conduit for traffic crossing the Zambezi on the Regional Transport Corridors.

The avoided transboundary health risks given the current and expected level of region wide traffic through the border is also poignant. As mentioned in the health benefit section above, WSP estimate that the cost of an epidemic outbreak – of which faecal contamination of the environment is the root cause – will cost Zambia alone is the area of US$ 2 million per year in required responses. Should an epidemic break out in Kazungula there is a high likelihood that it will spread to surrounding countries.

The location of Kazungula at the intersection of Zambia, Namibia, Zimbabwe and Botswana also means that any avoided pollution of the surrounding environmental and international waters, is directly relevant to all countries; the attractiveness of the area as a destination is directly contingent on the quality of the environment, and the quality of WASH facilities available. As mentioned above ‘access to improved sanitation’ and ‘access to improved drinking water’ are both key indicators in the World Economic Forum (WEF) Travel and Tourism Competitiveness Report, of which Zambia is currently ranked very poorly.

Sustainability Analysis

The economic appraisal shows that the project is justified from a socio-economic perspective. The financial appraisal shows that with external funding support for capital investment costs, there is adequate cash flow to maintain operations at assumed current tariff levels. The affordability analysis that follows aims to assess at a high level the affordability of current tariff levels, based on the average monthly income of the population.

Affordability Analysis

Income levels for Kazungula used are based on national estimates. AfDB find GNI per capita of US$ 970 (2009) for Zambia[61]; The World Bank published GNI per capita for Zambia of US$ 1,810 (2013)[62]; and the Rural

[59] PAEDCO Co. Ltd & Mitsubishi UFJ Research and Consulting Co. Ltd (2010) “Preparatory Survey for Southern Africa Integrated Transport Program” Japan International Cooperation Agency
[60] Egisbceom International & Egisjmi (2010) “ Environmental and Social Impact Assessment VOLUME 2”, African Development Bank & SADC
[61] African Development Fund (2011) Project: Kazungula Bridge Project (SADC North-South Transport Corridor Improvement), Project Appraisal Report, AfDB
[62] http://data.worldbank.org/indicator/NY.GNP.PCAP.CD

Poverty Portal, publish a GNI per capita for Zambia of US$ 1,070 (2010)[63], but stress that the Eastern and Southern provinces have a particularly high concentration of poverty.

Hutton (2012)[64], in his review of the affordability of water and sanitation services after 2015, looks at various global indicator options. He finds that in Africa, the affordability index for median households is around 2.8% of monthly income, and for poor households connected to public water supply can easily reach 7.5%. International agencies have however set their own affordability thresholds:

- UNDP:3%
- World Bank: 5%
- OECD unofficial: 4%
- African Development Bank:5%

At the water tariffs used in the CBA, table 63 below gives an indication of the percentage of monthly income that is likely to be spent on water and sanitation. For all connection types an additional 20% for sanitation is added onto household monthly expenditure for sanitation to account for the cost of sanitation even if it is not a connection to the reticulated system.

Table 48: Affordability Analysis

	Per capita demand (l/c/d)	Household demand (m^3 /month)	Applicable tariff (US$ /m^3)	Sewerage charge (%)	Expenditure (US$ /month)	% income (US$ 500 /month)	% income (US$ 1,070 /month)
Standpipe	30	4.32	0.44	0.20	2.28	**0.46%**	**0.21%**
Yard	50	7.2	0.64	0.20	5.52	**1.10%**	**0.52%**
House	100	14.4	0.64	0.20	11.03	**2.21%**	**1.03%**
	100	14.4	0.76	0.20	13.13	**2.63%**	**1.23%**
	200	28.8	0.76	0.20	26.26	**5.25%**	**2.45%**
	200	28.8	0.58	0.20	20.04	**4.01%**	**1.87%**

At current assumptions of consumption for each domestic connection types, the tariffs appear to be affordable even at the estimated income levels in Kazungula, and at an assumed lower monthly income of US$ 500/month. If consumption is assumed to increase, to 200 litres per capita per day, water and sanitation is still roughly in

[63] http://www.ruralpovertyportal.org/country/statistics/tags/zambia
[64] Hutton, G. (2012) " Monitoring "Affordability" of water and sanitation services after 2015: Review of global indicator options", PhD – A paper submitted to the United Nations Office of the High Commission for Human Rights, http://www.wssinfo.org/fileadmin/user_upload/resources/END-WASH-Affordability-Review.pdf

line with all the affordability benchmarks, and remains so when the tariff increased to US$ 0.76/m3. Only at a monthly income of US$ 500/month, consumption of 200l/c/d, and a higher tariff of US$ 0.76/m3, does the percentage of monthly income marginally exceed 5%.

It is therefore expected that, the project water and sanitation services will be affordable to the Kazungula population.

Financial and Economic Risk Assessment

The sensitivity analysis of the financial and economic appraisals indicated that no project parameters were extremely critical to the financial and economic feasibility of the project (capital costs in the financial appraisal, and the health benefit to the transitory population in the economic appraisal, are marginally critical). The possibly of the project parameters varying to a degree that might alter the outcomes of the CBA (i.e. a negative financial appraisal, and positive economic appraisal) is very low, as indicated by the sensitivity analysis.

Domestic water demand; the average domestic water tariff rate; the water supply system coverage; and O&M costs are however all critical to the financial operational cost-recovery of the project.

A high-level risk analysis relating to the above project parameters is therefore shown in the subsequent Risk Matrix (see 230).

Financial and Economic Conclusions and Recommendations

- There is an overwhelming economic justification for the project, as indicated by the quantitative results of the economic appraisal in conjunction with the qualitative benefits arguments. In the short term the provision of WASH infrastructure is fundamental to basic human needs; in the medium and longer term, WASH infrastructure will be catalytic to economic development at a local (community) level, as well as for Zambia and the SADC region.
- The project alone however is not commercially viable – the revenue generated by the project is not sufficient to cover the investment cost over the project life. This is neither surprising nor uncommon for water and sanitation projects of this scale, given that such projects are fundamentally providing a public good. Traditional financing is therefore not appropriate to this project; long term developmental/concessional loans or grant funding are required to cover the vast majority of the capital investment.
- The financial appraisal indicates that the project is operationally sustainable. Annual revenues generated exceed the annual operation and maintenance requirements of the infrastructure over the project life. Moreover the assumed tariff rates for services appear to be well within various international affordability benchmarks. Domestic demand, O&M costs, and water supply coverage are however critical to the operational sustainability of the infrastructure. As such, should these parameters vary significantly over time; the SWSC must adjust the phased investments as appropriate.

Potential Financiers

Potential funders were investigated in 2014 and a report prepared on a number of possible sources of funding (D03 FP22-001 dated 30 June 2014). These have been arranged in groups and are discussed below, together with some updating. In summary, there is considerable potential for raising funds but most conventional funders would prefer to see Kazungula packaged with other border towns to make a bigger project. There is some potential for smaller funders to be involved with non-engineering components.

Zambian stakeholders

SWSC (Southern Water & Sewerage Company) – The "owner/operator" of the proposed WSS system. They have already invested small amounts recently in Kazungula. They will be asked to make further counterpart contributions towards capital costs, plus contributions in kind. Their balance sheet could not support a substantial loan.

MLGH (Ministry of Local Government and Housing) – The Ministry regards the border towns project as a priority and they are the official GRZ sponsor of the projects serving border towns. They will be asked to make the official request to probable funders and make counterpart contributions if required by a funder.

RDA (Roads Development Agency) – Bridge construction activity has begun with the temporary relocation of some housing and the water supply intake. This has been sponsored by the RDA. Further relocation will be required and SWSC is negotiating for RDA to meet all the relevant capital costs.

Residents – residents will contribute in kind through self-help measures such as construction of own toilets and trenching for pipelines to connect existing communities, under the proposed immediate measures sub-project.

Development Banks

AfDB (African Development Bank) – They have expressed an interest in funding water and sanitation in the hitherto named 12 Border Towns of Zambia, provided the proposed loan to GRZ is large enough. They would require a clear request from MLGH which is also considering support for competing proposals for different groups of towns. AfDB would not consider a project in a single town.

KfW (German Development Bank) – They will be approached to consider funding the border towns package. They may be more interested because German technical assistance (GIZ) is preparing feasibility studies for two border towns and these are being included in the package for funding.

World Bank – They attended a briefing meeting in which Kazungula was presented. They will be contacted with a proposal to fund all the border towns. As with AfDB they would not consider a single town.

EIB (European Investment Bank) – No contact to date, but they should be approached. As with AfDB and EIB they would not consider a single town.

Bi-laterals

CRIDF – apart from sponsoring all the preparation work so far, it is recommended that CRIDF support capital expenditure for the immediate measures phase. This work is becoming urgent since in-migration has already picked up as a result of increased traffic flows and construction activities related to the bridge.

Foundations

GETF (Global Environment & Technology Foundation – sponsored by Coca Cola Company) – The Kazungula concept note was shared with them and they expressed interest. A follow up will be made.

Small funders

A number of possibilities exist for funding parts of the project, notably sanitation promotion, ablution blocks, water kiosks, capacity building, zonal management and other "non-engineering" aspects of the project. CRIDF could support SWSC in approaching organisations that could play an important supporting role that would enhance the impact of this project. These include the following:

WaterAid and PLAN International (International NGOs), and UNICEF (UN Children's Fund) these agencies specialise in community water supply and sanitation. They could contribute their own resources in cash or kind, especially if aspects of the project are innovative or need their particular skills.

Private sector such as fuel companies and tourism operators – these could invest in communal facilities and related promotion programmes to provide for passing vehicles and to clean up the environment.

Private sector operators will be encouraged to operate and maintain ablution blocks and water kiosks, and the proposed zonal management system. These facilities and the related micro-enterprises may be of interest to local banks and even specialist impact investors.

Procurement Options

It is anticipated that CRIDF will process the proposed Immediate Measures and Phase 1 components through to Bankability and Financial Closure. The subsequent investment Phases will be subject to later reviews and their requirement assessed based on the actual development of Kazungula.

The Procurement processes through to implantation will be subject to the conditions of the sources of capital funding. Interest has been shown in funding the Immediate Measures and Phase 1 of the project and this will

be further investigated by SWSC and MHLG supported by CRIDF. It is possible that the Immediate Measures will be eligible for CRIDF funding in which case the CRIDF Procurement procedures would be engaged through to implementation. Three other financiers have expressed some interest in Phase 1 and this interest will be followed up and the appropriate donor/lender's Procurement processes then engaged through to implementation.

Table 49: Procurement process considerations per phase

	Immediate Measures	Phase 1	Phase 2	Phase 3
Procurement Process	1. Bankability 2015 2. Financial Closure 2015 3. CRIDF Funding 4. CRIDF Procurement Processes	1. Bankability 2015 2. Financial Closure 2015 3. Funding TBD 4. Procurement Processes TBD	1. Bankability 2021 2. Financial Closure 2021 3. Funding TBD 4. Procurement Processes TBD.	1. Bankability 2027 2. Financial Closure 2027 3. Funding TBD 4. Procurement Processes TBD.

Institutional Assessment

Introduction

A fundamental requirement to provide efficient and effective water services is an institutionally sound utility. It is understood by all Kazungula stakeholders that the objectives of 'sustainability and improved service levels' cannot be achieved by solely constructing new infrastructure. To achieve the desired results the new infrastructure will need to be supported by a parallel institutional strengthening program.

It is strongly recommended that the Institutional Strengthening program is conditional to and part of the infrastructure capital funding package.

The Feasibility Study looked at the SWSC Institutional arrangements pertaining to Kazungula and how they impacted on the services provided in the town, however is did not, and was not intended to carry out a full Institutional review of SWSC.

Background

The Zambian water sector has undergone some significant reforms in recent decades. The reforms were linked to reforms in a number of other sectors of government, notably the decentralisation of governance and corporatisation of service delivery using public utilities. In this regard, new water legislation and division of functions created new institutions such as:

- National Water Sector Coordinating Council as the sector regulator (service standards, quality, tariffs, utilities, etc.)
- Local water utilities as source-to-tap potable commercial water providers, registered as public utilities or private companies

The Ministry of Local Government and Housing oversees the creation and performance of local authorities (district and city councils) who are responsible for local government functions. Publicly owned commercial water utilities are established as joint ventures by local authorities and operate within the confines of existing provincial boundaries.

The Southern Water and Sewage Company was established in 1999 as a commercial utility jointly owned by eleven (11) local authorities[65] in the Southern Province of Zambia. The company only provides water supply and sewage services in urban areas, and local authorities are responsible for supplies in rural areas.

The Southern Water and Sewage Company target levels of service are high, yet appropriate and well defined. The Strategic Plan[66] sets out the Vision and Mission Statements:

[65] Extracted from SWSC 2012-2017 Business Plan

SWSC Vision Statement

"To be the leading potable water and sewerage service provider in Zambia, consistently exceeding stakeholders' requirements".

SWSC Mission Statement

"To provide potable water and sewerage services effectively, efficiently and sustainably, to the benefit of our customers both in urban and peri-urban areas in Southern Province".

Some principle SWSC Target Levels of Service [including Kazungula] are:

- 24/7 continuous supply @ 100 litres per person per day;
- 100% coverage by individual house connections with meters;
- Sustainability - implementation of the SWSC vision of full cost recovery;
- Unaccounted for Water (UFW) Target – 25% or less.
- water quality standards to meet Zambian National Standards;
- installation of a central sewerage system;
- Installation of a Sewage Disposal station with final effluent discharge designed to meet Zambian Standards.

Current Institutional Set-Up in SWSC

Governance

The company has an 11-member governing board made up as follows:

- Mayor/Council Chairperson 1
- Town Clerk/Council Secretary 1
- Engineering Institute of Zambia 1
- Provincial Local Government Officer 1
- Private Sector 2
- Community Representative 1
- Domestic Representative 1
- MLGH Representatives 2
- SWSC Managing Director 1

Executive Leadership

The executive leadership constitutes of the Managing Director and two divisional directors - Director for Operations and Director for Finance and Commercial services, who is also the Company Secretary.

Organisational Structure

The organisational structure of the SWSC is presented in **Figure 18**. Note the following with regard to the presented organogram:

- The structure presented captures how the SWSC is internally organised and does not reflect all positions in the organisation.
- The structure is fairly decentralised with functions in regional and branch offices
- Current staffing demonstrates strong capacity in terms of human resource capacity, both in terms of numbers and competency required.

Operational Structure

SWSC is mandated to provide water and sewerage services in a total of 20 urban and peri-urban centres in the Southern Province of Zambia. These centres, which are all shown on the map in **Figure 19**, are spread over an area of 85,000 square kilometres. The estimated population of the areas falling within the SWSC service boundaries is presently (2012) about 297,221[67].

[67] Extracted from SWSC 2012-2017 Business Plan

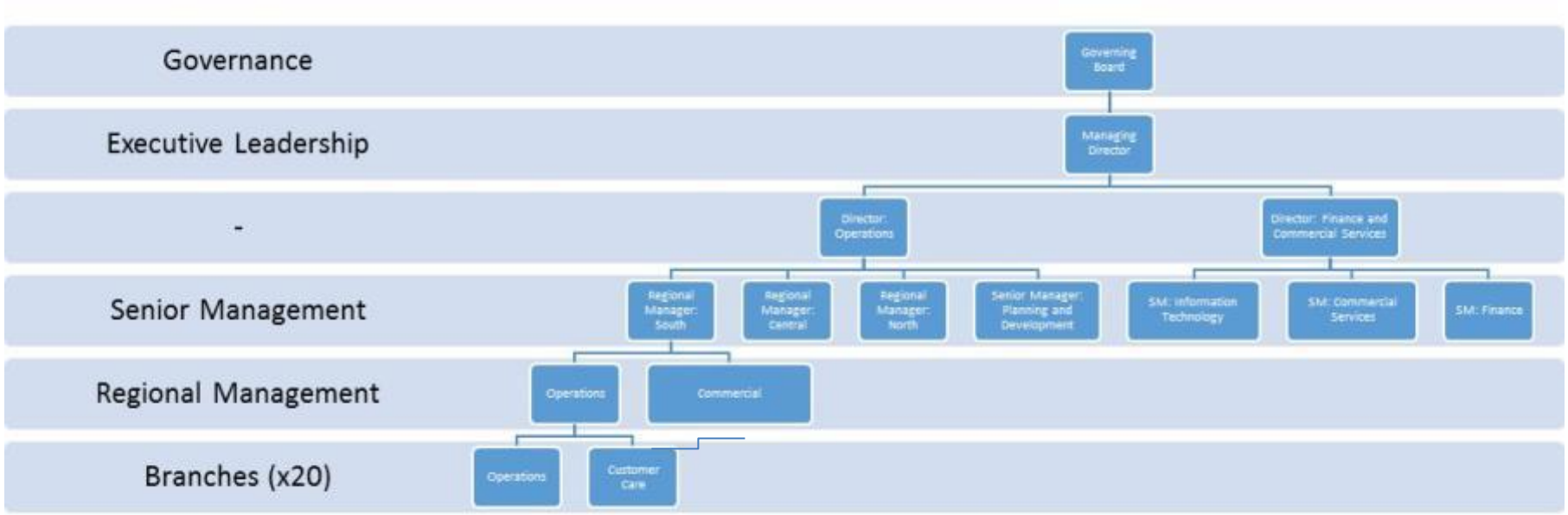

Figure 18: SWSC Organisational structure

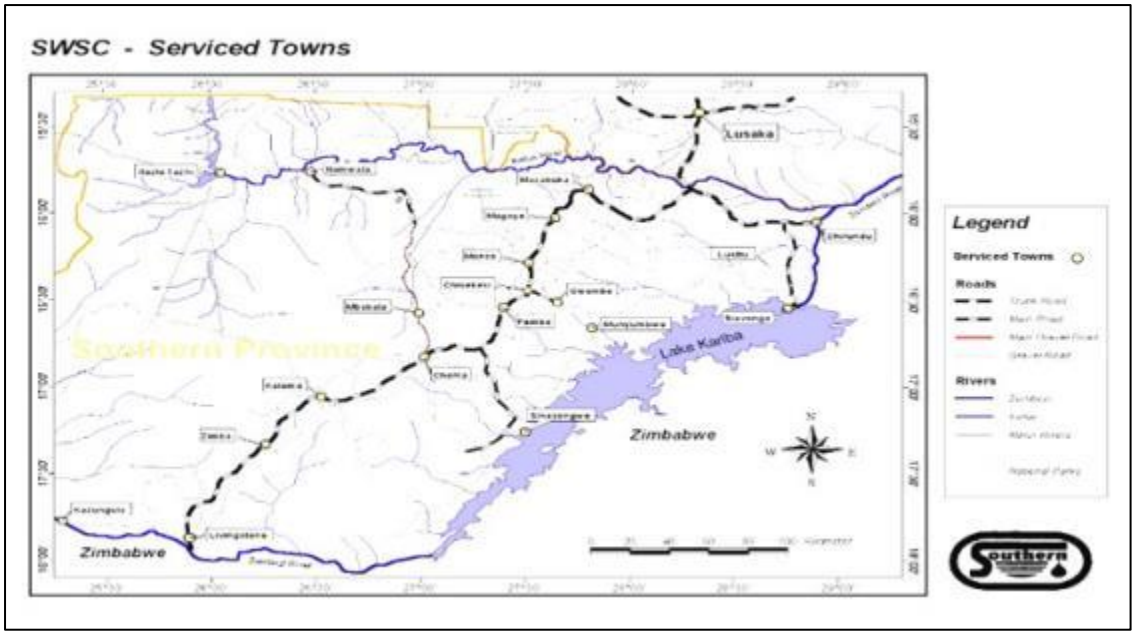

Figure 19: Operational area of SWSC

The SWSC's operational structure has:

- A head office which also serves as regional office for Central Region
- Three regional operations: Southern, Central and Northern. In addition to managing operations of the SWSC each regional office also undertakes functions related to commercial services (billing, customer services, etc.) and human resource management overseen by head office.
- Branch operations for each water supply and sewage system in the eighteen towns currently served by the water utility. Functions are limited to operations and customer service (meter reading, billing and collections).

The Operational Structure is summarised as follows:

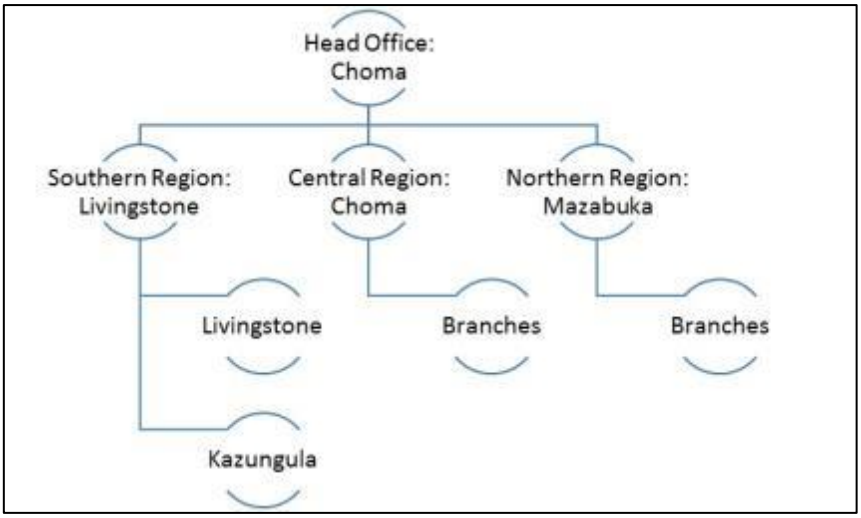

Figure 20: Operational Structure of SWSC

General Observations on the Institutional Set-Up and Performance

The company is well-structured to execute its mandate fully with direction and clear indications of:

- Separation of governance and operation functions
- Division of operation functions across different levels (devolution of functions)
- Clearly defined performance standards and indicators

From the field observations and company documents accessed, it is important to note that SWSC, as a relatively newly established public utility, is still yet to fully mature into an efficient and financially viable water supply utility noting the following challenges (which also affect other public utilities):

- It took over ageing and arguably dilapidating water and sanitation infrastructure which was poorly maintained for a period of time
- Its area of operation is fairly large even though its customer base is only urban and peri-urban
- Although the company is a full body corporate with full access to financial markets, its financial viability is constrained by a history of non-payment of water services.
- Linked to the afore-stated point is the limitation placed on setting its tariffs, and therefore resulting largely in tariffs that are not differentiated according to individual water supply systems

The competency of the SWSC senior management team is very good and they have a clear understanding of the strategic direction the utility is heading. The performance of the organisation at the lower levels however would indicate that some Institutional Strengthening would be beneficial for improving service levels to the public and for improving SWSC efficiency and effectiveness.

Table 50 presents an overview of performance against set targets.

Table 50: Overview of SWSC Kazungula system performance

Indicator	Target	Performance	Comment
A. Coverage			
1. Water (Different LOS)	100%	100% [supressed]	There is significant suppressed demand. The service is turned on for a max of 15 hours of water per day. The majority of the population rely on standpipe and yard taps. 8% have house connections
2. Sewage (Different LOS)	100%	0%	Households use own on-site septic systems or pit latrines.
B. Water Production			
1. Production: Ml p/a	Cb	292 Ml p/a	Production data needs to be verified with accurate metering.
2. Consumption: Ml p/a	Cb	195 Ml p/a	
3. Metered consumption**:** Ml p/a	Cb	195 Ml p/a	
C. Unaccounted for Water			
1. Non-revenue water	25%	55%	With substantially new infrastructure in Phases 1 and 2 together with Distribution Management the Target level should be reviewed downwards.
D. Metering			
1. Proportion of connections with meters	100%	69%	
2. Proportion of functional meters	100%	Unknown	

Indicator	Target	Performance	Comment
3. Proportion of bulk supply with meters	DNI's	Unknown	
E. Pipe Network Performance			
1. Pipe breaks	Unknown	>8 per Month	
2. Sewage breaks	To be set	To be set	
F. System Performance			
1. Supply assurance	90+%	60%	System pumping capacity below supply demand
2. Water quality	100%	?	Limited purification process carried out. Drip feed chlorination only.
3. Quantity per capita per day	100 litres	44 litres/day	This is the theoretical LOS but qualitative surveys indicate much lower quantities.

Current Institutional Situation in Kazungula - Operational Matters

The operations branch for Kazungula Town is staffed as follows:

- 1 x Branch Foreman
- 1 x Plumber
- 1 x General Worker

The position of plant operator is currently vacant. This team currently operates and maintains a system that supplies about 5,500 people and institutions. The team operates from the water treatment plant which also provides housing for some staff members.

The following has been observed during field studies:

- Poorly maintained water treatment plant which is likely a result of poor availability of spare parts or, as reported, inappropriate technology used for the water treatment plant (spares not available in the country)
- The operation and maintenance procedures are not strictly followed, and the operating manuals are absent
- Over 55% of water supplied is unaccounted for (non-revenue water)
- The SWSC Kazungula branch team are however fully committed to providing the best service they can but possibly lack adequate support to be able to significantly improve services without additional resources and expertise.
- Planning is a key function within the utility and this is in need strengthening particularly when using the existing Kazungula water system as a point of reference. The implementation of the current Kazungula system, constructed after establishment of SWSC did not provide for growth or supplying the entire town. The selection of the water treatment process was arguably not 'appropriate technology' as several treatment stages are now not functioning and are by-passed. This has Water Quality and Water Quantity implications for customers.
- The current method of extending the Kazungula distribution system is ad hoc and the resulting design does not lend easily to distribution management techniques and controlling UFW and maximising revenues. This is fundamentally a planning shortfall. No formal record drawings are made or kept of the distribution network.
- Regular Kazungula stakeholder coordination meetings are not held and these would assist SWSC expansion of services in accordance with development needs. The meetings would assist maintain compliance with SWSC design criteria and Bye Laws/Plumbing Codes. Regular stakeholder coordination meetings would also have a positive impact on SWSC public relations.

- Site supervision of new SWSC infrastructure construction also needs to be addressed. There are several instances of poor construction workmanship which have had led to negative implications on the services and has impacted negatively on revenue generation.
- The full understanding of SWSC being a 'business' is also weak at some lower levels in SWSC. A stronger commercial culture needs to be encouraged and developed. New customers, such as the Bridge contractors in Kazungula should be seen as a business opportunity and not as a threat to the status quo.
- A similar commercial culture is required in the operations department to ensure existing assets are maximised to deliver the highest possible service levels and to maximise water sales. Water production in Kazungula is stopped for approximately 6 hours per night even though there is a suppressed demand in the town. Some of this 'lost' production could by arrangement be gained back by asking customers with on-site storage tanks e.g. KDC, The Bridge contractors to take water during the night. This would benefit customers and increase SWSC water sales.
- Operational data is not extensively collected and acted upon. A review is required to ensure operational data is collected and used to manage the operations efficiently and effectively. This will ensure optimum operational decisions being made. Collecting data may entail establishing a modest Operations Control Room for the joint use of Livingstone and Kazungula towns. The review should include investigating what data is needed and the most appropriate method of collection and recording. This most likely will entail including some new/appropriate technology which could be integrated into this project at the detailed design stage.
- The potential then exists to forward the Kazungula operational data to HQ in Choma and give visibility to senior managers on the live situation in Kazungula, to include reservoir levels, pressures, flows, etc.
- The management concepts proposed for Kazungula to include DNI's, water balances, and other measures could place Kazungula in a position to be a 'model' town for SWSC with potential to replicate in other SWSC towns in the future.
- The opportunity also arises to rationalise the operations of Livingstone and Kazungula into closer harmony using the above suggested information system. The water supply and sewerage systems of Livingstone will be technically nearly identical so it would be reasonably straightforward to share resources and expertise between the two towns with cost saving benefits for SWSC.
- It is suggested that a new operational Organisational Structure is developed showing staff for both towns. The areas of expertise that could be shared would include Scientific/Laboratory, Water Plant Operators, Sewage Plant Operators, Mechanical & Electrical technicians, Distribution Management engineers, etc. This will result in improved services and lower operational costs.
- The consumables and spare parts could be similarly rationalised if the two towns are considered operationally together. SWSC should consider similar plant and equipment in both locations to facilitate lower maintenance costs.

- An essential component for the supply of consumables including chemicals, spare parts and other such supplies is an adequate operational budget. The provision of this inextricably becomes linked to cost recovery which typically comes back to efficient management of the distribution system through DNI's and working in conjunction with a correspondingly efficient Commercial Department [Billing and Collection].
- The proposed design for the new water supply system will have a distribution Ring Main feeding a series of distribution zones called DNI's [Distribution Network Improvements]. Each zone is completely separate from adjacent zones and is supplied by a single metered connection. The volume of water into the zone is therefore measured. The volume of water out of the zone is the sum of the water through customer meters. SWSC will be able to check each zone to ensure that the volume of water 'in' correlates with the volume of water 'out' and achieve a 'water balance'. Water balances are typically carried out on a monthly basis. Zones that do not balance will trigger an investigation to establish why; this can be a number of reasons, leaks, stolen water, broken meters, etc. The important concept is that DNI's enable water problems to be 'spotted' and remedied.
- The introduction of DNI's will bring in a new business culture to SWSC and give water a real monetary value to employees and to the customers. A frequently used concept to introduce payment for water is the 'water kiosk'. This is typically a small building housing the standpipe with a vendor dispensing the water in standard sized containers. The tariff for the water is set through a regulatory process to ensure a reasonable price for the consumer and the water utility. The suitability of 'water kiosks' needs to be fully tested in Kazungula but if found appropriate the proposed ablution blocks under the Immediate Measures could be integrated into joint purpose 'water kiosks' as well.
- A similar DNI approach to water management is being introduced into Livingstone. The Institutional Strengthening work on DNI's in Kazungula could support the Livingstone work and vice versa.
- The Institutional Strengthening will build the working relationship between the Distribution and Commercial Departments so that they operate each DNI as a mini business centre. The Distribution Department will carry out water balances in each DNI to keep UFW under control. The Commercial Department will carry out revenue balances ensuring correlation between volume of water into DNI's and the revenue collected.
- There are no SWSC sewerage operations in Kazungula but it was observed that maintenance of the Sewerage Lagoons in Livingstone required improvement. The
- Operation of the Kazungula Lagoons will be very similar and it is recommended that the Organisational structure for operating the Lagoons in both towns is combined, sharing expertise and resources.
- Similarly the maintenance of the sewerage network of both towns should be shown on the same Organisational chart sharing expertise, equipment and resources.

- Many of the Institutional Strengthening recommendations will be for changes to 'operational and commercial procedures' which will accumulatively improve the effectiveness and efficiency of SWSC resulting in improved services. These changes are sometimes referred to as 'Business Process Improvements' or BPI's.
- Operation and maintenance procedures are yet to be fully institutionalised and there is a requirement for Operating Manuals and record drawings, etc.
- There is a requirement for Training Program and re-training of branch staff.

Current Institutional Situation in Kazungula - Customer Services & Commercial

The commercial office of SWSC in Kazungula is staffed as follows:

- 1 x Cashier
- 1 x Customer Service Assistant

The team is responsible for meter reading and collections. Billing is done centrally in Livingstone.

There is a fully established payment and customer care office in Kazungula located within easy access.

Recommended Institutional Strengthening Under the Project

The following Institutional Strengthening (IS) is recommended:

- The IS component would be part of and a condition of the infrastructure capital finance package.
- The IS would support SWSC to prepare a new Operations Organisational Structure showing human resources required for both Water Supply and Sewerage for Livingstone and Kazungula combined.
- The Organisational Structure for the combined Livingstone and Kazungula operations is likely but not confined to include Scientific staff, WTW staff, STW staff, Distribution Staff, M&E staff, Ops Control Room Operator, Statistician, Instrument technician, Stores and Purchasing, Budget controller, Admin assistant.
- The IS would review the Commercial Department to ensure that it was configured to work with the Operations department particularly with regard to the benefits of DNI's.
- The IS would support SWSC appoint staff into the new Org Structure.
- The IS would support SWSC to identify training needs and prepare an appropriate training program.
- Some of the training requirements could be included in the Kazungula infrastructure contracts.
- The training plan would include operational and commercial training needs to run the DNI's.
- The training plan would include the preparation, control and use of 'operational budgets'.

- The training plan would include components that would support the full transition of SWSC to a 'business culture'.
- The training plan would include the benefits of operational information, how to collect it, record it and use as a management tool. The information system is likely to be centred in a dedicated room [control room] and probably located in Livingstone.
- The IS will look at and support the concept of Kazungula becoming a 'model' town for SWSC so that the benefits of the new business approach can be replicated in other SWSC towns.
- The IS would review the support activities required from other SWSC departments, e.g. Stores and Purchasing to ensure the efficient functioning of services in Kazungula.
- The IS would review the Planning processes in SWSC and make recommendations including frequent planning coordination meetings with stakeholders.
- The IS would review the internal SWSC processes for supervising construction of new infrastructure and make recommendations.
- The IS would review and make recommendations of the SWSC HR department to ensure continued support to Kazungula.
- The IS would review and make recommendations for operating the STW and small bore sewage system, and how to ensure full compliance with the final effluent from the STW.

A significant number of the above Institutional Strengthening recommendations for Kazungula potentially cross cut into other areas and departments of SWSC. It is suggested that Kazungula and other SWSC towns would achieve greater benefits if the Institutional Strengthening was assessed in the wider SWSC context under the Immediate Measures.

The Kazungula Feasibility Study introduces new approaches to managing water supply distribution systems with associated commercial and operational improvements. It is suggested that consideration be given to setting up Kazungula as a 'model town' so that the new practices can be trialled and expanded to other towns if applicable.

Similar improvements and initiatives are proposed for Kazungula for Ablution Block management and Facultative lagoon management. These improvements could also be integrated into the 'model town' trial.

It is therefore suggested that an Institutional Strengthening Assessment is made during the Immediate Measures phase which would investigate the advantages of implementing the above institutional recommendations. The Institutional Assessment would look at the wider SWSC responsibilities and make additional recommendations with a suggested implementation plan.

The table below shows the suggested institutional strengthening and trainings relevant for the different phases of the intervention, and basic cost estimates.

Table 51: Proposed Institutional Strengthening Initiatives per Phase

Phase	Proposed Institutional Strengthening	Budget
Immediate Measures	• Institutional Strengthening Assessment made of SWSC using the above recommendations as TOR's. • IS implementation plan is developed. • A Training Program is developed and integrated into SWSC program. • Awareness, training and education campaigns (including aspects like promoting yard and domestic connections to the water and sewerage network, compliance on bill payment, and utility-customer communications) • The 'model town' concept is developed.	$25,000
Phase 1	• Phase 1 of the IS and Training program is implemented in accordance with IS Assessment.	$60,000
Phase 2	• Phase 2 of the IS and Training program is implemented in accordance with IS Assessment.	$25,000
Phase 3	• IS and Training needs are reviewed.	$40,000

Environmental Assessment

Introduction and Description of Water and Sanitation Facilities

Status Quo

The Southern Water and Sewerage Company (SWSC) is the primary supplier of water and sanitation services in Kazungula. SWSC operates through a mobile office with the main office based in Livingstone. Samples of raw water and treated water at 3 supply points including at point of departure from treatment works are collected and tested at the Livingstone laboratory.

The town has no reticulated sewerage system. The residents use on-site sanitation systems that are mostly pit latrines. However, a few low-density residents have soak ways systems. Open defecation is common in the town arising from travelers as well as some of the community members of the informal settlements. The informal settlement residents reported that they were running out of space to construct new toilets as the old ones filled up. The soils in the area are largely the Kalahari sands that are very permeable thus posing a risk for ground water contamination, however the groundwater is not currently or proposed to be abstracted for human consumption.

An increase in human activity is anticipated in Kazungula due to the bridge construction and improved border facilities. As a result of this, an increase in human waste and litter is expected for the area and would need to be considered and managed so as to avoid unnecessary negative impacts to the environment. Thus water and sanitation provision is required, specifically improving the access to clean water and providing adequate wastewater treatment. There is need for sufficient public ablution facilities, as the border will have a significant mobile population in the town ship.

Proposed Infrastructure

The proposed water and sanitation facilities will include the following:

a) A water treatment works and storage reservoir

The location of the proposed new water treatment site (to be relocated in Phase 1) is to the North of the existing WTW and is at the summit of the land in Kazungula Town. It is a vacant plot accessed through an existing dirt road.

b) Proposed water intake relocation

The relocation site is approximately 1km upstream of the existing intake. The location can be easily be accessed from the water but the shore is low lying and swampy posing challenges for access from the land.

c) Sewerage facilities

The proposed sewerage facilities will include a conventional sewer collection system for all institutional infrastructure and some higher income residential areas, a simplified sewer collection system for some of the

low and medium residential areas and commercial land use zones (phased in through time), and the promotion of Improved VIP latrines for lower income communities.

d) The proposed Sewerage treatment works.

The sewerage treatment works is proposed to be located at Kazala 'Island', an elliptical shape area of higher ground surrounded by a low lying wetland on the floodplain, around 500m from the Zambezi River. The site has moderate dense vegetation with large trees. The swampy area around the island floods during the rainy season. The site is approximately 500m from the nearest residential areas. The proposed sewerage system is facultative lagoons.

Planned Technology Types

Water

The water reticulation system will make use of a Distribution Network Improvement Zones (DNI zones). The DNI model will meet the exiting demand and the supply of water will be boosted as the town grows in order to meet the requirements of the population. It is assumed that the ring main option described in the design section will be adopted.

Sewerage

The VIP latrines:

The Ventilated Improved Pit (VIP) Latrines are widely used internationally and in rural and peri-urban areas across Southern Africa. These systems are most successful in water-scarce and less densely populated environments. Failures are generally due to inadequate user education and/or poor design and construction. The VIP latrine has been found to be robust, not prone to negative impacts due to the failure of other services, and widely affordable even to the poorest (as VIPs can be made from local materials). However, some of the informal settlements in Kazungula are densely populated and already running out of space for digging pit latrines.

Water-borne toilets: Simplified small bore system:

The simplified small bore system relies on reliable household water connection and operates in the same way as a septic tank and soak-away system. The difference is that the liquid effluent is conveyed by a system of small-diameter pipes to a wastewater treatment system. For optimal functioning the septic tank has to be emptied periodically (2-3yrs), and the sludge has to be treated and disposed properly. Failures may occur due to lack of maintenance of septic tanks or pipe network. Sludge from existing septic tanks is currently transported to Livingstone for treatment.

Sewage treatment ponds:

The waste stabilization ponds are the preferred choice of sewerage system because they require the lowest cost in terms of capital outlay as well as operational and maintenance cost implications, and when well-maintained produce good effluent quality.

The Biophysical Environment

Kazungula is located in a very vulnerable environment in terms of the topography, the soils and hydrology i.e. the proximity to the Zambezi River and reportedly shallow water table. The area is also in a tourist zone being only located about 70 km upstream of the Victoria Falls and several wildlife sanctuaries.

The entire Kazungula district lies on the Batoka Basalts. The basalts form pronounced terraces along low-lying areas and have created the sandy soils that are abundant in the area. While most of the soils are sandy there occurs patches of black clays and red brown loams. The soils are highly permeable.

Water Resources and Quality

The main source of water for Kazungula is the Zambezi River. No other perennial rivers surround the town and as a result most people have no access to clean water except from the Zambezi River. Persistent droughts over the past years have contributed to the difficulties associated with surface water availability on the surface other than from the Zambezi River.

Results of water sample analysis show that the surface (raw) water quality from Kazungula is reasonably good. Although the current water treatment process bypasses the filters and mechanized chlorinators, the water quality is reported to be of acceptable bacteriological quality, although relatively high turbidity and suspended solids. However the treatment process does not guarantee that the quality will be high throughout.

Due to its proximity to Chobe National Park the area has abundant wildlife that includes large species such as elephant and buffalo, as well as predators such as lion, leopard and hyena, and a variety of antelopes (JICA 2001). Occasionally the animals migrate to the perimeters of the town and to the Zambezi River water front. The proximity of the town to Sichifulo Game Management Area and Mulobezi Game Management Area in Kazungula district give the town fair chance of attracting tourists.

The Zambezi River has a fairly diverse aquatic life; with around 20 common fish species and other large aquatic animals namely the Nile crocodile (*Crocodilus nilotica*), hippo (*Hippopotamus amphibius*) and Sitatunga (*Tragelaphus spekeii*). The area also supports many bird species among them the weaver (*Ploceus Velatus*), the African Morning dove (*Streptopelia, decipiens*) and Black flycatcher (*Melaenornis. pammelaina*).

Sewerage System Considerations

The main environmental concern with sewerage systems is whether the site for discharge or treatment is suitable in terms of topography, soils profiles, and percolation to contain the waste. Precautions have to be taken to avoid the risks of polluting surface water as well as ground water. While these are the main risks other environmental considerations also come into play.

Applicable Legislation

The water sector in Zambia is governed by various pieces of legislation that include i) the National Water Policy adopted in 1994 ii) the National Water Act 1994, iii) the Water Resources Management Act, 2011 and iv) the Water Supply & Sanitation Act of 1997. A developer of any sewerage and water treatment plant is required to follow conditions set out in these laws and any other applicable statutes, regulations, guidelines and procedures and to seek approvals in advance of any construction.

Pollution of the environment in Zambia, is regulated by the Environmental Management Act of 2011 and Waste Management Regulations (particularly statutory instrument 71 of 1993) i.e. the Licensing of Transporters of Waste and Waste Disposal Sites; Statutory instrument number 28 of 1997. Basically the environmental protection and pollution control regulations stipulates the requirement of an impact assessment for such projects as the proposed improved water and sanitation for Kazungula.

Other pieces of legislation that are applicable to the improvement of water and sanitation include the Public Health Act of 1930, the Local Government Act of 1991 and Town and Country Planning Act of 1961, among others.

- **The National Water Policy 1994**

The National Water Policy of 1994 outlines the development of Zambian water resources. The policy guides development in conservation, management, demand and supply of water resources in the country. Its objective is to ensure equitable provision of “an adequate quantity and quality of water to all user groups and, improved sanitation services for all at an acceptable cost’. Thus improving the quality of life and productivity of all people.

- **National Environmental Management Act (ZEMA)**

The Zambia Environmental Management Agency (ZEMA) - formally known as the Zambia Environmental Council, was established under the Environmental Management Act of 2011. The role of the Agency is, amongst other things, to: advise on policy formulation and make recommendations for the sustainable management of the environment; ensure the integration of environmental concerns in overall national planning through co-ordination with appropriate authorities; review environmental impact assessment (EIA) and strategic environmental assessment (SEA) reports; monitor trends of natural resources, their use and impact on the environment and make necessary recommendations to the appropriate authority; and publicize information on any aspects of the environment and facilitate public access to information on the environment.

ZEMA publishes all EIAs and SEAs carried out in the country on their website, including all policies and laws that concern the environment. It also carries out research and awareness raising on environmental issues, as well as natural resource management such as the impact of deforestation and environmental degradation. ZEMA is the main authority for implementing environmental safeguards by ensuring development interventions are preceded by appropriate EIAs and/or SEAs.

For the Kazungula water and sanitation project (from Phase 1 onwards) a full EIA will have to be carried out and approved by ZEMA. This includes the terms of reference for the EIA. ZEMA will also

Inspect the site for wastewater treatment and disposal; and if satisfied will issue a certificate for the contractor to go ahead with construction. A provisional site visit to the STP location and outfall area by key stakeholders (including ZEMA) has been undertaken.

- **The National Water Act (1994)**

The Water Act regulates all water related aspects in Zambia. The Act provides the guiding principles in the protection, use, development, conservation, management and control of water resources. A Water Act license from ZEMA is necessary for the construction of any new wastewater treatment works in Zambia. The license is issued after a satisfactory Environmental Impact Assessment has been conducted and ZEMA has been satisfied that the treatment works will not cause irreversible damage to the environment and humans.

- **The Water Supply and Sanitation Act in 1997**

This Act places the responsibility for the provision of Water and Sanitation Services (WSS) under local authorities that are supervised by the Ministry of Local Government and Housing (MLGH) through the Department of Infrastructure and Support Services (DISS). The Act provides room for operation of commercial utilities in the WSS sector and the creation of a regulator, the National Water and Sanitation Council (NWASCO). DISS also assists in the mobilization and co-ordination of financial resources for infrastructure development by WSS providers.

The National Water Supply and Sanitation Council (NWASCO), has a mandate to regulate the provision of water supply and sanitation services in the country. NWASCO became operational in June 2000 and its objective is to improve service delivery, efficiency and sustainability of water supply and sanitation at a fair price. NWASCO regulates large settlements and towns like Kazungula that service more than 500 people.

- **The Water Resources Management Act, 2011**

This Act defines the functions and powers of different government institutions in the water resources sector; provide for the management, development, conservation, protection and preservation of the water resource and its ecosystems. It outlines guidelines for water utilization by members of the society and among other things provide for the functions and composition of catchment councils, sub-catchment councils and water users associations; provide for international and regional cooperation in, and equitable and sustainable utilization of, shared water resources; provide for the domestication and implementation of the basic principles and rules of international law relating to the environment and shared water resources as specified in the treaties, conventions and agreements to which Zambia is a State Party. The Kazungula water and sanitation development will need to abide by the SADC water protocols for shared waters and the Zambezi River Authority guidelines, provided for by this Act.

- **The Waste Management- Licensing of Transporters of Waste and Waste Disposal Sites Regulations, 1993 Statutory Instrument No. 71 of 1993**

Licenses are required for the transport of waste or for the operation of a waste disposal site or plant, both solid and liquid waste. As mentioned above Kazungula will need a license for the operation of the wastewater treatment plant.

- **The Environmental Protection and Pollution Control Act (1990)**

This Act provides measures that should be employed to protect the environment from irreversible damage through development activities. It outlines actions to be undertaken in order to ensure that the environment and natural resources are not overstrained and how the polluter should be held responsible for any environmental damage.

- **The Public Health Act of (1930)**

The Act empowers Council and any other responsible Authority to prevent diseases and pollution that can harm human beings. The Act also requires that drinking water sources are protected from harm. In addition council is required to fumigate households under their jurisdiction to control malaria by killing the mosquitoes.

- **Flood protection – Disaster Management Act**

It is an understanding that Wastewater treatment plants and potable water plants should be protected against flooding. A plant must be so located that it is not subject to flooding or is otherwise protected from flooding and has all weather road access. The treatment plants must be located at an elevation higher than the 100year flood level or otherwise be adequately protected against 1000 flood damage.

NB This condition is addressed under 'Wastewater' of the Engineering Section.

Identification of Potential Environmental Impacts

Potential impacts in terms of climate, topography, soils, geology, hydrology and ecology were scored on the following basis as explained in the table below.

Table 52: Impact Score Criteria

Status	Whether the project would have a positive, negative or neutral impact
Extent	The distance for which the impact would be felt, locally, sub-regionally, regional or national
Duration	Whether the impact would be short –lived (less than 5 years), Medium-term or Long-term
Magnitude	Considers whether the impact would be negligible, low, medium or high
Likelihood	Improbable, possible, highly probable or definite
Significance	How the impact will be felt, negligible, low, medium and high

Impacts were also classified as direct or in direct where direct impacts refer to those impacts that will immediately result in an effect on the receiving physical environment, on flora and fauna as well as other humans and livestock. Indirect impacts occur as secondary result of the change caused by direct impacts.

It should be noted that different phases will have different potential impacts and requisite permits.

Impacts identified for the improved water reticulation system

Immediate measures phase will involve upgrading of the existing treatment site and relocation of the water intake from the current site to a location upstream of the new bridge abutments and developments in the town. The later stages will involve construction of a new plant and laying pipes for the DNI system. The upgrading of the existing facilities has very low impact on the environment, as most of the activities will be confined to an already existing space. Similarly the relocation may cause short-lived water and surface disturbances.

The water reticulation related activities will include construction at the new intake site, laying of pipes for raw water in some sections and pipes for treated water, relocation of the intake pipes and pump. These activities will disturb the earth, foul the Zambezi River water when the intake is being secured and thus increase human activity along the pipeline routes. Vegetation on the elevated site for new plant relocation will be cleared and the earth disturbed as the construction activities take place. On the positive side improved access to treated water will definitely improve the health standards of the community and indirectly impact on the social and economic development of the town.

Table 53: Impacts for water reticulation system

Impact	Negative /positive	Direct/indirect	Reversible/not	
Earth disturbance when laying pipes	-vet	direct	reversible	Not significant it will be short lived
Water fouling around old and new intake area	-ve	direct	reversible	Not significant
Clearing of vegetation, construction and taking up land for the new plant	-ve	direct	Not reversible	Low-moderately significant. Very small area required for this.
Human health	+ve	indirect	Cumulative over time	Highly significant
Increased access	+ve	direct	-	Improves health

Identified potential impacts for the sewerage treatment plant.

Establishment of water borne sewerage treatment facilities is a significant positive development for any society. However, if this development is not well designed and managed, serious environmental damage especially to surface and groundwater resources may result. The nature of waterborne systems also increase

the demand for water and this can contribute to increased treatment costs as more volumes are required and can also cause scarcity in areas that are water stressed. In light of the fact that there are communities downstream of Kazungula who do not have access to piped water but instead depend on the Zambezi waters, contamination of water sources by sewage constitutes a significant health risk to these community members as well as their livestock. It also constitutes an environmental hazard, in the Livingstone/ Victoria Falls tourist zone.

If the current situation is maintained there is a risk that effluent from pit latrines may be permeating into the ground water table that is reported to be shallow. However, no monitoring of the ground water has occurred and the real impacts are therefore not factually known. As the soils are reported to be highly permeable the risk of pollution from pit latrines is assumed to be high and worrisome in informal settlements that are near the river and where the toilets and wells are close to each other. However the groundwater is not currently used, or proposed to be used in the future for human consumption.

In order to fully appreciate the extent of impacts of establishing the sewerage treatment facility and upgrading latrines for the town it is important to start from a position where the sanitation situation remains unchanged. The table below highlights the unchanged situation.

Table 54: Potential impacts associated with the current situation remaining unchanged.

Potential impact	Status	Extent	Magnitude	Likelihood	Significance
Bio-physical aspects					
Continuing groundwater and surface water contamination risk over Kazungula (unimproved pit latrines)	Negative	Local to sub-regional	Unknown	Highly probable	High
Risk of soil and water pollution	Negative	Local	Unknown	Highly	High
Continuing health risk to humans and fauna (wildlife and livestock) due to water contamination	Negative	Local to Sub-regional	Unknown	Highly probable	High
Hampering of new development in Kazungula due to unavailability of effective water-borne sewerage	Negative	Local	Unknown	Definite	Medium
No uplifting of living standards in Kazungula in terms of sewerage provision	Neutral	Local	High	Highly	High
No construction-phase security risk associated with construction workers	Neutral	Local	Unknown	Definite	Unknown
No construction phase job creation associated with either the sewerage plant or the sewerage reticulation, nor support of jobs in related industries through local procurement of materials, equipment & services during construction	Neutral	Local	Low	Definite	Low
No visual impact of construction activities	Neutral	Local	Negligible	Definite	Negligible
Water demand levels	Neutral	Local	Low	Probable	Negligible

Impacts during project implementation

The proposed project operations are divided into the construction phase and an operation phase. During the construction phase, a few laborers will be engaged to lay pipes and build the treatment lagoons. The impacts may be experienced in the form of construction workers using the veld for ablutions, in the absence of toilet facilities. However, it is recommended that temporal lined pit latrines be provided to prevent such impacts. Furthermore, some community members and travelers already use the surrounding bush for ablution and therefore use by construction workers for the same (though discouraged) would not introduce new impacts.

Over and above this the physical environment, soil and vegetation will be cleared and disturbed. The impacts will be low to moderate if controlled and unnecessary clearing is undertaken especially in pipe laying. Topsoil and the rest of the spoil should be used for back filling.

Table 55: Potential impacts during the Construction Phase

Potential	Receiving	Status	Extent	Duration	Magnitude	Likelihood	Significance
None	(Climate)	-	-	-	-	-	-
Workers using the veld for ablutions	topography, soils, geology and	Negative	Local	Short term	Negligible	Possible	Negligible
None anticipated	surface freshwater	-	-	-	-	-	-
Fire risk associated with “hot”	vegetation	Negative	Local	Short term	Unknown	Possible	Low
Animal fatalities resulting from	Fauna	Negative	Local	Short term	Negligible	Possible	Negligible
Disruption of the activities of fauna on and around the site due	Fauna	Negative	Local	Short term	Negligible	Possible	Negligible
Trapping / hunting / killing fauna by laborers	Fauna	Negative	Local	Short term	Negligible	Possible	Negligible

Potential Impacts for VIP Latrines

The VIP latrines should be located/upgraded to prevent ingress of storm water to pit, as well as to prevent the contamination of local groundwater. The system cannot accept domestic wastewater. For the VIPs to last long they have to be properly constructed and the community educated to manage them properly.

Table 56: Potential Impacts of Latrines

Potential Impact	Status	Extent	Magnitude	Likelihood	Significance
Bio-physical aspects					
Groundwater water contamination	Negative	Local to sub-regional	Unknown	Highly probable	High
Risk of soil pollution	Negative	Local	Unknown	Highly probable	High
Contamination of surface water due to flooding	Negative	Local to Sub-regional	Unknown	Highly probable, but upgrades to address this issue	High
Poor ventilation causing odor	negative	Local	low to medium	Probable	Unknown
Fly breeding	negative	Local	Low	probable	Low
No running Water demand	Positive	Local	High	Definite	High
Improved hygiene and health	Positive	Local	Medium - high	Highly probable	High

Potential Impacts during operational Phase

Compared to the existing situation the proposed reticulation project is anticipated to reduce chances for contaminating the surface water. Hence there will be reduced risk contamination of the Zambezi River water during normal operations. There are however, high risks of overflowing or flooding leading to partially treated or untreated sewerage flowing to the river. This negative impact is expected to be of medium to high significance.

This potentially negative risk is considered highly probable and significant and has to be mitigated. Because of this, the upgrading promotion work for domestic sanitation will promote technical options that are more flood resilient, and further consideration for the location and flood proofing for the STP will be required.

With regards to siting the proposed project is fairly close to residential areas such that there is a possibility of polluting the air from potential production of odors, although the system is being designed in such a way that odors will be minimized and should not be a significant impact. In the event of odors being released from the system, however, wind direction would be the main factor determining whether such odors would cause discomfort to the neighborhood.

Foul odors can also be expected if leakages occur along the pipe system to the treatment ponds. It is anticipated that the facility will be managed properly to avoid odor impacts from these sources, even though the risk of foul odors at the plant may occasionally occur.

Table 57: Potential sanitation-related impacts during the operation phase

Potential impact	Receiving	Status	Extent	Duration	Magnitude	Likelihood	Significance
Potential transportation of odors to Kazungula by wind	Air	Negative	Local	Long term	Low	Possible	Medium
Groundwater contamination	soils and hydrology	Negative	Sub- regional	Long term	Unknown	Improbable	Medium to high
Reduction in current groundwater pollution by sewage	soils and hydrology	Positive	Sub- regional	Long term	Medium	Highly probable	Medium
Reduction in current surface water pollution by sewage	surface freshwater quality	Positive	Local to Sub- regional	Long term	Medium	Highly probable	Medium
Contamination of the Zambezi River in case of spillage / leakage	surface freshwater quality	Negative	Sub- regional	Long term	Unknown	Improbable	Medium-high
May promote breeding of insects in the ponds (e.g. flies an mosquitos)	Vegetation	Negative	local	Long-term	Medium	Possible	High
Ponds may attract wildlife- manure will increase BOD	wildlife	negative	local	Short-long-term	Medium	Possible	low

Potential impact	Receiving	Status	Extent	Duration	Magnitude	Likelihood	Significance
Risk of overflows and flooding of the area	Surface water and the Zambezi	negative	Local to Sub-regional	Short term		possible	high
Reduced health risk to fauna due to improved water quality (particularly aquatic fauna e.g. fish, but also fauna dependent on the river for drinking or foraging, e.g. wildlife & livestock)	Fauna	Positive	Local to sub-regional	Long term	Medium	Possible	Medium

Cumulative impacts

As is the case for any activity, impacts are not limited to those directly or even indirectly associated with the proposed activity – potential cumulative impacts need to be considered as well, so that activities can be seen not as stand-alone entities but as part of the larger picture of which they inevitably form part.

Should this proposed upgrading project be implemented, it may serve to stimulate further development in Kazungula, particularly (but not limited to) the area that will be newly served by waterborne sanitation and improved water supply. Such possible spin-off development would pose its own suite of impacts, both positive and negative.

Continuous release of nutrients from the sewerage effluent to the Zambezi River may lead to eutrophication of the rivers section adjust and below the Kazungula Town. Nutrients will slowly build up when the river fails to self-purify. The effects of eutrophication include a decrease in species diversity, and the change of dominant biota, increases in plant and animal biota, turbidity increases and increase in rates of sedimentation. As the situation continues anoxic conditions may develop.

All these results in problems of human health, decline in amenity value of water and an increase in aquatic vegetation. Vegetation may alter the natural flow and fish populations may be replaced by less valued fish. There also may be a change of water taste and odor as the plants decompose. However given the flows from Kazungula's wastewater treatment plant relative to the volume of water in the Zambezi, this is not anticipated to be a major issue.

Table 58: Potential cumulative impacts

Potential impact	Status	Extent	Duration	Magnitude	Likelihood	Significance
Operational Phase						
Increase in water demand	Negative	local	Long-term	high	possible	Medium
Reduction in water pollution	Positive	Local – sub-regional	Long-term	High	Highly probable	High
Facilitation of further development	Positive or negative	Local	Long-term	Unknown	Possible	Unknown
Eutrophication of the River	Negative	Local- Sub regional	Long term	medium	possible	high

Table 59: Summary of potential impacts during construction phase

Potential Impact	Status	Extent	Duration	Magnitude	Likelihood	Significance	Mitigation/Monitoring
Construction phase							
Workers using the veld for ablutions	Negative	Local	Short term	Negligible	Possible	Negligible	Monitoring required during construction
Animal fatalities and disturbance of fauna resulting from construction-related	Negative	Local	Short term	Negligible	Possible	Negligible	Management and monitoring required during construction
Visual impact of construction activities and site clearing	Negative	Local	Short term	Low	Probable	Negligible	No further studies required
Noise associated with construction activities	Negative	Local	Short term	Low	Probable	Low	Monitoring required
Operational phase for stabilization ponds							
Potential transportation of odors to Kazungula by wind	Negative	Local	Long term	Low	Possible	Low	Monitoring required

Potential Impact	Status	Extent	Duration	Magnitude	Likelihood	Significance	Mitigation/Monitoring
Reduction in current groundwater and surface water pollution by sewage	Positive	Local to Sub-regional	Long term	Medium	Highly probable	Medium-high	Management and monitoring required throughout operational lifetime of system. Six-monthly
Reduced health risk to fauna (wildlife, livestock & aquatic fauna) due to improved water quality	Positive	Local to Sub-regional	Long term	Medium	Possible	Medium	No mitigation needed
Possible pollution of surface water and groundwater	Negative	Local	Long term	Unknown	Improbable	Medium-high	Management and monitoring required Six-monthly reporting to
Removal of plant species around the stabilization ponds, including long-term follow-up	Positive	Local	Long term	Low	Possible	Low	Management and monitoring required
Visual impact of the treatment plant	Negative	Local	Long term	Negligible	Possible	Negligible	No mitigation needed
Stimulation of further local development	Positive / Negative	Local	Long term	Unknown	Highly probable	Unknown	No mitigation as part of this project, but the applicant/s will need to adhere to relevant environmental
Operational phase for VIP latrines							

Potential Impact	Status	Extent	Duration	Magnitude	Likelihood	Significance	Mitigation/Monitoring
Groundwater water contamination	Negative	local	Long term	high	Highly probable	high	The pits may need to be lined and properly sealed in certain areas
Risk of soil pollution	Negative	local	Long term	medium	possible	medium	
Contamination of surface water due to flooding	Negative	Local	Long term	high	Highly probable	high	Recommended for council to provide for storm water diversion to risk areas. To include promotion of flood
Poor ventilation causing odor	Negative	Local	Long term	low	likely	Low -medium	Ensure optimal ventilation and repair vent pipe if damaged
Fly breeding	Negative	local	Short term (if corrected)	medium	possible	Low -medium	Maintain dark interior, lower seat cover when not in use, repair and replace fly screen
Improved hygiene and health	Positive	Local	Long term	high	probable	high	Provide hand-washing facility

Management of Potential Impacts

As eluded above if the planned project activities are not properly planned and managed they may contribute many potential negative impacts on the environment that are direct and indirect. The indirect impacts tend to impact on human and terrestrial animal health, and general welfare of the community. The two major significant impacts i.e. contamination of the surface and ground water due to leaking of sewerage treatment lagoons or overflows can be mitigated by taking measures that ensures that the ponds are sealed and well lined. When the sewerage treatment ponds are constructed they should be fenced to discourage people and wildlife from entering the facility. The grass around the ponds has to be cut low at all times to avoid mosquito breeding and accumulation of algae.

During construction the amount of soils and vegetation removed has to be kept to a minimum and the construction requirements observed in managing spoil, and topsoil. Spoil can be used to heighten embankments for the sewerage pond. These should be compacted to minimize washing away of the soils.

Due to the nature of the soils and high water-table in Kazungula the construction of sewerage facilities, VIP latrines, pipelines and septic tanks needs to be properly managed and pits potentially lined to avoid seepage of sewage effluent into the surrounding environment. While sewerage treatment and increased access to clean water reduce the likelihood of water-borne diseases, this needs to be enhanced by provision of hygiene education through schools and ministry of health. People should be sensitized of the dangers of water borne diseases such as cholera, dysentery, malaria and bilharzias by use of various awareness campaigns.

The sewerage ponds may create breeding grounds for flies and malaria mosquitoes. Apart from keeping the grass low there may be need to spray the grass around the ponds periodically.

A monitoring plan is necessary during construction and operation of the project. The monitoring plan is designed to encourage compliance to proposed mitigations with the aim of reducing or eliminating negative impacts and enhance the positive impacts where possible. Although the project is expected to present more positive impacts than the negative impacts there are factors highlighted in the sections above, such as reduction of sewerage seeping into the ground or flowing to the river in order to keep the water quality acceptable and reduce of risk of pathogenic infections and diseases that have to be controlled in order to manage and enhance positive changes.

Permits Required

It is anticipated that the permits shown in **Table 60** will be required to implement the full activities of this project, but obtained during each phase when the work is to be implemented.

Table 60: Overview of Permits Required

Permits required:
A Water Act Licence
A Waste Water Plant operating/ discharge licence
Undertake a full EIA (depending on the stage)
SWSC requires a raw water abstraction permit as this is a shared water course. Notification will need to be given to the other countries.

Recommendations

While this assessment has led to the conclusion that the proposed improvement of the water and sanitation system would in fact be an improvement upon the current situation of no sewage treatment and limited water access, a full Environmental impact assessment would be needed for the planned project.

Baseline information on the following needs to be established:

a) The ground water table in Kazungula and Kazala Island area and susceptibility to flooding.
b) The ground water quality.
c) The percolation levels of the soils in the area.

Project Implementation Plan

Initially it was proposed to construct the required infrastructure to meet 2030 demands in a single investment. The subsequent Cost-Benefit Analysis (CBA) showed that this was not viable, therefore a phased approach has been adopted enabling investments to be made as the town grows and providing some flexibility if the population growth differs from the predicted.

The Feasibility Study looks at the period until 2030 and has phased the project into Immediate Measures, Phase 1 (2020), Phase 2 (2025) and Phase 3 (2030). The study recommends that sanitation improvements are carried out in the same phases, to match the implementation of improved water supply. It should be noted that the dates linked to the phases are the dates when the infrastructure will need to be in place to meet the demand. Therefore to meet these dates, probably more than two years for planning, funding and construction needs to precede the demand / phase date.

The Medium Scenario population projection has been used for the design of the water supply and sanitation system. The actual population growth should be monitored to allow sufficient planning time to upgrade the system in a phased approach, i.e. although the phasing has currently been linked to implementation years, it may be necessary to implement earlier or later based on actual population growth (or increase in water demand).

The following section provides a summary of the infrastructure based on a phased implementation approach.

Table 61 shows the proposed distribution improvements.

Table 61: Target Expansion Areas per Phase

Phase	DNI Zone	Remarks
Immediate Measures	4, 5 and 6	Water Production increased. Primarily Standpipe services provided to improve ease of access for the poor. Provision to meet some commercial demand.
Phase 1	1(part) 4 and 5	Standpipe, Yard and house connections available. Provision for some commercial demand.
Phase 2	1(part), 2, 3, 6 and 8	Standpipe, Yard and house connections available. Provision for some commercial and tourist demand.
Phase 3	9, 10, 12 and 13	Standpipe, Yard and house connections available. Provision for some commercial and tourist demand.

It is proposed that the sanitation interventions are phased as per **Table 62**.

Table 62: Proposed Phased Sanitation Interventions

Phase	DNI Zone	Remarks
Immediate Measures		• Construction of 5 public ablution blocks • Behavioural change campaign linked with sanitary enforcement and sanitation marketing, to promote upgrading of domestic sanitation facilities and prevent open defecation
Phase 1		• Construction of main sewer line and treatment works, serving institutions and public facilities and limited network in residential areas • Ongoing behavioural change campaign linked with sanitary enforcement and sanitation marketing (particularly for new residents)
Phase 2	1, 2, 3, 4, 9, 10 and 13	• Expansion of sewerage mainline network • Construction of treatment works on Kazala Island • Ongoing behavioural change campaign linked with sanitary enforcement and sanitation marketing (particularly for new residents)
Phase 3	1, 2 and 3 4, 5, 6 and 7 residential areas	• Expansion of sewerage network • Extend a simplified sewerage network into • Increase number of sewage treatment ponds to handle the increased sewerage flows. • Ongoing behavioural change campaign linked with sanitary enforcement and sanitation marketing (particularly for new residents)

In Phase 1 residential users will be encouraged to develop and upgrade their 'on-site' solutions to include VIP latrines and septic tanks. The initial residential development is expected to take place in the two zones north and east of the market. These are the zones where the water supply distribution will initially be focused.

Phase 1 will also include a primary sewerage system that will collect effluent from the larger institutional and commercial customers and convey this to the STW. The Sewage Treatment Works will also be part of Phase 1 and will initially comprise of 2 lagoons south of Makalanguza Suburb. Future phases will move the

treatment works to Kazala Island and add lagoons as the town develops. Phase 1 also extends to the Government housing area to the west of the WTW where a conventional sewerage system is required.

Phase 2 would see a further extension of the conventional system that would extend to additional commercial, industrial and tourism customers as the town develops.

Phase 3 provides for a 'small bore' or simplified sewerage system to residential areas as the aspiration to improve levels of service unfold.

The proposed sewerage system is designed to be flexible to accommodate a variable growth rate. The sewerage system will fundamentally follow the water demand as residential and commercial growth occurs.

Table 63 provides a summary of the various interventions in the form of a phased implantation plan.

Table 63: Phased Implementation Plan

ITEM No.	ACTIVITY DESCRIPTION	SOURCE OF FUNDS	IM1 / IM2	PHASE 1	PHASE 2	PHASE 3	REMARKS
1.	'Immediate Measures' Operational changes to increase Water Production in the short term.	CRIDF	✓				Requires Operational changes. Initially operation of 2nd Raw Water Pump and improved Distribution Management procedures. Followed by operation of new intake. Benefits: (i) Water Production Increased by 60+%. (ii) Hours of service to Kazungula town increased to 24/7. (iii) Increased revenue.
2.	'Immediate Measures' Operational changes to Improve Water Quality	CRIDF	✓				Requires Operational changes. Renovate Filters and CL2 at the Water Treatment Plant. Increased Storage Capacity. Benefits: (i) Water Quality improved to Kazungula.
3.	'Immediate Measures' Distribution Improvements to reach priority customers.	CRIDF	✓				Distribution Extensions into the poorest and highest priority Communities using 'self help' labour. Benefits: (i) Water distributed into Kazungula's highest priority [poor] communities, estimated to be approximately 2,000 people. (ii) Health & Social benefits.

ITEM No.	ACTIVITY DESCRIPTION	SOURCE OF FUNDS	IM1 / IM2	PHASE 1	PHASE 2	PHASE 3	REMARKS
4.	Institutional Support (Technical)	CRIDF (IM1), external funder	✓	✓	✓	✓	Revised Operational Procedures introduced into SWSC to provide Efficient and Effective Services. Benefits: (i) Improved levels of service to all customers in the form of better reliability, quantity (24/7) and improved water quality. Revised procedures would lead to reduced operating costs and increased revenue. (ii) Procedures could be applied widely across SWSC to benefit SWSC and their customers. Introduction of knowledge of environmentally sound, low cost sewage treatment.
5.	Institutional Support (Commercial)	External funder		✓	✓	✓	Revised Operational Procedures introduced into SWSC. To support becoming sustainable. Benefits: Revised Commercial Procedures introduced into SWSC. Benefits could be applied more widely in SWSC.
6.	Environmental Safeguards Program	External funder		✓	✓	✓	New investments and revised Operational Procedures introduced into SWSC. Benefits: Reduced contamination of river water from open defecation. All members of the community have access to clean water from water works. Sewerage centrally treated and disposed safely. Clean and healthy environment.

ITEM No.	ACTIVITY DESCRIPTION	SOURCE OF FUNDS	IM1 / IM2	PHASE 1	PHASE 2	PHASE 3	REMARKS
7.	Social Safeguards Program	External funder		✓	✓	✓	Activities: (i) Provide low cost services in poor communities. (ii) Promotion of –health & hygiene, water conservation, cost recovery. (iii) Community involvement in design of services. (iv) Community-based management of services/water committees. Benefits: (i) improved access to water and sanitation, increased revenue, improved usage efficiency (ii) Reduction of vandalism (iii) Improved utility-customer relationships (iv) Creation of jobs/Economic Development
8.	Sanitation Program + Health Safeguards Program	CRIDF (IM1), External funder	✓	✓	✓	✓	Activities: (i) Support to Provision of low cost services in poor communities. (ii) Promotion of – health & hygiene, water conservation, cost recovery. (iii) Community involvement in design of services. (iv) Community-based management of services/water committees. Benefits: Reduced incidence and severity of Dysentery and Diarrhoea, Malaria, Bilharzia and worm infestations. The focus on sanitation is around promoting low-cost technologies for upgrading on-site facilities, developing the local private sector supply capacity for these products, and consider customer financing options. Also to include community mobilisation and sanitary enforcement against open defecation and unhygienic latrines.

ITEM No.	ACTIVITY DESCRIPTION	SOURCE OF FUNDS	IM1 / IM2	PHASE 1	PHASE 2	PHASE 3	REMARKS
9.	'Immediate Measures' 5 Communal Toilet Blocks	CRIDF	✓				Construction of 5 Toilet/Ablution Blocks in the vicinity of the Bridge Crossing and in priority poor communities. Benefits: Provides sanitation services in the short and long term. Opportunity for water kiosk included with Toilet Blocks.
10.	Relocation of Water Intake	Bridge Project (IM2)	✓				Priority Investment. Required because of proximity of Intake to the New Bridge. Benefits: Enhanced 'Climate Resilient' Water Intake to meet future demand. Funded by Bridge Project.
11.	Water Supply Distribution Phase 1	External funder		✓			Required to provide increased coverage and level of service to priority communities. Benefits: (i) Metered house connection service to extended number of people plus Social and Health benefits. (ii) Increased revenue (water sales) for SWSC.
12.	New Raw Water Main	Bridge Project (IM2)	✓				Required due to relocation of intake and to increase water production. Benefits: Meets Future Water Production needs for Kazungula. Has the potential for SWSC to expand water supply to other communities in Kazungula District. Additional revenue for SWSC.

ITEM No.	ACTIVITY DESCRIPTION	SOURCE OF FUNDS	IM1 / IM2	PHASE 1	PHASE 2	PHASE 3	REMARKS
13.	New Service Reservoir IM1, Phase 1 and 2	External funder	✓	✓	✓		Priority. Required to meet peak day demand. Benefits: Ensures 24/7 continuous water supply service to all Kazungula residents through peak demand periods.
14.	Increase WTW Capacity Phase 1 and 2.	External funder		✓	✓		Required to meet current and future water demand. Similar treatment processes as Livingstone to ensure consistent and appropriate technology in SWSC. Benefits: (i) Ensure water quality to Zambian standards. (ii) Potential for SWSC to provide commercial and tourist demand.
15.	Conventional Sewerage Network Phase 1 and 2	External funder		✓	✓		Required to meet Health and Environmental Standards. Benefits: (i) Social, Health and Environmental benefits for 2,000 people including (ii) Bridge project, 'One Stop' Border Post, through both construction and operating stages. (iii) Potential for Capital contribution from Bridge project. (iv) Increased revenues for SWSC.
16.	Waste Stabilisation Ponds for Sewage Treatment. Phase 1 and 2.	External funder		✓	✓		Ditto above plus:- (i) Has the potential for SWSC to expand services to other communities in Kazungula District e.g. by providing Septic Tanks emptying service. (ii) Would have Social, Health, Environmental benefits plus (iii) additional

ITEM No.	ACTIVITY DESCRIPTION	SOURCE OF FUNDS	IM1 / IM2	PHASE 1	PHASE 2	PHASE 3	REMARKS
							savings for SWSC, lower operating costs.
17.	Water Supply Distribution Phase 2 and 3	External funder			✓	✓	Required to provide increased coverage. Benefits: (i) Metered house connection service to 2,000 people plus Social & Health benefits. (ii) Increased revenue for SWSC.
18.	Sewerage Network Phase 3. Small Bore	External funder					Required to meet Health and Environmental Standards. Benefits: (i) Social, Health and Environmental benefits for 2,000 people. (ii) Increased revenues for SWSC.
19.	Surface water drainage [Outside the scope of this Project]						Required to meet Health and Environmental Standards. Benefits: (i) Reduction/elimination of overflowing pit latrines and septic tanks in lower reaches of the town during heavy rains. (ii) Reductions/elimination of worm infestations.

Risk Assesment

A risk assessment has been undertaken for the Kazungula Water Supply and Sanitation Project to identify the potential risks that could prevent the project from progressing as planned, or from successful completion. The assessment recognizes those obvious risks that are inherent to the project itself and those that are a result of external influences that are completely outside the control of the project team.

The risks have been grouped under Technical risk, Water Availability risk, Operation and Maintenance risk, Socio-economic risk, Financial risk, Environmental risk, Political risk and Force Majeure risk.

The assessment indicates that there are high technical risks associated with quality and performance risk resulting from the procurement of a contractor with inadequate capacity. This would result in delays in the completion of the project and infrastructure not being completed to specification leading to reduced service levels to the community. This risk can be mitigated through the engagement of Project Management and Quality Assurance Contractors. There are also high socio-economic risks relating to the community's resistance to accepting new technology and the ability to pay for the services. These socio-economic risks can be mitigated through awareness campaigns, which are included in the design of the project. The inadequacy or interruption of funding is another risk identified which can be mitigated by engaging potential funders in the early stages of the project development cycle, which has already been initiated.

Details of the risk assessment are presented in the Risk Matrix in **Table 64**.

Table 64: Risk Matrix

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
1. **Technical**					
1.1. Misunderstanding the requirements of the project	CRIDF have maintained close working relationship with all Stakeholders which will reduce misunderstandings.	Medium	High. Cost, delays and reduced service levels.	• Ensuring involvement of stakeholders by relevance in a timely manner. • Continued close working relationship with stakeholders through both Bankability and Financial Closure stages.	• Low
1.2. Changing scope/objectives – deviating from the intended horizons and 2030 targets	CRIDF has maintained close working relationship with Stakeholders. Population predictions could change if Bridge project was postponed.	Low	Medium. Cost, delays and reduced service levels.	• Define and communicate to all stakeholders the scope and expected outputs of the project with regards to provision of safe drinking water and practical sewer and sanitation.	• Very Low
1.3. Introduction of new technology – resistance to accept new technology or systems	CRIDF has maintained a close working relationship with stakeholders.	High	High. Cost and delay	• Conduct awareness campaigns for stakeholders before introducing new technologies.	• Medium

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
1.4. Design and Construction – construction of infrastructure is not completed on time/ budget or to specification.	For the Immediate Measures CRIDF to mobilise a strong supervision team.	High	High. Cost and delay	• Involve all necessary stakeholders to manage and administer the project. SWSC to engage a project management partner as well as a quality assurance partner • Ensure also direct involvement of stakeholders by relevance.	• Medium
1.5. Lack of skilled and qualified staffing	CRIDF can reduce the probability of this by suggesting Institutional Strengthening as a precondition of the capital funding.	Medium	High. Cost and delay. Reduced service levels.	• Introduce an appropriate Institutional Development program and make the implementation a condition of the capital funding.	• Low
1.6. Performance and delivery – services may not be delivered to specification	Suggest Institutional Strengthening as a precondition of the capital funding.	Medium	High. Cost and delay	• Maintain a culture of high quality workmanship and close supervision and assessment at all stages of the project. • Ensure good design and ensure construction is in accordance with the contract	• Low

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
				and IS as 1.5 above.	
2. **Water Availability**					
2.1. Given that the abstraction levels of Kazungula are less than 1% of available water in the Zambezi, there is no risk of shortage of supply for the short to medium future even if the town's population and consequent water demand grow, unless climate changes are very huge and negative.	Very low risk identified as a result of opting for the Zambezi water instead of ground water.	Very low	High	None	Very Low
	Zambezi is a prolific and reliable source. CRIDF can ensure climate resilience in the design of the River Intake.	Low	None	Ensure River Intake design is climate resilient and animal resilient.	Very Low
2.2. Inadequate SWSC capacity in Operation and Maintenance	CRIDF has in agreement with the stakeholders made the proposed infrastructure in Kazungula similar to the existing Infrastructure in Livingstone. Institutional Strengthening	Low	None [Subject to the IS program being implemented]	Instigate an appropriate Institutional Strengthening program and make the implementation is a condition of the capital funding.	Very Low

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
	program must be implemented.				
3. **Socio-economic**					
3.1. Affordability - Low ability to pay for improved water and sanitation services, by various groups of the population	Low	Medium - high	High	• Ensure that the water supply and sewerage system designs incorporate service level options to correspond with the varying ability and willingness to pay for services. These should be able to be upgraded/ improved over time as incomes and demand increases	• Very Low
3.2. Lack of supporting infrastructure – the development of other key basic infrastructure / institutions (roads; waste removal etc.) are not developed in correspondence / alignment with the water	Low	Medium - high	Medium - high	• Ensure adequate collaboration with KDC in designing and developing the water and sewerage system • Base designs and expectations on realistic assumptions / projections around town development	• Very Low

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
and sewerage system. This will mean the economic development envisaged to raise incomes and demand will not materialise					
3.3. Misalignment – The town's development is not aligned to the water and sanitation system (e.g. population growth happens outside of the areas marked for supply). This will mean that the population will not be served and the socio-economic benefits of the project will not be realised	Medium	Low-medium	High	• Ensure adequate collaboration with KDC in designing and developing the water and sewerage system • Stress on KDC the importance of implementation of town planning, and the risk a lack of structure poses • Periodic review of the proposed design based on population growth and distribution	• Low
3.4. Affordability (HH), Domestic Tariff Rates - Affordability constraints pose the risk of the average domestic tariff	Low	High	High	• A more detailed analysis of affordability should be conducted as part of project implementation (particularly	Very Low

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
rate stretching the financial ability of the poorer segments population in particular. This could result in either low uptake of the project infrastructure and failure to realise all of its associated socio-economic benefits; or lower tariffs compromising the cost recovery and operational sustainability of the systems.				because new populations migrating into Kazungula may have a lower / no monthly income), however the affordability at the current average domestic tariff is expected to be high (in line with the high level affordability analysis discussed earlier). • Ensure that detailed designs incorporate adequate service level options to correspond with the varying ability and willingness to pay for services. These should be able to be upgraded/ improved over time as incomes and demand increases. • Provide government grant funds to off-set any loan funding; get households to contribute	

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
				connection fees.	
3.5. Acceptance by stakeholders	Medium. Awareness campaign but can be resource intensive.	Low	High	Consultation with affected parties throughout process from design to implementation	Low
3.6. Exclusion of the marginalised groups	Medium. CRIDF has maintained close working relations with stakeholders.	High	High	Provide different levels of services and give consumers a choice	Low
3.7. Sustainability of the Project	Medium. Institutional Strengthening program must be implemented.	Medium	High	Balance finance, socio-economic status, technical choices (appropriate technology), environmental imperatives and institutional capacity	
4. Financial					
4.1. Capital Costs - An excessive capital investment that is not appropriate to Kazungula, and the resultant inability to	Medium	High	High	• The phased approach to the project aims to ensure that capital investments are fully demand driven by the growth and expansion of Kazungula.	• Medium/Low

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
fund the investment					
4.2. Cost Recovery - Despite the positive annual cash flows expected under the project infrastructure, there is a risk to cost recovery if inadequate management and financial capacity means that potential revenues are not realised (billed for and collected).	Medium	Medium	Medium	• The technical design (DNI's) of the project aims to maximise the cost-recovery in the early stages of the system implementation, and the Institutional Strengthening component aims to ensure there is adequate financial and management capacity in SWSC to realise service revenues.	• Medium/Low
4.3. Failure to raise required investment costs	High	Low-medium	High	• Engage public stakeholders and potential funders from early on in the project development process	• Medium
4.4. SWSC financially unsustainable	Low	Medium	Medium / High	• Use design to try and maximise cost-recovery of SWSC in the first stages of the system implementation • Support financial capacity building / technical assistance	• Very Low

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
				to SWSC to reform the company's financial model	
4.5. Water Supply Coverage - SWSC indicate that the water supply system coverage is 100% (although some of the coverage is far away from customers). Should coverage not remain 100%, full demand will not be met, and expected revenues not realised, thereby compromising operational cost-recovery.	Medium	Medium	Medium	• Ensure adequate collaboration with KDC in detailed design and development of project to avoid misalignment of the town's development is to the water and sanitation system (e.g. population growth happens outside of the areas marked for supply), resulting in coverage lower than 100%.	• Low
4.6. Excessive O&M requirements may lead to unsustainable infrastructure, as customer payments for the services become consistently unable to meet the O&M	Low	Medium	Low	• The project design should ensure appropriate technology is utilized to minimize operational and particularly maintenance costs.	• Low

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
requirements.					
5. Environmental					
5.1. Pollution of ground water from sewage treatment plant	High. Assume adherence of agreed standards in the design of the STP. Implement IS program.	Medium	High	• Ensure Good design and ensure construction is in accordance with the contract and IS	• Low
5.2. Pollution of the Zambezi River from sewage effluent	High. Assume adherence of agreed standards in the design. Implement IS program.	Low	Low	• Ensure Good design and ensure construction is in accordance with the contract and IS	• Very Low
6. Political					
6.1. Political will	Political will for this project is high. Ministry to be kept fully informed. Slight political risk associated with bridge	Low		• Keep Politicians fully briefed through the Ministry and District Commissioner. • Should be politically attractive because of the potential to replicate improvements in other Zambian towns.	• Very Low

Risk	Extent of CRIDF control over the identified risk	Risk Assessment		Summary risk mitigation strategies	Risk After Mitigation
		Probability	Impact		
	construction.				
7. Force Majeure	None.	Low	High		• Very Low

Risk Assessment - Conclusions and Recommendations

The assessment indicates that the risk of failure of the project from water availability is very low. Of major concern is the ability to raise the required capital investments for the subsequent phases, the ability of the stakeholders to pay for the improved water supply and sanitation services and the inadequate capacity of the SWSC to operate and maintain the system sustainably.

It is recommended that resources be mobilised to implement an Institutional Strengthening Programme complemented by stakeholder's awareness campaigns for key messages on paying for water and public health and hygiene.

Conclusions & Recommendations

Summary

This Feasibility Study is for improvements to the water and sanitation system in Kazungula town; a rapidly expanding settlement on the banks of the Zambezi river, at the junction of four SADC states.

The study proposes a phased investment strategy, with short term 'immediate measures' to meet the needs of the poor and existing population, and then phased upgrading to meet the future projected needs up to 2030. The phasing is designed to cope with the uncertainties in the growth and affordability of the future customer base. This study has been undertaken on behalf of the Government of Zambia, Kazungula District Council, (KDC) and the Southern Water & Sewerage Company (SWSC) by CRIDF, with funds from the UK Government Department for International Development (DfID).

Overall, the proposed improvements are found to be highly feasible, and hold major potential to improve the health and livelihoods of the population, stimulate economic growth, and support regional transboundary trade and integration in SADC. The completion of the new bridge over the Zambezi at this location will speed up transport links between the wet north and the dry south of SADC, enabling a regional response to climate change. The bridge will link SADC's fastest growing economies in Angola and Zambia, with the region's highest agricultural potential, to the largest markets to the south. Increased trading of agricultural and mining products through this hub will increase cooperation between the SADC Member States, deepening regional ties and strengthening regional economies. The likely establishment of bonded warehouse facilities and one-stop border controls will enable trading in perishable goods, will encourage regionally based tourism and will provide increased job opportunities for at least 4 SADC States.

The interventions are designed to be climate resilient and prioritise services to the poor. The project will require an EIA but it is considered that the environmental impact can be fully mitigated using conventional solutions. The interventions include some 'self-help' components and accommodate the requirements of both men and women. The proposed investments will enable Kazungula District Council's development plan to build 4,000 new homes to proceed. Through a combination of technical and institutional improvements the performance of the new investments will support SWSC achieving sustainability and could be used as a 'model town' for replication in other parts of Zambia, including the '12 Towns' project. The design concept of Low Mechanical Content LMC has been integrated into all the proposed improvements.

In summary there is overwhelming socio-economic justification for the project, however the project in isolation is not commercially viable hence long term developmental/concessional loans and/or grant funding are required to cover most of the capital investment. Preliminary discussions have been held with potential financiers and it is recommended that these discussions are jointly continued by MLGH, SWSC and CRIDF including the possibility of packaging this project with other border towns. The financial appraisal indicates that the project is operationally sustainable. Projected annual revenues generated exceed the annual operation and maintenance requirements of the infrastructure over the project life. Moreover the assumed tariff rates for services appear to be well within various international affordability benchmarks. Water demand, O&M costs, and water supply

coverage are however critical to the operational sustainability of the infrastructure. Should these parameters vary significantly over time; the SWSC may need to adjust the phasing of investments as appropriate.

Conclusions

1. It is technically feasible to provide climate resilient water and sanitation services to Kazungula to meet the requirements of 2030. CRIDF criteria can be met.
2. The estimated capital cost for the water supply system is US$7.3 million (not including the anticipated bridge funded components) and for sanitation system is US$4.3 million.
3. There are significant local and transboundary health benefits associated with the service level improvements. This is considered particularly important given the location of the town at the intersection of 4 SADC countries and the ease of international travel with the new bridge.
4. There are urgent water and sanitation health problems associated with the queue of traffic crossing the river. This will be exacerbated when bridge construction starts. This problem needs to be addressed quickly.
5. Services to the poor can be improved quickly through an Immediate Measures Phase and will also meet the requirements of the new bridge. This is also a commercial opportunity for SWSC.
6. The Kazungula community is willing to contribute to the improvements of the services and examples of this have already been demonstrated. There is a high willingness to pay.
7. There is an overwhelming economic justification for the project, as indicated by the quantitative results of the economic appraisal in conjunction with the qualitative benefits arguments. In the short term the provision of WASH infrastructure is fundamental to basic human needs; in the medium and longer term, WASH infrastructure will be catalytic to economic development at a local (community) level, as well as for Zambia and the SADC region.
8. The financial appraisal indicates that the project is operationally sustainable. Annual revenues generated exceed the annual operation and maintenance requirements of the infrastructure over the project life. Moreover the assumed tariff rates for services appear to be well within various international affordability benchmarks. Water demand, O&M costs, and water supply coverage are however critical to the operational sustainability of the infrastructure. As such, should these parameters vary significantly over time; the SWSC must adjust the phasing of investments as appropriate.
9. The project alone however is not commercially viable – the revenue generated by the project is not sufficient to cover the investment cost over the project life. This is neither surprising nor uncommon for water and sanitation projects of this scale, given that such projects are fundamentally providing a public good. Conventional financing is therefore not appropriate to this project; long term developmental/concessional loans or grant funding are required to cover the vast majority of the capital investment.
10. There is considerable interest form a range of potential sources for raising funds but most conventional funders would prefer to see Kazungula packaged with other border towns to make a bigger project. There is some potential for smaller funders to be involved with non-engineering components. It is expected that the bridge project will finance costs related to the relocation of the raw water intake/raw water transmission, and that the immediate measures may be suitable for CRIDF financial support.

11. The institutional vision of SWSC is robust and well-founded but the institutional capacity of SWSC needs strengthening in Kazungula.
12. Subject to EIA processes and appropriate detailed designs both the water supply and sanitation systems can installed with minimal impact to the environment.
13. The Zambian Government vision for the development of Kazungula through the KDC Strategic Plan indicates significant economic growth. This development will require the support of improved water and sanitation services.
14. The proposed investments include 'distribution management' techniques which support achieving sustainability. This could be an opportunity for Kazungula to become a 'model town' and the concept replicated elsewhere in SWSC and Zambia.
15. Surface water during the rainy season causes flooding and overflowing of latrines and septic tanks particularly in the poorer communities. This is the cause of many health problems and requires remedial action by KDC.

Recommendations

1. It is recommended that the proposed improvements are implemented in phases to accommodate variations with the population growth. The 'immediate measures' should be effected as soon as possible to provide early relief to the most critical problems.
2. It is recommended that services to the poor are prioritised; this is reflected in the Feasibility Study report.
3. It is recommended that the detailed designs are Climate Resilient and consistent with the infrastructure/processes in Livingstone and implemented using 'appropriate' technology. The design philosophy of 'Low Mechanical Content' LMC has been incorporated throughout the designs of both water supply and sewerage projects.
4. It is recommended that Institutional Strengthening is integral with the improvements and a condition of the capital funding.
5. It is recommended that the SWSC commercial improvements are fully harmonised with the infrastructure designs and linked through institutional strengthening e.g. Billing linked to DNI management. Thus improving services and supporting sustainability.
6. Grant funding is required for the project capital investment. It is recommended that CRIDF consider providing grant funds for part of the 'Immediate Measures' phase of the project (with the Kazungula Bridge Project who have indicated they will fund specific components in the IM phase around relocating the water supply intake). The total investment required for the 'Immediate Measures' is US$ 886,100 – of this it is expected the Bridge Project will provide US$ 436,100. It is therefore recommended CRIDF consider funding the remaining 'Immediate Measures' investment of approximately US$ 450,000.
7. In addition, it is recommended that CRIDF support SWSC in leveraging external grant financing for the remaining capital investment requirements in the subsequent phases of the project. It is recommended that CFIDF supports the immediate measures Phase through to Bankability and Financial Closure.
8. It is recommended that procurement of the IM phase to be in accordance with CRIDF rules, assuming that CRIDF supports the capital financing of the IM. Procurement of later phases to be in accordance

with the appropriate Financiers and SWSC & MLGH rules. Detailed design to be by Consulting Engineers managed by SWSC/MLGH & Financiers through a PMU and in accordance with 12 Towns strategy.

9. It is recommended that SWSC takes immediate action to acquire the 3 pieces of land required for the New Intake, WTW and STW.
10. It is recommended that surface water pollution problems are addressed by KDC as a priority to improve lifestyles and minimise sanitation related health problems.
11. It is recommended that SWSC investigates commercial opportunities to sell services to Botswana especially to the Border Post [transboundary] and to neighbouring larger communities outside the existing service area.
12. This feasibility study has been carried out to determine broad parameters for the determination of the bankability of the Kazungula Water and Sanitation Improvement Project. The following field work should be included in the detailed design phase and Financial Closure:
    a. Land survey of the whole area picking up detail of existing works, services etc. Orthophotos or other information in this regard may be available.
    b. Details of bridge survey, 4000 house development, old construction drawings and any other mapping
    c. Floodline determination is critical - this should be obtainable from the bridge designers through SWSC.
    d. Geotechnical assessment to determine founding, ground water table, nature of material at treatment facility, bedding material, road to WWTW.
    e. Raw water quality analyses. Liaison with Kasane, Livingstone, Victoria Falls may provide longer period raw water test results which are expected to be similar for Kazungula. The results must capture seasonal variations.

Annex 1: Meeting Minutes and Key Decisions

Annex 2: Detail of Existing Kazungula Water Supply and Sanitation

Annex 3: Bill of Quantities for Water and Sanitation Investments per Phase

Annex 4: Feasibility Drawings

Attached separately as a PDF.

Annex 5: CBA Tables

Table 65: Financial Appraisal Summary Table

			IM			Phase 1						Phase 2						Phase 3														
			0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
			2015	2016	2017	**2018**	2019	2020	2021	2022	2023	**2024**	2025	2026	2027	2028	2029	**2030**	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
Population			**7465**	7939	8427	**8930**	9198	9474	9758	10051	10352	**10663**	12463	14317	16226	18193	20219	**22305**	22974	23664	24373	25105	25858	26634	27433	28256	29103	29976	30876	31802	32756	33739	34751
	NPV	**IRR**																															
Capital costs	9 678 575		878 262			5 194 398						3 770 726						1 934 591														-1 676 821
incremental O&M	2 216 393		-	15 290	15 290	15 290	48 429	48 429	48 429	48 429	48 429	48 429	129 210	129 210	129 210	129 210	129 210	129 210	220 308	220 308	220 308	220 308	220 308	220 308	220 308	220 308	220 308	220 308	220 308	220 308	220 308	220 308	220 308
Total Costs	11 029 675		**878 262**	**15 290**	**15 290**	**5 209 688**	**48 429**	**48 429**	**48 429**	**48 429**	**48 429**	**3 819 155**	**129 210**	**129 210**	**129 210**	**129 210**	**129 210**	**2 063 801**	**220 308**	**220 308**	**220 308**	**220 308**	**220 308**	**220 308**	**220 308**	**220 308**	**220 308**	**220 308**	**220 308**	**220 308**	**220 308**	**220 308**	**-1 456 513**
Income																																	
Total Incremental Revenue	**2 685 503**		**0**	**16465**	**21696**	**28233**	**41220**	**45629**	**50042**	**54464**	**58902**	**59845**	**82219**	**95554**	**109509**	**124096**	**139328**	**176690**	**236784**	**244662**	**252739**	**261023**	**269521**	**278241**	**287189**	**296373**	**305802**	**315483**	**325425**	**335637**	**346126**	**356903**	**367976**
Net Revenue	**-8 344 172**	**-6.56%**	**-878 262**	**1 175**	**6 405**	**-5 181 455**	**-7 209**	**-2 800**	**1 613**	**6 035**	**10 473**	**-3 759 310**	**-46 991**	**-33 656**	**-19 701**	**-5 113**	**10 119**	**-1 887 110**	**16 477**	**24 354**	**32 432**	**40 716**	**49 214**	**57 933**	**66 881**	**76 065**	**85 494**	**95 175**	**105 118**	**115 329**	**125 819**	**136 595**	**1 824 490**
	BCR	**0.24**																															

Table 66: Economic Appraisal Summary Table

				IM			Phase 1						Phase 2						Phase 3														
				0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
				2015	2016	2017	**2018**	2019	2020	2021	2022	2023	**2024**	2025	2026	2027	2028	2029	**2030**	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045
	NPV (10%)	**NPV (3.5%)**	**EIRR**																														
Capital costs	7 246 229	7 789 096		707 610			4 167 518						3 024 581						1 552 673														-1 341 457
incremental O&M	625 599	1 704 297		9 545	9 545	9 545	9 545	35 891	35 891	35 891	35 891	35 891	35 891	97 064	97 064	97 064	97 064	97 064	97 064	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339
Total Costs	6 041 865	8 838 842		717 154	9 545	9 545	4 177 063	35 891	35 891	35 891	35 891	35 891	3 060 472	97 064	97 064	97 064	97 064	97 064	1 649 736	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	162 339	-1 179 118
Total	13 636 953	36 367 004		108 661	111 288	113 993	116 779	1 322 849	1 561 226	1 566 297	1 571 520	1 576 900	1 582 441	1 669 523	1 704 119	1 739 753	1 776 457	1 814 261	1 853 200	2 108 653	2 122 646	2 137 058	2 151 903	2 167 193	2 182 941	2 199 163	2 215 870	2 233 079	2 250 805	2 269 062	2 287 867	2 307 235	2 327 185	20 726 311
	7 595 089	27 528 162	26.33%	-608 493	101 743	104 448	-4 060 284	1 286 958	1 525 335	1 530 406	1 535 629	1 541 008	-1 478 031	1 572 459	1 607 055	1 642 690	1 679 393	1 717 198	203 464	1 946 314	1 960 306	1 974 719	1 989 563	2 004 853	2 020 602	2 036 823	2 053 531	2 070 740	2 088 465	2 106 722	2 125 527	2 144 896	2 164 846	21 905 429
	BCR (10%)	**BCR (3.5%)**																															
	2.26	**4.11**																															

Table 67: Financial Appraisal Sensitivity Analysis Summary

Parameter	Change		New NPV	New BCR	New IRR	NPV % change
Capital costs	30%		-10 988 156	0.20	-6.93%	**31.69%**
		Operational cash-flows	469 110	1.21		
Capital costs	-30%		-5 700 187	0.32	-5.92%	**-31.69%**
		Operational cash-flows	469 110	1.21		
O&M	30%		-9 009 090	0.23	-7.96%	7.97%
		Operational cash-flows	-195 808	**0.93**		
O&M	-30%		-7 679 254	0.26	-5.31%	-7.97%
		Operational cash-flows	1 134 028	1.73		
Capital costs & O&M	-30%		-5 035 270	0.35	-4.30%	**-39.66%**
		Operational cash-flows	1 134 028	1.73		
Domestic water demand	-30%		-9 063 227	0.18	-8.18%	8.62%
		Operational cash-flows	-249 945	**0.89**		
Domestic water demand	30%		-7 625 117	0.31	-5.17%	-8.62%
		Operational cash-flows	1 188 165	1.54		
Institutioanl water demand	-30%		-8 464 182	0.23	-6.81%	1.44%
		Operational cash-flows	349 100	1.16		
Institutioanl water demand	30%		-8 224 162	0.25	-6.31%	-1.44%
		Operational cash-flows	589 120	1.27		
Dom. & Instit. water demand	-30%		-9 183 237	0.17	-8.48%	10.06%
		Operational cash-flows	-369 955	**0.83**		
Dom. & Instit. water demand	30%		-7 505 107	0.32	-4.95%	-10.06%
		Operational cash-flows	1 308 174	1.59		
Domestic water coverage 70%	=70%		-9063226.83	0.18	-8.18%	8.62%
		Operational cash-flows	-249945.20	**0.89**		
Average domestic tariff	30%		-7 625 117	0.31	-5.17%	-8.62%
		Operational cash-flows	1 188 165	1.54		
Average domestic tariff	-30%		-9 063 227	0.18	-8.18%	8.62%
		Operational cash-flows	-249 945	**0.89**		
Institutional tariff	30%		-8 224 162	0.25	-6.31%	-1.44%
		Operational cash-flows	589 120	1.27		
Institutional tariff	-30%		-8 464 182	0.23	-6.81%	1.44%
		Operational cash-flows	349 100	1.16		
Domestic & Institutional tariff	30%		-7 505 107	0.32	-4.95%	-10.06%
		Operational cash-flows	1 308 174	1.59		
Domestic & Institutional tariff	-30%		-9 183 237	0.17	-8.48%	10.06%
		Operational cash-flows	-369 955	**0.83**		
Sewerage system coverage	=70%		-8 444 867	0.23	-6.78%	1.21%
(demand 70 % of capacity)		Operational cash-flows	368 415	1.17		
Sewerage system charge	30%		-8 243 477	0.25	-6.34%	-1.21%
		Operational cash-flows	569 804	1.26		
Sewerage system charge	-30%		-8 444 867	0.23	-6.78%	1.21%
		Operational cash-flows	368 415	1.17		

Annex 6: CCRA Explanatory Notes

Attached separately as a word document.

Annex 7: Funding Alignment and Intake Relocation Study Reports

Attached separately as a word document.

Annex 8: GESI Rating Operations Table

DIMENSIONS	CRITERIA: THE ACTIVITY ….	CHECKLIST: DOES THE PROJECT ……	CHECK	SCORE	RATING
Analysis	Includes analysis and/or consultation on gender related issues	• Identify and analyse gender issues *relevant* to the project objectives or components?	✓		
		• Report findings of country/regional gender diagnostics (gender assessment, poverty assessment, etc.) as part of a social, economic and/or environmental impact assessment	✓		
		• Reflect the result of consultations with women/ men/ girls/ boys/ indigenous groups/marginalised groups and/or NGOs that focus on these groups and/or their specific line ministries?	×		
		If at least one check above (yes)		**YES**	
Significance rating (relevant, evidence-based & numerical/proportional significance) (none = 0; weak = 1; modest = 2; encouraging = 3; and significant = 4)					**3**
Actions	Is expected to narrow gender disparities, including through specific actions to address the distinct needs of women/ girls and/or men/ boys/ and/or marginalised or vulnerable groups and/or to have positive impact(s) on gender equality and/or social	• Include specific or targeted actions that address the needs of women	✓		
		• Propose gender specific and/or social inclusion safeguards in a social/environmental assessment or in a resettlement framework	x		
		• Show how interventions are expected to narrow existing gender disparities	✓		

DIMENSIONS	CRITERIA: THE ACTIVITY ….	CHECKLIST: DOES THE PROJECT ……	CHECK	SCORE	RATING
	inclusion				
If at least one check above (yes)				**YES**	**3**
Significance rating (relevant, evidence-based & numerical/proportional significance) (none = 0; weak = 1; modest = 2; encouraging = 3; and significant = 4)					
Monitoring & Evaluation	Includes mechanisms to monitor gender impact and facilitate gender disaggregated analysis	• Include specific gender and sex-disaggregated indicators in the results framework?	✓		
		• Propose an evaluation which will analyse the gender specific impacts of the project?	×		
If at least one check above (yes)				**YES**	
Significance rating (relevant, evidence-based & numerical/proportional significance) (none = 0; weak = 1; modest = 2; encouraging = 3; and significant = 4)					**3**
RATINGS					
Overall Score		In how many dimensions does the project score 1?		**3/3**	3
GESI-informed		Does the document score in at least one dimension		**Y**	YES
GESI significance		In how many dimensions does the project demonstrate a contribution to GESI results			**3**
Significance Score		What is the total score across all three dimensions related to demonstrating a contribution to GESI results (none = 0; weak = 1; modest = 2; encouraging = 3; and significant = 4)			**9/12 [3/4]**

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