Chirundu Water Supply and Sanitation: Feasibility Report

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

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Disclaimer

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List of Acronyms

Acronym	Long-Form
AfDB	African Development Bank
CDC	Chirundu District Council
COMESA	Common Market for East and Southern Africa
CRIDF	Climate Resilient Infrastructure Development Facility
CSO	Central Statistics Office
CU	Commercial Utilities
DOF	Department of Fisheries
DPPH	Department of Physical Planning and Housing
ECZ	Environmental Council of Zambia (now ZEMA)
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPB	Environmental Project Brief
ERB	Energy Regulation Board
ESIS	Environmental and Social Impact Statement
ET	Evapotranspiration
FDC	Flow Duration Curve
FGD	Focused Group Discussion
IDP	Integrated Development Plan
GESI	Gender, Equality and Social Inclusion
GHS	Green House Gases
GI	Galvanised Iron

Acronym	Long-Form
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GMA	Game Management Area
GWP	Global Warming Potential
GW	Global Warming
GRZ	Government of the Republic of Zambia
HDPE	High Density Polypropylene
IAP	Interested and Affected Party
KII	Key Informant Interview
KfW	Kreditanstalt für Wiederaufbau
km	Kilometre
LHA	Lake Harvest Aquaculture
LWSC	Lusaka Water and Sewerage Company
MAL	Ministry of Agriculture and Livestock
MLGH	Ministry of Local Government and Housing
MMMD	Ministry of Mines and Mineral Development
MWS	Ministry of Works and Supply
NEP	National Energy Policy
NRW	Non-Revenue Water
NWASCO	National Water Supply and Sanitation Council
O&M	Operation and Maintenance
OBC	Outline Business Case
REC	Regional Economic Community

Acronym	Long-Form
SACU	Southern African Customs Union
SADC	Southern African Development Community
SWSC	Southern Water and Sewage Company
USD	United States Dollar
VIP	Ventilated Improved Pit latrines
WARMA	Water Resources Management Authority
WASH	Water, Sanitation and Hygiene
WHO	World Health Organisation
WSS	Water Supply and Sanitation
WTP	Willingness To Pay
WWG	Water Watch Groups
ZMW	Zambian Kwacha
ZRB	Zambezi River Basin

Executive Summary

Access to reliable and safe water supply and sanitation facilities at border towns in the SADC region has emerged as a major challenge that requires urgent action to ensure continued activities at these strategic centres. The Climate Resilient Infrastructure Development Facility (CRIDF), DFID's innovative water infrastructure programme for southern Africa, has to date proceeded with studies in 5 of the 12 Zambian border towns (Kazungula, Mwami (Chipata), Chanida, Siavonga and Chirundu).

The CRIDF interventions provide the entry point and platform for CRIDF to engage with, support and influence key SADC interventions, river basin organisations and national stakeholders. It is envisaged that through CRIDF, the inhabitants of the SADC region will benefit from climate-resilient water infrastructure thereby enhancing sustainability and cooperation amongst the stakeholder.

This report is a summary of the feasibility study undertaken to provide improvements to the existing water supply and sanitation infrastructure at the Chirundu Border Post on the Zambian side of the border. The Chirundu border serves as a crossing point between Zambia and Zimbabwe, which has experienced high growth, especially after the construction of the second bridge across Zambezi River, completed in 2002.

Chirundu is an important international border for the north south corridor linking a large number of countries in eastern and southern Africa. The transport corridor linking South Africa to its northern countries is the busiest regional transit transport link in eastern and southern Africa, carrying 5.8 million tons of cross-border traffic. The corridor extends over the territories of three regional and economic groups, COMESA, SADC and SACU.

The high volume of traffic has brought commercial opportunities to Chirundu, while at the same time placing the existing services under pressure. The pressure on services has increased the risk of waterborne diseases in Chirundu and the possibility of cross border infection. This is exacerbated by the high HIV infection rate that is experience in Chirundu, partially due to the high transient cross border population that spends time in Chirundu while completing the cross border formalities.

Chirundu residents clearly expressed their dissatisfaction with the current water supply and sanitation services as provided by the LWSC. Residents re-emphasised the need for adequate water supply and sanitation as they felt the high temperatures and low rainfall in the area has already compromised their quality of life.

No clear town planning has been completed for Chirundu, which is complicated by the ongoing negotiations to obtain a larger town boundary by obtaining a portion of surround customary land. It is critical that the planning of the town be undertaken, with the input from LWSC with regard to most efficient method of servicing the entire town.

The Feasibility Study has identified the capacity of the bulk infrastructure, including Water Treatment Plant, bulk distribution and storage, as the main water supply constraints that need to be addressed. A phased approach is recommended to optimise the available capital and match the population growth. The proposed implementation phases is shown in the following table, however the phases would need to be prioritised with available funding. Furthermore the Medium and Long Term planning horizon needs to be implemented based on actual population growth.

Planned Implementation Phases

Phases	Planning Horizon (Year)	Main areas of intervention	Implementation plan
Phase 1	Short Term (2021)	Upgrade intake pontoon Upgrade of treatment plant to 2ML/d Upgrade pumping system, pumps and pumping mains Upgrade bulk main pipelines Introduce bulk meters Increase storage to 2ML/day Construct new and refurbish existing ablution facilities	Design and construction before 2021.
Phase 2	Medium Term (2026)	Upgrade treatment plant to 6Ml/d (double from 2ML/day) Increase storage to 6ML/day (12hr) Upgrade secondary distribution network within DNI zones Refurbish sewer system and connect high water consumption users	Design and construction before 2026 – to be confirmed based on actual population growth.
Phase 3	Long Term (2036)	Expand secondary distribution network with increase in population	Design and construction before 2036 – to be confirmed based on actual population growth.

The estimated capital investment is shown in the table below. The estimated intervention for Chirundu Water Supply and Sanitation is GP£5,514,100 (excluding any VAT or taxes).

Total Preliminary Implementation Costs - All Phases of Works

Total Capital investment 2016-2036			
Item No.	**Item Description**	**Amount US$**	**Amount GB£**
1	Short Term (Phase 1) – Water Supply	2,335,000	1,604,500
2	Short Term (Phase 1) – Sanitation	75,000	51,500
3	Medium Term (Phase 2) – Water Supply	2,388,600	1,641,300
4	Medium Term (Phase 2) - Sewer and Sanitation	3,029,400	2,081,600
5	Long Term (Phase 3) – Water Supply	196,700	135,200
	Total	**8,024,700**	**5,514,100**

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.

The project is not expected to have significant environmental impact, as it is mainly within the urban area, which is already severely degraded. The intake may require special attention, as it is based in a lush riverine environment, close to a forest area. A detailed environmental assessment will be required, in accordance with the Environmental Management Act. Furthermore a number of permits will possibly be required before any construction project can be contemplated.

The project could actually be used to enhance certain environmental challenges, like improved sanitation in Chirundu, i.e. making Chirundu an open defecation free zone.

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 is expected to result in significant improvements to the health of Chirundu residents, as well as border patrons, along with time savings and ecological improvements, all of which indicate that the project should be implemented.

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, grant or subsidised funding are required to cover 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. 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; LWSC must adjust the phased investments as appropriate.

The following table summarises the findings from the Financial and Economic Assessment.

CBA Results	
Capital investment Budget	£5,514,146
Beneficiaries	
Direct beneficiary households	3,774
Indirect beneficiary households	255,500 truck drivers per year, 204,400 other border patrons per

CBA Results		
	year. The indirect beneficiary population includes the significant transitory population passing through Chirundu. As the project infrastructure includes ablution facilities for this population, they are included as indirect beneficiary households.	
Assumed number of people per household	5.1	
Analysis timeframe	20 years	
Financial appraisal performance indicators (5.3% Discount Rate)		
Financial Net Present Value (FNPV)	-£3.8 million	
Financial Internal Rate of Return (FIRR)	-13%	
Financial Benefit Cost Ratio (FBCR)	0.32	
Economic appraisal performance indicators		
	(3.5% SDR)	**(10% SDR)**
Economic Net Present Value (ENPV)	£7.6 million	£2.7 million
Economic Rate of Return (ERR)	24%	24%
Economic Benefit-Cost Ratio (EBCR)	2.21	2.52
Sustainability		
In isolation, the project is not financially viable due to its capital cost and would require grant funding. However, the project has strong operational sustainability, suggesting that should a grant be sourced, the scheme will be able to generate sufficient revenues to cover its on-going operations and maintenance. The average monthly spend for a rural household in Chirundu is equal to GBP 3 per month for high cost households (based on an average monthly water consumption of $11m^3$ and an associated tariff of GBP 0.25). For communal access households, the average monthly spend is GBP 0.5, based on an average monthly use of $2m^3$. Using the average monthly wage in the agriculture of GBP 40 (600 ZMW), communal access households will spend roughly 1% of their household budget, assuming that only one household member works. For high-cost households, this equates to roughly 7% of their monthly wage, assuming only one member of the household works. At the current assumed income levels, the tariffs appear to be affordable for both rural and high cost households.		

CBA Results

The sanitation facilities' tariffs are based on the current prices that border patrons face at the ablution facility at the border. Basing the tariffs on those applied in the market suggest that there will be sufficient willingness to pay for these services and that in reality it may be possible to charge higher tariffs for the same services offered through a formal and more efficient system. However, if tariffs remain at current levels, the project is still operationally sustainable.

Sustainability of the project relies strongly on revenue generating parameters such as the current population figures and the expected population growth rate and number of border patrons passing through Chirundu. Sustainability also relies on the on-going cost parameters of the project, including the operation and maintenance costs of the proposed intervention. As these are calculated as a percentage of the total capital expenditure on the project, the percentage assigned to these costs as well as the total cost of the immediate investment are both important variables in determining financial viability as well as operational sustainability. Changes in these parameters are discussed in more detail under the sensitivity analysis.

From an institutional perspective, there is moderate to low risk with respect to this project. Partly this is because the size is relatively small and partly because LWSC, though it has its challenges, has demonstrated significant institutional capacity over the years. There are admittedly concerns regarding the ongoing financial viability of the utility and the draft financials for 2014 are disappointing in this regard. It is hoped that this is an anomaly, rather than a negative trend. In general however LWSC has demonstrated a trend over a number of years of gradually gaining institutional and financial strength. In view of the concerns, some consideration should perhaps be given to initiatives that further strengthen LWSC's viability, in addition to delivering a high quality and sustainable project at Chirundu.

It is therefore recommended that this project should proceed, either through CRIDF support by taking the project to Financial Closure or for CRIDF to support the LWSC with obtaining grant funding for the project. It will be greatly beneficial to undertake some technical assistance work with the Chirundu District Council and LWSC to strengthen the institutional ability, review planning options and obtain verifiable data / information on the existing water supply and sanitation system. Technical assistance could also be of benefit to the Chirundu District Council to finalise the town boundary, which will potentially increase the LWSC supply area dramatically.

Introduction

Access to reliable and safe water supply and sanitation facilities at border towns in the SADC region has emerged as a major challenge that requires urgent action to ensure continued activities at these strategic centres. 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.

The Climate Resilient Infrastructure Development Facility (CRIDF) is DFID's innovative 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.

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.

It is envisaged that through CRIDF, the inhabitants of the SADC region will benefit from climate-resilient water infrastructure thereby substantially enhancing sustainability on one hand and also benefit from enhanced cooperation amongst the stakeholders countries on the other. The programme is also expected to contribute to the ultimate goal of peaceful, climate-resilient and sustainable planning and management of shared waters in SADC, which will generate benefits for the poor both in the short and long run.

This report is a summary of the feasibility study undertaken to provide improvements to the existing water supply and sanitation infrastructure at the Chirundu Border Post on the Zambian side of the border. The Chirundu border serves as a crossing point between Zambia and Zimbabwe, which has experienced high growth, especially after the construction of the second bridge across Zambezi River, completed in 2002.

The Lusaka Water and Sewerage Company (LWSC) is mandated to provide water and sanitation services in Chirundu.

The Feasibility Study report follows on from the scoping mission that was conducted for various Zambian border towns in 2013[1].

[1] CRIDF, '12 Towns Water and Sanitation (Pre-Feasibility), 2013

Project Location

The Chirundu Border Post is located in the Lusaka Province of Zambia, at geographic co-ordinate 16°2'5.67"S and 28°51'2.58"E, on the boundary between the Republic of Zambia and Zimbabwe. Chirundu is about 140 km south east of Lusaka. Chirundu is the District Capital of the Chirundu District. **Figure 1** shows the location of Chirundu border post in relation to the Lusaka Province and Zambia.

Figure 1 Location of Chirundu District and Town

The report is divided into the following key sections:

- Section 1 – Introduction (this section)
- Section 2 – Social Assessment, including Gender, Equality and Social Inclusion (GESI)
- Section 3 – Technical Assessment, including Climate Change Risk Assessment (CCRA)
- Section 4 – Environmental Assessment
- Section 5 – Financial and Economic Assessment
- Section 6 – Institutional Assessment
- Section 7 – Risk Assessment
- Section 8 – Conclusions and Recommendations

Social Assessment

Introduction

A key component of developing a water supply and sanitation project in Zambia, is the social assessment, which establishes full stakeholder engagement. The social assessment obtains the involvement of the relevant government agencies, local authorities, Non-Governmental Organisations (NGO), local leadership, and consumers in the area of project influence to obtain understanding of the current situation and buy-in for the proposed project.

CRIDF acknowledges that early engagement provides valuable opportunity to influence public perceptions and set a positive tone with stakeholders, despite the many uncertainties and unknowns. It is also an opportunity to help generate ideas and alternative solutions on early design questions.

This section of the Feasibility Study presents a brief socio economic and gender assessment profile of the Chirundu border town as regards, settlement patterns, sources of livelihood, access to services, water security and employment opportunities. The report reveals public perception of the existing and proposed water supply and sanitation services. It also presents some of the predicted project related social impacts and associated mitigation measures to ensure social sustainability.

This second concludes with recommended community engagement in the management of proposed project interventions.

The socio economic and gender assessment fieldwork was undertaken during the months of April and May 2016. It contains information obtained through literature review, Focused Group Discussion (FGDs) and inter personnel interviews with public and private sector personnel and residents (see Key Informant Interviews in **Annex E**).

Project Area Description

Chirundu was officially declared a district under Lusaka Province in January 2012. At present the district has a well-established district administration with the presence of a district council, other government, private and non-government organisations. The district is approximately 140 km south east of Lusaka, on the banks of the Zambezi River. The border area (One-Stop Border Post between Zambia and Zimbabwe) forms a large part of the urban centre. It is the busiest border post linking Zambia to its COMESA trading partners, Zimbabwe directly, and South Africa, Lesotho, Swaziland and Mozambique through Zimbabwe.

Project Area Settlement Pattern

Like many other border towns in Zambia the Chirundu border area[2] consists of three distinct built up areas, which include:

- The administrative and commercial area, including government offices, the border port and business establishments,
- Residential areas, categorised as low, medium and high density areas, and
- Customary land, beyond the formal residential areas are villages in the peripheral located on customary land.

According to the 2010 Central Statistical Office (CSO) census, Chirundu district had a total population of 47,971 people. The entire district falls under Siavonga constituency, which politically is composed of six Wards. The project area falls under the Chirundu Ward with an approximate population of 14,864 (7,132 males and 7,732 females) and 3,025 households.

The project area is confined to the urban centre where Lusaka Water and Sewerage Company (LWSC) is mandated to provide services. However, the district administration has plans of expanding the urban boundaries, which would result in an increased service area for the commercial utility.

The Chirundu population consists of:

- Government employees from government institutions such as the Ministries of Finance (through the Zambia Revenue Authority (ZRA)), Education, Health, Home Affairs, Community Development and Social Welfare, Transport and Communication, Works and Supply.
- Statutory entities like, the Road development Agency (RDA), Roads, Traffic Safety Agency (RTSA), Zambia Bureau of Standards (ZABS), LWSC and the Chirundu District Council (CDC).
- Private companies such as banks, cell phone providers and transportation logistic companies.
- Regional organisations, including the Common Market for East and Southern Africa (COMESA).
- Entrepreneurs, traders and persons in transit, and
- Residents from adjoining areas and villages.

Land Tenure System and Ownership

Given the district status, the border area is under the CDC planning jurisdiction and the council is in the process of acquiring additional land from the traditional leadership. After acquiring additional land, it is expected that the urban centre will be about four times larger than the current size. Thereafter, the LWSC would provide services within the extent of the local authority's planning mandate and land acquisition would not be a barrier in the project.

[2] Chirundu border area also serves as the Chirundu district urban centre.

Employment and Income Generating Opportunities

Existing economic activities offer a relatively stable income for the border community. Therefore individuals including vulnerable women, youths and other groups already engaged in different activities would have to operate at optimal levels in response with the demand. The main economic activities in the project area can be categorised under either formal employment, business and trading ventures or small holder farming activities.

Formal employment

There are a significant number of residents employed in formal public and private institutions and organisations that are based in Chirundu. These form a majority of residents living in low and medium density residential areas.

Business and Trading Ventures

Local residents and migrants from different parts of the district and Zambia that have settled in the area, have taken advantage of the business opportunities created by the border post activities and travelling public. Most enterprises include forwarding and clearing agencies, restaurants, retail shops and stores, bars, salons and barbershops, taxi drivers, hawkers, money changers, casual labour assisting travellers. There are a significant number of transit traders engaged in cross border trading from Zambia, Zimbabwe and ultimately South Africa.

Smallholder farming activities

Agriculture and farming is a major activity amongst residents residing in the high density and adjoining villages. Due to the climatic conditions of the area, agricultural activities are mainly confined to crop production along the Zambezi and Kafue Rivers and rearing of livestock. Goat rearing is quite common as sales goats fetch higher prices in nearby urban centres like Kafue and Lusaka. Other crops grown include vegetables and citrus. Commercial farmers within the district owning banana plantations and cotton fields offer seasonal employment to some residents. The two rivers also provide an opportunity for fishing activities specifically amongst residents in the high density and adjoining villages.

Infrastructure and Social Services

This section provides information on infrastructure and services including, health, education and energy available in the project area, while water supply and sanitation as the focus of the project is covered in a later section.

Health

The project area is served by the Mtendere Mission Hospital owned and operated by the Catholic Church (diocese of Monze). The facility also serves as a referral hospital for the entire Siavonga constituency and caters for non-Zambians mainly Zimbabweans and other nationalities in transit. The hospital offers an extensive range of in-patient and out-patient diagnostic and treatment services including laboratory, ultrasonography,

endoscopy, radiology, operating theater, dental care, mother and child health, public health services and pharmacy.

As a border town, Chirundu sustains a highly variant population, due to the high border crossing transient population. The movement of the transient population is one of the major causes of HIV infection in the area. In recognition of this the hospital implemented an HIV and AIDS care and prevention programme in 1999, as a response to the AIDS illness and its multiple social economic effects in the community. Other common ailments include high cases of malaria, non-bloody diarrhea, respiratory infections and bilharzia. The hospital charges fees for admission care and other specialized services such as surgery.

Education

Chirundu border area has one primary school and a secondary school. According to the new Chirundu District Profile report 2014, education is one area of high investment opportunity. The majority of the parents who can afford boarding schools, have enrolled their children in other districts.

Energy

The border area is connected to the national grid and nearly all administrative, commercial and dwelling housing units are connected. Other sources of energy include use of firewood and charcoal for cooking and candles and batteries for lighting.

Existing Water Supply and Sanitation

The Lusaka Water and Sewerage Company (LWSC) supplies water to the Chirundu border area including the entire urban area. The company provides water through two main water supply systems, namely piped house and yard connections and communal water points. The majority of the commercial and administrative area and households rely on LWSC water supply, although it was observed that institutions such as the Mtendere hospital, the secondary school and some individuals have developed their own private water systems.

Water Supply and Sanitation Services for Truckers and other Travellers

As part of the One Stop Border Post infrastructure, water and sanitation facilities for truckers and other travellers have been provided within the enclosed border area. ZRA owns the infrastructure and management of the facilities lies with the same. Water supply services were, however handed over to the commercial utility, LWSC.

In the passenger terminal the ablution blocks are equipped with toilets and wash hand basins only (see **Figure 2**), while the commercial terminals also include showers. A cleaning company (known as Scenario Cleaners) contracted by ZRA manages the passenger terminal ablution block.

Figure 2 Wash basins in the Passengers Terminal Ablution Block

The entire border area is connected to the LWSC water reticulation system and therefore are affected by water supply disruptions, which are experienced in the Chirundu urban area. During periods of disruption, CDC delivers water to the border area as a matter of priority.

Water Supply and Sanitation Services to Other Commercial Areas

CDC owns a public ablution block consisting of two flush toilets and four showers for male and female users. This ablution block caters for entrepreneurs conducting business around the border area, traders selling merchandise at the main market and also travellers utilising the council bus station. The CDC ablution block is in a deplorable state with non-functioning toilets and missing fixtures. The block is located at a vantage point in close proximity to the main road and the border area – see **Figure 3**.

Figure 3 Chirundu District Council Ablution Block

The council also owns and manages public ablution blocks with water borne sewer system at the main bus station and main local market. The fee-paying toilet at the bus station is in good condition whilst the one at the market is closed due to lack and erratic water supplies. During the visit the market was in the process of commissioning a borehole equipped with a hand pump.

Water Supply and Sanitation Services for Households

Households have the following water supply and sanitation facilities.

House and yard connections

The LWSC has a total of 928 house and 60 commercial connections. These service areas are supplied with water up to the house or business premises. Most of the businesses, low and medium density housing areas have extended the connections into the buildings, whilst a limited number of dwelling units in the high-density areas have yard connections. The current meter coverage is about 45% of the connections, whilst the rest is on fixed charges.

Communal Water Points

The company provides water to communal water points through kiosks (refer **Figure 4**). There are a total of 9 kiosks located in the high-density residential area. These are managed by water vendors who are contracted by the company. All the nine vendors are women and operate kiosks from 6:00 to 18:00 hours every day of the week. The vendor is paid a commission of 40% of the total water sales. Communal water point users pay a water user charge of 25 ngwee ($ 0.24) for 20 litres of water. 20 litre container used for cooking oil packing is typically used as a measure in Zambia.

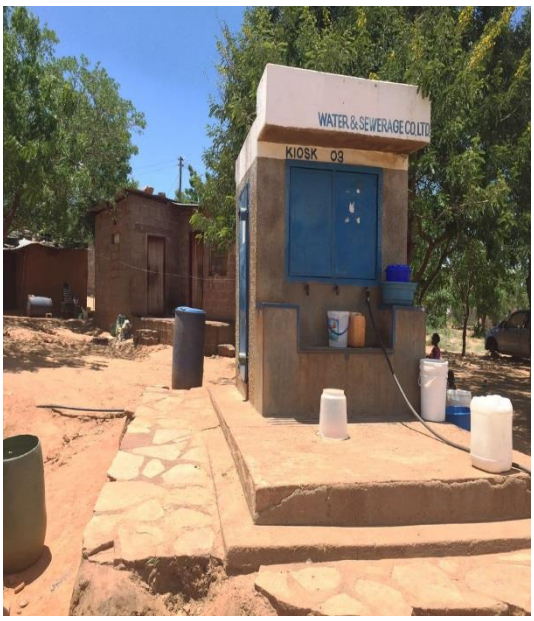

Figure 4 Kiosk in a High Density Area

Private water supply and sanitation systems

As earlier mentioned some institutions, entrepreneurs and individuals have developed their own water systems through the use of water from either boreholes or from the Zambezi River. Due to availability of water, typically such premises have water borne sanitation systems using septic tanks.

Since LWSC does not provide sewerage services, the entire area operates on-site sanitation provided by developers. From observations and discussions majority of the sanitation facilities found in housing areas were using ordinary pit latrines. A number of Ventilated Improved Pit latrines (VIPs) and flush toilets using septic tanks were reported.

Perceptions of Existing Water Supply Facilities and Services

During the FGDs and other interpersonal interviews, respondents expressed varying levels of satisfaction with the water supply and sanitation services provided by the LWSC, other developers and themselves. Their perceptions are categorised into broad themes of quantity, quality, reliability, tariffs, distance and technology.

Quantity

In general residents residing in the originally planned low and medium density areas had a positive perception of the quantity of water supplies. Those living further away from the planned area and in high-density areas experienced low pressure and intermittent supply. Residents using communal water points reported that they had no problems of quantity in the past but have over time experienced low pressure due to the high number of house connections.

Quality

As regards quality, respondents expressed trust in the LWSC and were certain that they received treated water. However, they observed that the water had a brownish colour and had some solids particularly in the rainy season. Those who draw water from private households with boreholes complained of a metallic taste and gastric problems. Further during times of water deficit, residents were forced to utilise extremely unsafe water from the Zambezi River.

Reliability

All respondents interviewed presented a negative perception of water supply reliability. The LWSC was viewed to be unreliable and unable to meet the needs of not only the travelling public but of the entire resident population. Women expressed dissatisfaction in the unscheduled disruptions, which cause stress amongst users. Women with house connections from medium cost reported that on a typical day water would be available for 6 hours from 23:00 to 5:00 hours. Those from high-density areas complained that at times water would only be available from 23:00 to 1:00 hour. As has been observed water would usually not be available in the day time and most households resort to either paying for casual labour to draw from private premises with private water systems or from the Zambezi River. The fees ranged from ZMW 5 to 10 per 210 litres drum

depending on the demand. Residents revealed that they have experienced the worst water shortages in the recent year due to power outages.

Distance

Residents drawing from kiosks were the only ones expected to provide perceptions on the distance to the water sources and those who utilise alternative water sources in times of deficit. It was observed that the 9 kiosks were evenly spread out within reasonable distance. The only households that complained of distance were those that were newly built as the settlements are expanding outward. As reported by LWSC some of the households served were outside the council planning area.

Water Tariffs

The tariffs were viewed as being fair and residents were willing to pay for water. This was confirmed by the LWSC who revealed that they had an overwhelming 80% payment rate. Residents drawing water from kiosks ware on a pre-paid system and did not complain of the tariffs. The major grievance of most residents especially the marketers was not the prices of water but the lack of reliable water supplies.

Water Facilities

Respondents utilising house connections reported to be contented with their infrastructure. Those drawing from kiosks were relatively fulfilled although they would prefer to have house or yard connections. Some of the challenges of communal water points included reliance on the vendor who understandably has to close the kiosk in order to attend to household chores. Therefore operations of the kiosk were largely dependent on water availability and commitment of the Vendor. Other challenges such as queuing up and drawing water at midnight and in the early hours of the morning were experienced in instances of water shortages. Nevertheless residents were satisfied with the service as the tariffs were affordable.

Perceptions of Existing Sanitation Facilities and Services

Flush Toilets

The flush toilets at the border area were perceived to be adequate and relatively clean although there is an average of 1,000 to 1,200 passing through the border every day. A Scenario Cleaners employee explained that the facilities were adequate and the only problem was ensuring a high level standard of cleanliness. This was because there were challenges of water supply from time to time. Storage water tanks installed were damaged and the company was using drums. It was reported that CDC had the responsibility of ensuring that there is water at all times.

The ablution block at the market served the market and other clients adequately, and its closure has led to deteriorating sanitary conditions around the market. Marketers and farmers who sleep over at the market utilise unfinished buildings, inconvenience nearby households or practice open defecation behind stalls and bushes.

Flush toilet technology in households is perceived to be the best option. However the major criticism was the non-functionality due to lack of water. These have become pouring - flush toilets and most households have resorted to constructing pit latrines as a backup.

Ventilated Pit latrines

VIPs were mainly utilised by institutions and a few households. These were viewed to be a better option in situations where water supply was inadequate. Though VIPs were perceived to have a longer lifespan in comparison to ordinary unlined pit latrines, the only problem was the lack of sludge emptying services in the area.

Ordinary Pit latrines

Ordinary unlined pit latrines were highly prevalent both in commercial and residential areas. It was observed that these latrines were not only found in high density but even in the low and medium density areas. Respondents perceived this technology as the worst technology contributing to unsanitary conditions in the project area. They complained of the inconvenience of digging pits around the premises. This was a serious problem for those with smaller plots. Due to the terrain of Chirundu it was difficulty to dig pits and a number collapsed in the rainy season. Other complaints included odours, and flies.

Public Perceptions of the Proposed Interventions

The LWSC is clearly not able to meet the current water supply demand due to inadequate water production capacity, which includes abstraction, filter, transmission line and storage reservoir capacity. Additionally, the distribution network is not servicing the full customer base. The Chirundu border community is growing very rapidly due to enhanced status of “one stop border facility”. The location is characterised by long queues and waiting times for trucks due to large traffic volumes. This translates into prolonged stay of travelling population who would require water supply and sanitation services. Although the border area is served by a proper water supply and sanitation service, this area is closed around 22:00 hours, leaving overnight travellers to utilise other public water supply and sanitation services. As mentioned alternative sanitation facilities provided by the Chirundu district council are limited and in a poor condition.

Therefore and future intervention in Chirundu should provide support to increase the potable water production and supply capacity, as well as rehabilitation of the council ablution blocks to cater for truckers and travellers.

Water Supply Improvements

Using stakeholder and consumer perception, the technical assessment proposes to develop a ring main network, comprising a ring mains allowing for improved coverage of supply to Chirundu. Water kiosks would be constructed to cover all the residential areas, although the number and location would be determined and finalised after consultation with stakeholders at the detailed design stage.

Sanitation Improvements

The technical assessment proposes the construction of public ablution facilities for use by travellers crossing the border and at high foot traffic areas like the local market. The ablution block would consist of toilets, shower and laundry facilities, which will be separate for males and females. Sewage treatment would be by means of a septic tank, designed to be emptied every 3 years. The sludge would be discharged into sewage ponds located at the nearest town with sewage treatment facilities. In future, these facilities could be connected to the existing sewer network system, which would need to be refurbished, which could include a faecal sludge handling facility.

The low to medium income residents would be encouraged to use on-site treatment solutions, while construction of VIP latrines for the low income communities would be considered on condition of affordability.

The existing non-functional sewerage treatment plant would in future be redeveloped to full operation to receive and treat wastewater from the operations of a **conventional sewerage** system conveying sewerage from the border post and surrounding commercial area. A **small bore sewerage** system from other high volume water consumers (lodges, hotels, businesses, homeowners) can be incorporated into the existing system. All the wastewater would then be conveyed to the refurbished oxidation ponds.

Public Perceptions of the Proposed Water Supply Technology

The proposed support of enhanced production capacity would result in increased and more reliable water supplies. Both men and women felt that the current Zambezi river water resources were adequate and in close proximity. They discouraged the use of ground water, which from experience had an undesirable metallic taste. Majority of stakeholders interviewed preferred house connections, which provided privacy and ease. Kiosks were viewed to be pro poor servicing those that were unable to pay for house and yard connections. Kiosks were suitable as they had a designated vendor responsible for collection of fees, cleaning the surroundings and maintaining order. There was a demand for more kiosks to service new areas. Residents maintained that the LWSC should continue to allow residents who have the ability, to pay for house connections. The projection for future water needs and technology should therefore be made on the basis of yard / household connection, rather than communal water points.

Public Perceptions of the Proposed SanitationTechnology

Residents interviewed lamented over the state of the Council managed facilities near the border and at the main local market. Marketers revealed that the problem was due to inadequate water supplies and management of the facilities. They proposed that both facilities should be placed under contract management. They felt that the private sector should be given a build operate lease so that the facilities are modernised.

The most preferred sanitation technology for households was the water borne sewerage system. Residents of Chirundu are from different parts of the country, and majority of those in formal employment have been exposed to water borne systems. Public and other private sector employees expressed the need for what they termed

'modern' facilities that would change the face of Chirundu given that it was an international entry point and had gained a district status.

Further the Council personnel indicated that the current border and residential area would eventually become the Central business District (CBD) of the district. They therefore recommended that the sewage treatment plant should be commissioned and made operational. They however realised that payment for the improved service would increase.

It was further recommended that those that would not be able to afford to pay for sewer connection would be encouraged to construct VIPs. In order to ensure environmentally friendly and hygienic sanitation facilities, in the absence of operational water borne sewerage system, residents could be coerced to construct VIPs through formulation of Council By Laws.

Socio-Economic Impacts of the Proposed Project

Typical water and sanitation projects inevitably produce both positive and negative impacts. The direct socio-economic benefits of the project include the net results of improved livelihoods through health improvements, increased productivity, and improved community resilience to climate change. Indirect effects include a positive impact on tourism in Chirundu due to healthier and more resilient communities. Other positive impacts include modernised sanitation infrastructure and potential for greening the area that would improve the aesthetic environment of the area. Some of the critical impacts with accompanying enhancement and mitigation measures are as follows:

Positive impacts

Improved Health

Improvements in water supply production and treatment infrastructure translate into increased quantity and quality. Higher quantities of water will enable household members to improve cleanliness and hygiene, which results in reduced water borne disease. In relation to quality, communities will be assured of safe, quality water, as the company would treat sufficient volumes to meet demand and conduct periodic quality analysis. Evidence of improved health shall be monitored through health indicators at the nearest health facilities.

Increased Productivity

Improved health will have a positive impact on productivity in whichever occupation one is involved in, as there will be less absenteeism from tasks. Higher quantities of reliable water will enable residents to engage in economic productivity tasks such as backyard gardening, block making, managing restaurants and hair salons more efficiently. These enterprises assist households to earn incomes that are used for other household requirements.

Time saving

This is particularly important for households that draw water from kiosks where time is spent on queuing up and waking up at awkward hours. Reliable water supplies will result in time savings, as women will be able to draw

water at reasonable times and use the time saved for other household and other productivity activities. Women involved in enterprises outside the home are usually disrupted by erratic water supplies as they give priority to water thereby delaying or abandoning their productivity activities. This results in reduced household incomes.

Increased Population

Increase in population will result in both positive and negative impacts. A combination of improved water supply and trade will attract more business people, tourists and settlers to the area. This will create demand for water, but more revenue for LWSC. The increased revenue provides an opportunity for LWSC to expand the system as the population increases.

Negative Impacts

Water wastage

There is a likelihood of water wastage in households through leakage and inefficient practices such as watering lawns, car washing, leaking taps and so on. There is also a possibility of water loses through the main reticulation system. These losses can be mitigated by installing meters in each premise including kiosks. This measure should be coupled with customer sensitisation on demand management. Promoting water use efficiency would benefit the company, as they would generate adequate revenue to cover operational costs for them to deliver a good service.

Vandalism

Chirundu is likely to emerge as one of the fastest growing districts in Lusaka Province, as it is a transit area that has been elevated to a district. More people from different parts of the Zambia and other countries will flock to the area, taking with them other urban vices, such as theft and vandalism that would impact negatively on trade, and local residents. In relation to water supply, vandalism impacts negatively on the provision of safe water due to contamination of water through infiltration and breakdowns. The Company should therefore be alert and use vandal proof materials. Vandalism can also be minimised through community sensitisation.

Generation of solid waste

Management of solid waste is cardinal as indiscriminate disposal increases chances of contamination of water in the event of leakages. The mandate of waste collection and disposal lies with the local authority within their planning jurisdiction. In this light Chirundu council should establish a sustainable waste collection, and ban the current waste disposal practice of using pits and burning that is undesirable for an area that is frequented by tourists and other travelers.

Gender Equality and Social Inclusion (GESI)

This section summarises the Gender Equality and Social inclusion (GESI) issues, with a specific focus on the following elements:

- Outlining community development issues including employment and income generating opportunities and the water and sanitation needs of women, girls and the vulnerable;
- Description of the expected changes in the quality of life to women, girls and the vulnerable including the poor as a result of the project activities.
- Review of the inclusive nature of the project outcomes and how the benefits would accrue to the beneficiaries.

Information provided in this section was obtained through field Focus Group Discussions (FGDs) with women, girls and men in Chirundu border area. Supplementary information was also obtained from secondary sources (see Key Informant Interviews in **Annex E**).

Policy, Legal and Institutional Framework for GESI in Zambia

There are a number of national legislative and policy frameworks that promote GESI in the delivery of water and sanitation services to the Zambian population, both in rural and urban areas. Of significance in the context of this project are the Constitution of the Republic of Zambia, the National Water Policy, The National Water Supply and Sanitation Act, and the Gender Policy.

The Constitution of the Republic of Zambia

The overriding guidance document is the Constitution of the Republic of Zambia which guarantees equal opportunities of women and men in the development process, where every person has the right to a reasonable standard of sanitation. Furthermore, any law, culture, custom or tradition that undermines the dignity, welfare, interest or status of women or men is prohibited. This is in addition to the National Cultural Policy that ensures that traditions and customs do not discriminate against women.

The National Water Policy of 2010

The National Water Policy gives recognition to the fact that management and development of water resources from the lowest to highest decision making levels requires effective participation by both men and women. It acknowledges that women play a vital role in the provision, management and safeguarding of water, therefore it is imperative that women take proactive decisions on how these resources can be developed and managed. In order to operationalize these statements to a practical level, the Policy has made provisions that implementing agencies formulating strategies and implementing programmes and projects have to enforce. These include:

- Accelerating the representation of women at all levels and in all spheres of water resource management;
- Ensuring gender balance by defining the key roles played by women, men, and children so that there is no gender discrimination in the ownership, management and sharing of benefits of various water schemes operated by communities in particular;
- Gender mainstreaming in water sector programmes to be articulated with the full involvement of women; and
- Appropriate and gender sensitive technology to be introduced.

The National Gender Policy

The Zambian government formulated the National Gender Policy in 2000, which addresses the need to build and strengthen national capacity for advocating and mainstreaming gender in the developmental process. Under the guidance of the Ministry of Gender and Child Development, all government ministries have appointed and trained gender focal persons from headquarters through the province to the district levels. Therefore the working context of CRIDF projects it is expected that all respective districts under which the border areas fall, must have Gender Focal Persons.

The National Water and Sanitation Act no. 28 of 1997

The Act establishes the National Water Supply and Sanitation Council (NWASCO) and defines its functions to provide for the establishment, by the local authorities, of water supply and sanitation Commercial Utilities (CUs). These CUs are mandated to provide efficient and sustainable supply of water and sanitation under the regulation of NWASCO. It is by this Act that that NWASCO is mandated to provide guidelines to CUs on how they can provide efficient services. At present the regulator has instructed all the CUs to formulate and implement gender and HIV and AIDS strategies to ensure gender equality and pro poor service provision. At the same time NWASCO has established Water Watch Groups (WWGs) comprising consumers from respective service areas.

Given that water supply and sanitation services for Chirundu shall be developed and managed by Lusaka Water and Sewerage Company (LWSC), it is expected that they shall take cognisant of the policy, legal and institutional framework in addition to recommendations made in this report on how to strengthen GESI integration in their activities.

Other Policy

Other gender equality guiding references include the Southern African Development Community (SADC) Gender Protocol Barometer.

GESI issues at Chirundu Border Area

Distribution of roles and responsibilities Amongst Males and Females

Economic activities in Chirundu offer a relatively stable income for the border community. Therefore individuals including vulnerable women, youths and other groups, already engaged in different activities, would have to operate at optimal levels in response to the demand.

Discussions with women revealed that although public workers in formal employment inhabit the area there were fewer formally employed females. The majority of the population was entrepreneurs involved in trading (equal number of men and women) and clearing goods at the border (male dominated). It was further revealed that more men than women were involved in business that involved travelling to distant places. Most married women were housewives engaged in trading from their homes or at the market.

Further it was observed that women from rural areas were involved in selling vegetables whilst the men sold small animals. Those involved in farming were confined to the Zambezi and Kafue Rivers, which offered an opportunity for vegetable cultivation and fishing. In general nearly each household had an active member engaged in a variety of income generating activities.

Vulnerability of residents

There are three main incapacitating situations that expose the Chirundu residents to hardships, which are climatic conditions, the HIV and AIDS pandemic and inadequate water supply and sanitation.

Chirundu area lies in a livelihood zone that receives less than 700 mm annual rainfall and is prone to periodic hazards, including drought and accompanying high temperatures. Due to the low potential for agricultural activities in the developing urban area, the unskilled labour force is mainly engaged in trading as their major source of income. Further there are minimal formal employment opportunities as a result the educated younger people migrate to nearby towns such as Kafue and Lusaka.

As a border town, Chirundu sustains a highly irregular and transient population, which is one of the major reasons for high HIV infection rates in the area. A number of studies have been conducted to identify measures of curbing the high infection incidence. In response the Mtendere Mission Hospital and NGOs such as Tasintha, and Corridors of Hope have implemented HIV and AIDS programmes. Nevertheless, the population is highly vulnerable to HIV infection due to the overnight travelers and the economic hardships faced by the general public in Zambia.

Chirundu area experiences high temperatures that create a requirement for reliable safe drinking water. This is in addition to water for maintaining high hygiene standards. This is particularly critical for women and girls who require water for Menstrual Hygiene Management and ensuring cleanliness amongst household members and activities. The lack of managed sewerage services by the LWSC and non-existent enforcement of sanitation principles by the Chirundu District Council (CDC), has exacerbated the unacceptable sanitary conditions in the area. This exposes the entire population to water borne diseases such as cholera, typhoid and dysentery.

Existing Support Programmes for Women

Three GESI FGDs were held with the following groups:

- Six women's clubs, attended by the woman's club chairperson
- The market committee, attended by 6 male and 6 female entrepreneurs.
- Women representing the border area low, medium and high-density areas.

The Community Development officers from the Ministry of Community Development and Social Welfare (MCDSW) mobilized women for the FGDs.

The MCDSW works with vulnerable and incapacitated households both in the rural and urban areas. In Chirundu town the Department of Community Development has facilitated the formation of a total of 27 women's clubs. The club members have been trained in various disciplines such as entrepreneurship and financial management, saving and investments, leadership, mother and childcare and other topics as requested by the women. A primary activity undertaken by women in the project area is the savings and loan scheme.

Group savings are a positive and empowering activity, which women are using to solve households adversities. Some women used savings to improve their housing units, and as capital for either initiating or boosting different

types of enterprises. Some of the popular enterprises that women are undertaking include, selling vegetables, cross border trading of marketable goods, poultry and livestock rearing, tailoring, hair dressing and taxi businesses.

The department also manages vocational skills training for the youth. These are trained in crafts such as welding, blacksmiths, plumbing, bricklaying, carpentry, tailoring and so on.

Associated Gender Equality Social Inclusion Challenges

The existing water supply and sanitation situation has given rise to a number of GESI specific challenges.

Unreliable Water supply

Whilst the water quantity is not a noted as major problem, women and other residents lamented over unreliable water supplies. They attributed the problem to LWSC's limited production capacity, because the supply from the Zambezi River, which is in close proximity, has adequate water throughout the year.

The erratic water availability causes stress amongst women who at most times have to wake up at awkward hours to draw water. Women drawing water from kiosks complained of the risk of rape and mugging, which they are exposed to as they are forced to draw water in the middle of the night. The emotional drain of waiting and expecting water makes women complacent to undertake productivity activities. Women proposed that the LWSC should maintain a consistent schedule of supply, to allow them to store adequate water. Preferably disruptions should occur at night and permit residents to rest.

Prolonged Time Spent on Water

Although the nine available kiosks are evenly spread out within the settlement, the increase in population and construction activities has contributed to congestion at the kiosks. This is compounded by the vendor's timetable of closure, which at times is not regulated. Women complained of the time and emotional strain spent on ensuring that the household had adequate water supplies. This diverts women's attention from other household chores and productive activities.

Further when water is available vendors dictate the times and this disturbs the rhythm of women's work and rest schedules. Women however showed concern for the vendor's long work hours. A reliable system would provide the vendors with adequate time for rest and other necessary chores.

Long Distances to Water Points

The long distances to the kiosks were mainly experienced by residents residing in new housing areas that were not initially part of the population planned for. These areas will have to be supplied with additional kiosk or house connections in the event of urban area expansion. Another set of residents exposed to long distances are those residing further away from the Zambezi River. The river is usually used as an alternative source of water

for other uses in times of serious water deficits. In such eventualities some women and children spend almost an hour to and from the Zambezi River.

Revenue Spent on Water Supplies

Some households particularly those with adequate income have devised ways of overcoming the problem of queuing up and fetching water from private households by paying private water vendors. Marketers who use bulk water such as women managing saloons and restaurants particularly reported that they resort to buying water from water vendors. This increases expenditure on water as the prices charged vary in accordance with the demand. This impacts on the revenues earned as more money is spent on inputs. Further poorer women who are unable to buy water have to abandon their productive work and draw water themselves. This impacts on the revenues earned and imposes a burden on women.

Exposure to Accidents and other Risks

The Zambezi River is the major alternative source of water in times of water deficits in the project area. It was reported that women, men and children are exposed to crocodile attacks as the river is infested with crocodiles. Respondents including the CDC personnel confirmed that fatalities had been reported from time to time.

Increased burden of drawing water for sanitation

Some houses have water borne sanitary facilities whose functionality is dependent on adequate water supplies.

The major complaint amongst household members without private boreholes is that these facilities have become ‘pour and flush’ toilets. The other problem associated with pour and flush systems is the need for constant water supply that was not feasible with the current water supply services. The lack of adequate water supplies in the household has created a burden on women and other female members who have to ensure adequate water for all domestic uses including ‘water for sanitation’.

Unfavourable Sanitation Technology

The Chirundu project area residents are highly aware of the dangers of poor sanitation. Women therefore complained of the inappropriateness of the ordinary pit latrines, although these are widely used in the project area. Pit latrines present a number of nuisances including contamination of ground water, odours, flies and a major source of water borne disease. Further, households with smaller plots complained of inadequate space for digging latrines from time to time.

Social exclusion of Different Social Groups

Furthermore, improved and ordinary latrines are built with squat holes. Specific members of households such as pregnant women, the aged, the sick and children are faced with challenges when using squat holes due to their physiology. Therefore, selection of sanitation technology should be based on the needs and usability of special social groups in the households.

Threat of Defilement and Rape amongst Female Members

Due to the closure of the local market ablution block, marketers and other transient vendors utilise unfinished buildings, practice open defecation behind stalls or seek services form nearby households. Allowing strangers in the homestead exposes the household to thefts and risk of defilement of female household members. Provision of water supply and sanitary facilities at the market would eliminate this risk.

Poor sanitary conditions at the Market

Women expressed great dissatisfaction with regards sanitary conditions at the market. Their main concern was that majority of the women spent their time operating their income generating activities at the market. Further the market is a critical place where foodstuffs are sold and prepared in the case of restaurants. Therefore adequate sanitation, which includes both liquid and solid disposal, should be of high priority to all concerned stakeholders. Closure of the ablution block has led to deteriorating sanitary conditions that exposes the community to health risks, thereby increasing their health bills and reduces productivity.

Expected Positive Changes in the Quality of Life

The Project is expected to produce specific outputs that will result into specific GESI outcomes that will impact the lives of women, girls and the poor.

Increased Safe Water Supply

Expansion and rehabilitation of the current water supply infrastructure will translate into increased quantities of water. There would be adequate water to service existing and additional houses under construction. Women in these houses will be relieved of the burden of fetching water from unsafe water sources such as the Zambezi River.

Further adequate safe water supply would contribute to improved hygiene and ultimately on the health of household members.

Improved water supply and sanitation for the travelling community

Rehabilitation of CDC public facilities will greatly improve the sanitary conditions at the market where majority of resident and travelling females conduct their businesses. Marketers will be able to dedicate their time to their enterprises and gain more incomes. Availability of sanitary facilities is particularly important for travelling women and girls who have special needs.

The threat of insecurity in nearby households will be eliminated providing a sense of safety and peace in households. This enables household members to live in harmony and have the freedom to engage in their various activities without fear.

Wealth Creation Opportunity

Increased water quantities will contribute to productivity, as residents would be able to engage in ventures that they cannot undertake due to inadequate water supplies. Some of the activities that women felt could be conducted easily included poultry, gardening and block making for men. At present men were unable to generate revenues from block making due to erratic water supplies. Although water can be drawn from the Zambezi, Chirundu is hilly and it is quite tedious to draw bulk water supplies.

In additional health personnel felt that adequate water supplies would promote initiation of greening projects that would contribute to the aesthetics of the area thereby attracting potential investors.

Recommended Actions for GESI

In order to ensure GESI is incorporated into the project, the following actions are recommended for the different stages of project development and implementation.

Project design stage

During feasibility the views of women over their preferred technology were solicited. As regards water supply infrastructure all the women preferred house and yard connections as opposed to communal water points. In order to cater for the poor, kiosks were also the most preferred infrastructure. Therefore project implementers should provide residents with an opportunity to have house and yard connections, with kiosks provided as a transitional solution to yard and household connections.

Sites for kiosks

Project implementers should be aware of the factors to consider when siting kiosks. Some of the issues to consider include not locating Kiosks in close proximity to bars, markets, bus stations and other congested public places. They should be located in sites that would provide safety, privacy and dignity to women as they draw water.

Support for Sanitation

Although the Project is mainly focussed on supporting sanitation for the travelling community, some form of support can be mobilised for household sanitation. In Zambia sanitation is regarded as a household issue however, developing partners have involved the private sector in financing sanitation through micro finance. Residents interviewed expressed willingness to obtain loans with minimal interest. Notably, they were concerned over the exclusion of household sanitation which was equally important and the major cause of water borne disease. Assistance to the local authorities to negotiate for a sanitation micro financing facility should be considered as part of technical assistance. This will allow household sanitation improvement that is fully integrated in the project.

Local authorities should be encouraged to formulate sanitation by–laws that will coerce households to adopt improved, appropriate and safe sanitation facilities.

Management of Communal Water Points

The LWSC is already utilising a kiosk system, which is well accepted by residents. The company should consider piloting pre-paid meters in Chirundu, which have been extensively tested in Lusaka. Pre-paid systems reduce dependence on water vendors who are not well paid and spend 7 days a week at the kiosk, which is more time than would be worked by a LWSC permanent employee. This is particularly important as the female vendors employed complained of low earnings compared with the amount of time spent at the kiosk. The Vendors are also not entitled to any LWSC accumulative benefits. It is recommended that LWSC should review the working conditions to make them more favourable or consider employing the Vendors on a permanent basis.

Pre-paid systems would withdraw the women water vendors from a productive paying activity, even if with low payment. This should therefore be considered prior to implementation of a pre-paid system.

GESI Summary Tables

The GESI assessment is summarised within the tables attached in **Annex A**:

- **Annex A1**: GESI Analytical Checklist
- **Annex A2**: GESI Action Plan
- **Annex A3**: GESI Rating Operations Table

The table presented in **Annex A3** is the CRIDF GESI Rating Tool, which for the Chirundu WSS project scores 9 out of 12, which places the project in the 'encouraging' category.

Community Engagement for the Proposed Project

LWSC is in possession of a licence to provide water supply and sanitation services in Lusaka Province until 2021. Therefore the company should use well established approaches in delivering water in different contexts - commercial, low, medium, and high density residential areas, and rural areas.

Management of Individual piped reticulation

In areas where individual house connections are provided the company should ensure that all the connections are metered as fixed rates currently in use lead to wastage of water. The company is already responsible for maintenance of main lines and any maintenance after the meter within the premises are individual's responsibility. However, leakages after the meter should be detected and monitored to avoid contamination.

Management of Communal Water Points

The LWSC is already utilising a kiosk system, which is well accepted by residents. The company should investigate the option of using pre-paid meters tested in Lusaka. Pre-paid systems reduce dependence on vendors who are lowly paid and spend 7 days a week at the kiosk.

Operation and Management the Council Public of Water Supply and Sanitary Facilities

Once the ablution blocks are rehabilitated, the management of the facility by a private sanitation company should be considered. The private company would be responsible for operation and maintenance of the facility. Services should be provided at a fee and these fees should be used to maintain the facility. Residents observed that the CDC did not have the capacity to manage public sanitation facilities. Alternatively the responsibility for the management of the communal ablution facilities should be transferred to LWSC.

Population

One of the complexities regarding confirmation of the population is the definition of the LWSC supply area in terms of the Chirundu Town boundary, which is still in slight doubt due to surrounding customary land. This is further complicated by the recent establishment of the Chirundu District Council, which used to be part of the Siavonga District Council (and similarly the water utility used to be Southern Water and Sewerage Company). Since the Chirundu District Council did not exist at the time of the Census 2010, where relevant, the population growth will be compared to Siavonga District Council. This is compounded by the uncertainty of the future development plans for the town.

LWSC estimates the number of households in Chirundu Town is about 2,500 (2013 estimate), with 6 people per household, which equates to about 15,000.

The Census 2010 data for Chirundu Town provides a population of 14,834 people in the urban area. This indicates that the LWSC population estimate for 2013 is lower than the census data. Therefore there is some doubt regarding the exact population in Chirundu Town. For the purposes of the Feasibility Study the census population data will be used.

Two District Councils that border Chirundu District, Siavonga and Kafue, have growth rates of 4.4% and 4.2% respectively. Since it can be expected that the Chirundu District will have similar growth characteristics, the figure for Siavonga (4.4%) has been used to determine future population. This population growth is higher than the Zambia average growth rate of 2.8%, but this is justified due to a number of significant changes in Chirundu Town that has already and will continue to contribute to future growth. Three key factors in particular have contributed to this increase:

- The construction of a ‘one-stop’ border facility with Zimbabwe has seen an increase in the number of passenger and goods transports passing through the border and a corresponding increase in the number of local residents serving border patrons.
- The establishment of Chirundu as an independent district has required the creation of local district offices, with a significant number of government officials moving to the town to take up positions.
- Given its proximity to national protected wildlife areas, Chirundu is increasingly being seen as a good tourist destination, particularly as the area becomes more developed.

Along with the new district status come significant plans for development of land, which has made Chirundu an attractive destination for investment, particularly given its short distance to Lusaka and relative low cost of land.[3]

The last point is particularly important in the context of the CRIDF project: land use plans for new district developments are currently being finalised and include provision for, among others, mixed-income residential use, schools and churches, and light industrial use. The planned area to be developed is around 600 ha in size.[4] While the timeline for these developments is not yet known, they are expected to result in further, large increases to the local population.

The population figures drawn from the 2010 census were before the town became a 'one-stop' border post and before Chirundu district was created. Both of these occurrences have according to the LWSC and District Council representatives, resulted in a rapid increase in Chirundu's population over the past few years.

Table 1 provides the population estimate for Chirundu Urban Area. LWSC has 928 connections in Chirundu, which they estimate is about 45% of the households within their mandated area. This would equate to a total household number of 2,062 houses – or a population of 10,517 people (using the 2010 Census people per household of 5.1). Comparing this population estimate, with the estimate in **Table 1**, it can be concluded that the Chirundu urban area from the Census includes some customary land. However, because it is expected that in the near future the LWSC supply area will be increased to incorporate a large number of additional people from the customary land or peri-urban areas around Chirundu Town, it is recommended that the population estimate is adequate for initial water supply and sanitation interventions in Chirundu.

LWSC and the Chirundu District Council should monitor the actual population growth and plan for implementation of the required infrastructure in shortly before reaching the previous phase design population.

Table 1 Population Estimates for Chirundu

	Unit	2010*	2016	2021	2026	2036
Chirundu urban areas	No.	14,864	19,246	23,869	29,604	45,535
Households	No.	2,915	3,774	4,680	5,805	8,928

*Source: CRIDF (2016); Zambia Census 2010**

[3] Interview with CDO
[4] Difficulties in obtaining approval from local chiefs has resulted in this number potentially being reduced in the short term.

Technical Assessment

Introduction

The findings of the Social Assessment have identified a number of issues that need to be addressed in Chirundu border town. These can be summarized as follows:

- The current system is not able to meet the current water supply demand due to inadequate water production capacity, which includes abstraction, filter, transmission line and storage reservoir capacity.
- The distribution network is not servicing the full customer base. The Chirundu border community is growing very rapidly due to enhanced status of “one stop border facility”.
- The transient travelling population require improved water supply and sanitation services. The sanitation facilities provided by the Chirundu district council are time limited and in a poor condition.
- The existing sewerage system is not operational, but could be incorporated into the future sanitation technology mix.

In order to mitigate the lack of capacity of the system the following interventions are proposed:

- Rehabilitate raw water pipeline from abstraction pontoon
- Upgrade the treatment capacity.
- Increase storage capacity
- Increase booster pump capacity (pumps and pipes)
- Upgrade bulk pipelines
- Introduce bulk metering
- Increase distribution network significantly
- Refurbish the sewer system and connect high consumption water users

It was observed that water production and treatment could be improved using (and upgrading) the existing water supply assets.

Based on the requirements for improved water supply and sanitation in Chirundu, the technical assessment will review the existing water supply and sanitation infrastructure, estimated water demand, water resource options, the water treatment infrastructure, the distribution system and sewerage management.

Existing Water Supply and Sanitation Infrastructure

Water Supply Infrastructure

The existing water supply system in Chirundu is of a conventional design suitable for a small urban community. The LWSC was able to provide the pipe network superimposed on a Google Earth map, although the map only shows bulk pipelines, with much of the small diameter pipes not included. The provided mapping is shown in **Figure 5**.

It is recommended that a complete and calibrated network model be setup as part of the detailed design, including provision of record drawings.

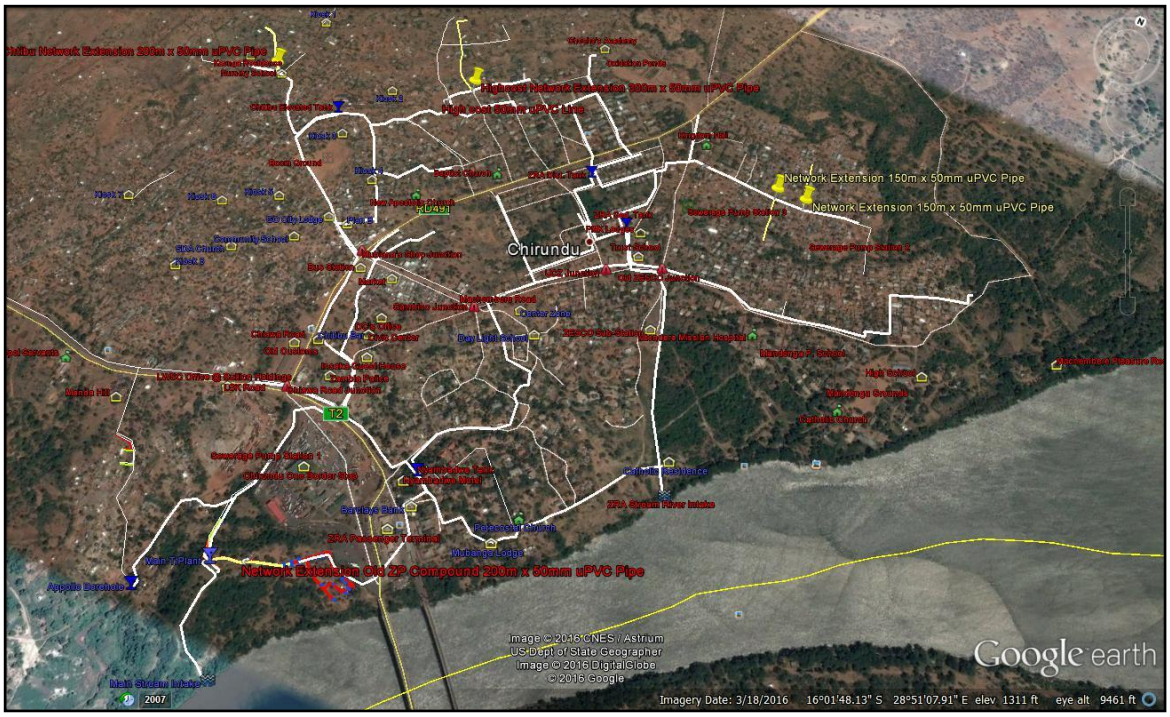

Figure 5 Existing Water Infrastructure

The water supply system comprises of the following basic components:

- Main Treatment Train:
  - A floating intake on the Zambezi River and raw water pumping main.
  - A Water Treatment Plant
  - Pump station
  - An 80 m³ over Head (Backwash) Tank at the Water Treatment Plant (WTP).
- ZRA Treatment Train:
  - A floating intake on the Zambezi River and raw water pumping main.
  - A Water Treatment Plant, comprising settling tank and filters at different locations
  - Pump station
- A gravity fed distribution system supplying of the treated water to the border and another 50 m³ Overhead tank within the town.
- Metered household standpipe connections **(Figure 6)**
- 9 No. Water kiosks
- ZRA Overhead tank and distribution network
- The Apollo Borehole System (minor system)
- Privately owned boreholes

A full description of the existing water supply system is provided in **Annex B**.

Figure 6 Metered connections

Sanitation Infrastructure

There is no existing public sewerage system, although there are abandoned sewer oxidation ponds and three sewer pump stations. No detail was available of the pipeline routes.

Therefore the Chirundu population use on-site sanitation solutions, pit latrines (**Figure 7**) of varying levels of improvement and a small number of septic tanks, with the practice of open defecation still prevalent.

Figure 7 Onsite Sanitation

In addition to the privately owned system, the Chirundu District Council owns two communal ablution blocks, one along the main road towards the border post and the other close to the market. The one at the market has been closed. The ZRA also operates two ablution blocks within the One-Stop Border Post area, one with showers, toilets and wash hand basins, while the other only has toilets and wash hand basins.

A full description of the existing sanitation system is provided in **Annex B**.

Water Demand

LWSC indicates that they are currently supplying approximately 2,000 m³/d to Chirundu consumers (1,400 m³/d from Chirundu Main Plant – although only half of this volume is treated and 600 m³/d from the ex-ZRA system, therefore total treated volume of water that can be supplied to Chirundu is estimated as 1,300 m³/d).

Considering the reported 2,062 houses (928 connections with 45% connection coverage) currently supplied by LWSC and 60 commercial connections, it is difficult to reconcile this volume of water produced to the consumption. This could be due to:

- Large water losses in the system
- There are more consumers obtaining water from the LWSC system, either legally or illegally.
- There are a number of high consumption users, e.g. the one-stop border post, which should be taken into account separately in the water demand.

Unfortunately the current supply system has insufficient bulk metering and the percentage of metered consumers is estimated at only 45%. For this reason a water balance across the system cannot be done and identifying the non-revenue sources is currently not possible.

In an attempt to balance the water demand the following assumptions have been made:

- The water loss in the system is 50%
- The split between High Cost, Middle Cost, Low Cost, Low Cost (Kiosk) is 30%, 30%, 25%, and 15% respectively.
- The average water use per High Cost, Middle Cost, Low Cost, Low Cost (Kiosk), is 150, 100, 40 and 25 l/person per day.
- The balance of the water is used by Institutional and Commercial users.

Based on these assumptions, and using the LWSC population estimate for 2016 and thereafter the Census 2010 population estimate from **Table 2** (assuming that by 2021 the entire Chirundu Town will be supplied by LWSC), the Water Demand for Chirundu has been estimated.

Table 2 Water Demand Estimate for Chirundu

	% Housing Type	Per Person Demand	2016	2021	2026	2036
		l/person/day	m³/d	m³/d	m³/d	m³/d
High cost	30	150	473	1074	1332	2,049
Medium cost	30	100	316	140	888	1,366
Low cost (formal)	25	40	105	239	296	455
Low cost (kiosk)	15	25	39	90	111	171
Total	100		933	1,543	2,627	4,041
Commercial / Institutional			67	110	187	288
Total Supply			**1,000**	**1,653**	**2,815**	**4,330**
System Water Loss			50%	35%	20%	15%
Total Treatment			**2,000**	**2,543**	**3,518**	**4,980**

The current treatment capacity is about 1,300 m³/d; therefore an upgrade is necessary to meet even the existing demand. At the same time as increasing the treatment capacity, it is recommended to improve the bulk metering and the reduction of the system water losses. This will provide information to LWSC to enable them to do better planning of the future requirements of the Chirundu Water Supply System.

Water Resources Assessment

Introduction

This section presents the findings of the rapid water resources assessment study for the Chirundu Border Town. The objectives of the study were to:

- Conduct a rapid water resources assessment (quantity and quality for both surface and groundwater) to determine sustainable source of water for the project;
- Recommend mitigation measures for the water pollution if it exists;
- Determine the current and projected future climate and water vulnerability of the project site including the specific climate impacts and recommend strategies that will reduce the identified vulnerability and increase the resilience of the beneficiaries;
- Assess any water use entitlements required to ensure regulatory compliance – including permits or general authorizations needed for abstraction.

Chirundu Border Town has historically depended on the Zambezi River as the main water source. The water is supplied by the Lusaka Water and Sewerage Company (LWSC) which operates two conventional water treatment plants located both downstream and upstream of Chirundu.

In principle, there are two other surface water bodies that could supply water to the Chirundu Border Town and these are the Lusitu River, located about 12 km south of the border town as well as the Kafue River which is located north of the Chirundu Border Town. Furthermore, water could also be supplied from the ground water aquifers.

Water Availability

The Chirundu border town is on the banks of the Zambezi River. The Zambezi watershed has a total catchment area of approximately 1.37 million km² and covers eight different southern African countries. Rainfall within the Zambezi Basin plays a major role in the water availability in the basin. The Kafue River and the Lusitu River are tributaries of the Zambezi River. There are also a number of streams rising from the mountains between Lusitu area settlement and Chirundu Border Town. These streams are predominantly ephemeral in nature, discharging into the Lusitu, Kafue or Zambezi Rivers.

Rainfall Pattern

At a regional scale, Chirundu Border Town falls within the Zambezi River Basin, which receives a mean annual rainfall of 950 mm or 1,300 km^3 of water[5]. Rainfall variability from year to year is considerable in the region and this leads to big differences in total run-off from year to year, estimates varying from some 500 km^3 in the wettest years to only 100 km^3.

[5] Mott MacDonald. 2007. *Integrated Water Resources Management Strategy for the Zambezi River Basin,* Gaborone

On the local scale, the annual rainfall is less than 800 mm/yr. The mean annual rainfall recorded at Chirundu station was 678 mm, and that at Kariba station (59 km south) was 767 mm[6]. High evapo-transpiration is dominant in the area. Monthly evapo-transpiration (ETo) exceeds rainfall in all but three months (Dec-Feb) of the year, and exceeds the effective rainfall in these three months[6].

The Lusitu River

The Lusitu River is located some 12 km south of the Chirundu Border Town in the Lusitu settlement area. The Lusitu River like most of the streams in the area is dry for the most part of the year. This is supported by GRZ [7] that observed that the majority of the streams in the Lusitu Settlement area are dry most of the year except for the Kafue and Zambezi Rivers which border the district.

In addition, the decision by the Government to abstract water from the Zambezi River for the Lusitu Irrigation Scheme instead of the Lusitu River further augments the variability of the water in the Lusitu River. The Government is implementing the Lusitu Irrigation Scheme consisting of pump stations, irrigation equipment, reservoirs and irrigation fields to be developed on 210 ha of land targeting smallholder farmers (individual farm plots of 1 ha or less); small-scale commercial farmers (farm plots of between one and five hectares), and large plots of at least 60 ha each under centre-pivot irrigation operated by a private company that will eventually be wholly owned by the community[6]. **Figure 8** shows the dry river bed of the Lusitu River.

Figure 8 The Lusitu River as seen from the Lusitu Bridge in March 2016

[6] GRZ. 2015. *Environmental and Social Impact Assessment: Irrigation Scheme in Lusitu in Chirundu District*, Ministry of Agriculture and Livestock, Lusaka

[7] GRZ. 2010. *Resettlement Policy Framework: Final Draft*, Ministry of Agriculture and Cooperatives, Lusaka

Source: CRIDF (2016)

GRZ estimated the annual water requirement for the Lisutu Irrigation scheme to be 3,212,000 m3. This annual water requirement for the Scheme is at least 4 times more than the annual volume of water currently supplied by LWSC to Chirundu Border Town.

It is therefore concluded that Lusitu River cannot provide water to Chirundu Border Towns at the required quantities because the river is dry for most of the year.

Box 1 - Basic Facts about the Kafue River Basin

- Total area coverage of basin 152,000 km^2.
- Mean annual runoff 350 m^3/s or 3.02 x 10^7 m^3/day.
- Area coverage of the Kafue River Basin represents approximately 20 percent of Zambia's total land area (752,000 km^2).
- Source of portable water for approximately 40 percent of the Zambian population in 1995.
- Host to the Kafue Gorge Hydroelectric Power Station that generates about 60 percent of Zambia's electricity supply.
- Supports and sustain vital ecological systems like wetlands, game reserves, bird sanctuary, etc.
- Provided for daily water demand of 42,228,650 m^3/day or 4.22 x 10^7 m^3/day to holders of 130 water abstraction rights in 1995 out of which 14,515,200 m^3/day (1.45 x 10^7 m^3/day) or approximately 34 percent was used for hydroelectric generation.
- *Source: Adapted from Kambole (2003)*

The Kafue River

The Kafue River is located at least some 10 km north of Chirundu Town. It stretches for about 1,576 km from its source on the Zambia-Democratic Republic of Congo border, in the northwestern region, and its confluence with the Zambezi River, traversing through the Copperbelt, Central, Southern and Lusaka provinces[8]. The Kafue River discharges 10 km^3/yr [9] or 1 x 10^{10} m^3/yr of water at the confluence with the Zambezi River. Box 1 presents some facts on the Kafue River Basin as summarized by Matiza et al. (1995) and WHO (1995) and reproduced in Kambole (2003).

[8] Kambole, M. S. 2003. *Managing the Water Quality of the Kafue River*. Physics and Chemistry of the Earth. Elsevier 23, p1105-1109

[9] http://www.fao.org/docrep/w4347e/w4347e0o.htm Accessed 17.05.2016

Applying the discharge of the Kafue at the confluence with the Zambezi River (1.0 x 10^{10} m^3/yr), therefore, the available water in the Kafue River at the point of discharge into the Zambezi River (Kafue River and Zambezi River confluence) is more than 10,000 times the current volume of water supplied to Chirundu Border Town by the LWSC (7.3 x 10^5 m^3/yr). Therefore, the Kafue River could be an alternative source of water supply to the Chirundu Border Town in respect to the quantities of water available in the surface waterbody.

The Zambezi River

The Zambezi River is located to the east of Chirundu Border Town and flows in the south-north direction. Chirundu Border Town has historically depended on the Zambezi River for its source of water supply from two abstraction points which are located upstream (southeast of Chirundu Border Town) and downstream (northeast of Chirundu Border Town). Each of these intake points pumps water to separate water treatment plants. A total of about 2,000 m^3 of water is supplied from the two water treatment plants to the Chirundu Border Town.

The Zambezi River Basin covers a total catchment area of catchment area of some 1.37 million square kilometres and the basin as a whole receives a mean annual rainfall of about 950 mm (Mott MacDonald, 2007). Historical discharge records at Chirundu bridge indicate peak flows ranging from 5,000 m^3/s to 7,000 m^3/s while minimum flow are as low as 450 m^3/s (GRZ, 2015). In comparison to the historical flow regime, the recent hydrographs (1993 to 2012), showed that peak flows ranged from 4,200 m^3/s to about 7,000 m^3/s, thereby indicating that the flows on the Zambezi River between Kariba Dam and Chirundu have also been consistent over the years (GRZ, 2015).

In terms of water availability, Zambezi River consistently provided water for different users along its length and the GRZ (2015) computed Flow Duration Curve (FDC) showed that for 95 percent of the time, the river carries 490 m^3/s (42,336,000 m^3/day) and for 50 percent of the time the flow was above 1000 m^3/s (86,400,000 m^3/day). Therefore, even at 95 percent of the time, water availability in the Zambezi River is 60 times more than the total water supplied by LWSC to Chirundu Border Town.

Nonetheless, Mott MacDonald (2007) computed the mean annual runoff at the Chirundu Bridge to be 4.44 x 10^{10} m^3/yr. The mean annual runoff at the Chirundu Bridge is therefore 60,000 times more than the annual quantities of the water supplied to the Chirundu Border Town.

Therefore, the Zambezi River will continue to be the most reliable source of water supply to the Chirundu Border Town, both in terms of the water availability as well as the close proximity to the border town. The upstream water intake is located approximately 300 m from the ex-ZRA Water Treatment Plant (although the plant has two separate treatment plants, one for sedimentation, one modified for filtration) while that on the downstream is located some 1 km to the Main Water Treatment Plant.

Water Quality

The flows on the Zambezi River downstream of the Kariba Dam are mainly outflows from the dam and are regulated. The flows therefore represent a combination of turbine and spillway discharge. For the purposes of

this assignment, water quality sample compliance monitoring analyses from the Lake Harvest Aquaculture (LHA), a fish farm located on Lake Kariba on the Zimbabwean side were used (see **Table 3**).

Table 3 Water quality in the Kariba Dam at LHA

Parameter	Results	Environmental Agency of Zimbabwe standards	Decision
1. Temperature (°C)	27.6	Less than 35	**Blue**, complies with standards
2. pH	7.42	6-9	**Blue**, complies with standards
3. Do (mg/l)	3.8	Greater or equal to 60%	**Blue**, complies with standards
4. Turbidity (NTU)	0.0936	Less or equal to 5	**Blue**, complies with standards
5. Conductivity (µS/cm)	84.0	Less or equal to 1000	**Blue**, complies with standards
6. BOD_5 (mg/l)	0.0038	Less or equal to 30	**Blue**, complies with standards
7. NH_4-N (mg/l)	0.019	Less or equal to 10	**Blue**, complies with standards
8. Total nitrates (mg/l)	0.353	Less or equal to 10	**Blue**, complies with standards
9. Total phosphates (mg/l)	0.043	Less or equal to 0.5	**Blue**, complies with standards

Source: Adapted from IESTO (2012)[10]

Therefore, based on the water quality analysis of water samples collected from Lake Kariba by Lake Harvest Aquaculture, it can be expected that the water quality in the Zambezi is good, as the results did not present any constraints to its availability for domestic consumption downstream. Note that turbidity results from Lake Kariba are not expected to be applicable to the Zambezi at Chirundu, as there will be some suspended solid increase after the lake, especially during high flow periods.

Groundwater Resources

Three major hydrogeological units in the Zambezi River Basin are distinguished, namely the:

- Kalahari sands;
- Dolomites, quartzite, shales and sandstone, and
- Basement granites and gneisses.

According to Mott MacDonald (2007), important aquifer types in the basin included intergranular aquifer that was well represented by the Kalahari sand aquifer as well as the alluvial aquifers. These aquifers were mostly high yielding with great potential for large scale use. In addition to the Kalahari sand aquifer, Karoo deposits were also intergranular aquifers but these were mainly poor yielding aquifers although occasionally they had high secondary porosity or faulting that resulting into moderate to high yields.

[10] IESTO. 2012. *Lake Harvest Limites Siavonga Aquaculture Project Environmental Social Impact Assessment (EIA) Report*, Institute for Eco-Development Strategies and Toxicology (IESTO), Lusaka

Dolomite, sandstones and limestones aquifers predominate in the Kafue sub-basin and the potential of these aquifers was good particularly in the presence of extensive secondary porosity (Mott MacDonald, 2007). Other aquifers of the Zambezi River Basin included:

- Crystalline formation or basement formation aquifers – the largest aquifer system of the Zambezi River Basin – where groundwater flows was predominantly in fissures, channels or discontinuities;
- Sedimentary formation of sands, silts and clays aquifers were common particularly in lower sections of the basin, Zambezi delta, and along the main river channels and flood plains, and
- Aquifers composed of sandstones, marine sandstones, mudstones, siltstones and shales and these are located in old valleys and depressions.

Overall groundwater yield potential in the Zambezi River Basin ranged from 1-2 l/s to 40-80 l/s. Basement aquifers yielded between 1 l/s to 2 l/s; yields from alluvial aquifers were up to 10 to 15 litres per second while those from dolomite aquifers ranged from 40 l/s to 80 l/s (Mott MacDonald, 2007). Therefore, Mott MacDonald (2007) concluded that the groundwater potential of the Zambezi River Basin, targeting large water use such as irrigation, was moderate to low but occasionally high especially in alluvial aquifers along the main river reaches as well as Karst aquifers that had high secondary porosity. Other aquifers with considerable potential were the basement aquifers that had extensive faulting despite these being localized systems and only present in few areas across the basin.

Projected future climate and water vulnerability

The main threats to water availability for the Chirundu Border Town are the stresses that would affect the Zambezi River Basin (ZRB). These stresses included the droughts resulting from below average rainfall as well as demand from competing users within the ZRB. The occurrence of these droughts, their frequency and magnitude over the coming decades both spatially and in time, would affect the mean annual flows in the Zambezi River and would primarily be due to water supply (because of climate change). Furthermore, growth in population and economic activities as well as agricultural activities (particularly expanded irrigated agricultural activities) within the ZRB over the coming decades would increase water usage as the result of water demand.

Beck and Bernauer [11] showed that while climatic changes were likely to have only relatively small effects on water availability in the Zambezi River Basin, population and economic growth coupled with expansion of irrigated agriculture and water transfers were likely to have very important transboundary impacts. Such impacts involved drastically reduced runoff in the dry season at key locations and changing (relative) shares of ZRB countries in the basin's total runoff and water demand.

Although the regional average annual rainfall is quiet high in the ZRB (approximately 950 mm), it is distributed very unevenly across the basin with the southern and western parts of the basin receiving much lower rainfall than the eastern and northern parts. Moreover, the more densely populated areas are located within the

[11] Beck, L and Bernauer, T. 2011. *How Will Combined Changes in Water Demand and Climate Change Affect the Water Availability in the Zambezi River Basin?* Global Environmental Change, 21(3), 1061-1072

medium and low rainfall areas and this asymmetry between water availability and population density would become even more pronounced in the future (Beck and Bernauer, 2011).

Water consumptive uses in the Zambezi River Basin were estimated to be between 15-25 percent of total runoff (Mott MacDonald, 2007 and SADC-WD, 2008[12]). Dams and agricultural lands are the largest consumptive water users, through evapotranspiration from impoundments and irrigated agricultural land, respectively. Evaporation through impoundments accounts for approximately 13 km³ per annum while agricultural irrigated lands accounts for about 1.5 km³ per year (Beck and Bernauer, 2011). By 2025, SADC-WD (2008)[12] projected that the consumptive uses of the water in the ZRB would reach up to 40 percent of the total runoff. Beck and Bernauer (2011) observed that the projected massive increase in consumptive water uses might become a source of conflicts among the ZRB riparian countries.

Therefore, in order to understand the effect of water demand and climate change on water availability in key areas of the ZRB, Beck and Bernauer (2011) developed a model consisting of two components namely: a hydrological model that mimicked the natural process and the demand model that represented water demand based on actual water use and water use projections. Three scenarios were therefore derived based on particular combinations of water demand and climate change projections for 2050 namely: Scenario 1 which was based on minor changes in demand; Scenario 2 was based on moderate changes in demand and supply, and Scenario 3 which was based on strong changes in demand and supply.

The results of the models by Beck and Bernauer (2011) under Scenario 1 showed the 9 percent reduction in runoff of the Kafue sub-basin compared to 4 percent for the whole ZRB (with 5 percent at the end of ZRB at the delta). Similarly, Scenario 2 showed all sub-basins experiencing a general drastic reduction in the runoff, averaging 31 percent although the reduction in the runoff at the delta was 17 percent of the annual flow compared to the year 2000. Reduction in runoff of the Kafue sub-basin was also 31 percent. Furthermore, the Scenario 3 had extremely negative effects on annual flows in all the sub-basins were on average there was a reduction in runoff by 77 percent. The annual flows in the Kafue sub-basin reduced by 85 percent while the runoff at the delta also reduced by 47 percent which also signified severe losses.

Table 4 shows the mean annual flows (m^3/s) for the 13 sub-basins, indicating total river flow at the end of each sub-basin for the year 2000 and under the three scenarios in 2050.

The decreases in mean annual flows under Scenario 2 and Scenario 3 were even more extreme when focused on the dry season. It was evident from the model that several of the sub-basins could have their water flows reduced to nil even under Scenario 2. Overall, the dry season average mean annual water flows for the 13 sub-basins was reduced to 10 percent under the Scenario 1, 69 percent in Scenario 2 and 95 percent in the Scenario 3 (Beck and Bernauer, 2011).

[12] SADC-WD, ZRA, SIDA, and DANIDA. 2008. *Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin*, SADC, Gaborone

Table 4 Mean annual flows for the year 2000 and Scenarios in 2050

Sub-basin	Year 2000		Scenario 1		Scenario 2		Scenario 3	
	MA flows[§]	**Dry flows**	**MA flows**	**Dry flows**	**MA flows**	**Dry flows**	**MA flows**	**Dry flows**
1. Delta	2597	2126	2457	1964	2162	1542	1383	462
2. Tete	1729	1457	1682	1397	1464	1069	834	105
3. Shire	445	279	354	181	307	110	165	0
4. Mupata	1248	996	1188	873	818	514	23	0
5. Luangwa	489	87	485	82	431	0	250	0
6. Kariba	929	748	898	687	598	405	0	0
7. Kafue	273	159	248	131	187	61	62	30
8. Cuando Chobe	32	26	31	24	0	0	0	0
9. Barotse	1007	204	1002	198	720	0	149	0
10. Luanginga	58	15	58	14	34	0	0	0
11. Lunge Bungo	263	124	263	123	235	84	152	28
12. Upper Zambezi	253	34	252	33	186	0	0	0
13. Kabompo	82	3	82	2	70	0	8	0

[§]MA flows = Mean annual flows

Source: Adapted from Beck and Bernauer (2011)

Effects of reduced flows on aquatic environment as well as the environmental flows were projected to be more adverse on the Kafue sub-basin. Required minimum environmental flows in the Kafue sub-basin were estimated by Denconsult (1998) to be 250 m³/s during the low flow season (Beck and Bernauer, 2011). Unfortunately, the minimum environmental flows in the Kafue River Basin were never achieved. This, however, was in contrast to the minimum environmental flows at the Zambezi Delta which were met in all three scenarios. Minimum environmental flows at the delta were recommended by SADC to be 250 m³/s (Dencosult (1998) as cited by Beck and Bernauer, 2011.

One of the significant finding by Beck and Bernauer (2011) was that the general effect of increasing water demand were clearly greater than the projected effects of the climatic change. As such, effective governance mechanisms for water allocation and for dealing with flow variability should be set up within the next few years in order to manage the situation cooperatively.

Water use entitlements

The Water Resources Management No. 21 of Act of 2011 is the principle law governing water resource planning, development and management in Zambia. The Act established the Water Resources Management Authority (WARMA) whose main functions included '*…to promote and adopt a dynamic, gender-sensitive, integrated, interactive, participatory and multi-sectoral approach to water resources management and development that includes human, land, environmental and socio-economic considerations, especially poverty*

reduction and the elimination of water borne diseases, including malaria'. Specific aspects of the Act that relate to the Chirundu Water Supply Project could be found under Part VII, VIII, IX, XI and XII.

Part VII relates to the management of shared water courses and water resources and enforces the need to retain territorial sovereignty over water resources whilst upholding rights and obligations arising from treaties, conventions, agreements or declarations relating to shared water courses to which Zambia is State Party and the same time safeguarding basic principles and rules of international law as contained in treaties, conventions, agreements or declarations the country is Sate Party.

Part VIII prescribes core principles fundamental to water uses and further provides guidelines on the uses. The Act also provides for the allocation of water and prioritizes its uses as well as stipulating regulations for use of water.

Part IX mandates WARMA as an oversight authority to input on any planned activities within a catchment and / or on, or along a water resource. In addition, the Act also provides for activities that require permits as well as those activities that are exempt from permitting. Procedures for applying for permits are also outlined.

Finally, Part XI deals with groundwater and boreholes while Part XII regulates water works. The Chirundu Water Supply Project when implemented will involve abstraction of water directly from the Zambezi River and that would require a water right. Therefore, LWSC will need to ensure that necessary permits and licenses regarding the water right are obtained.

Water Resource Assessment - Conclusions

Water supply for the Chirundu Border Town has historically been provided from the Zambezi River.

Two other surface waterbodies could offer alternative sources of water supplies for the Chirundu Border Town, namely the Lusitu River and the Kafue River.

The Lusitu River is located some 12 km south of the Chirundu Border Town, however cannot offer sustainable sources of water supply to the Chirundu Border Town due to the low flow in the river. The river only flows during the rainy season.

Groundwater supplies have never been considered because of the availability of good quality water from the Zambezi River throughout the year. Although good groundwater sources are available within the Zambezi River Basin and could possibly provide water for the Chirundu Border Town. Groundwater potential for large water uses such as irrigation were reportedly moderate to low although occasionally high particularly in alluvial aquifers as well as Karoo aquifer. Further geophysical work would need to be undertaken to assess the potential and position of high yielding aquifers. Therefore groundwater is not seen as a viable option considering the availability of water in the Kafue and Zambezi Rivers.

Although the Kafue River currently has sufficient water to supply the demand, it is disadvantaged because of the relatively long distance to the border town (~10 km). It is, however, more likely to be affected by both climate change and increased consumptive uses over the coming decades. Mean annual flows for the Kafue River sub-basin (Beck and Bernauer (2011)) were expected to be lower than the environmental flows estimated to be 250

m³/s. This, therefore, leaves the Zambezi River as the long-term sustainable source of water supply for the Chirundu Border Town.

Overall, Zambian laws demand the need to retain territorial sovereignty over water resources whilst upholding rights and obligations arising from treaties, conventions, agreements or declarations relating to shared water courses to which Zambia is State Party and the same time safeguarding basic principles and rules of international law as contained in treaties, conventions, agreements or declarations the country is State Party. The law also demands for permitting activities that are undertaken within, along or on the water resource.

Water Supply System design

Introduction

The water supply system design combined available information on the existing reticulation with expected future water demand to develop a feasible engineering design.

There is no Integrated Development Plan (IDP) for Chirundu and there was no town planning available to understand how the Chirundu town is envisaged to grow and develop. It is, however, understood that the Chirundu District Council is in discussion with the traditional leaders to acquire more customary land for the urban centre. The water demand has been based on the incorporation of additional areas by 2021.

Therefore, although it is expected that the supply side information (water demand and treatment) will be sufficient to accommodate the population growth, there is uncertainty regarding where the development will take place. It is therefore recommended that the necessary town planning be undertaken to allow for efficient detailed engineering designs.

The interventions in **Table 5** are proposed for Chirundu town, which has taken the condition of the existing infrastructure, the current capacity and future demand into account.

Table 5 Proposed interventions

	Component	Existing status	Intervention
1.	Water Source	The Zambezi River	This is the existing source and is satisfactory despite high turbidity at certain times during the year.
2.	Water Intake + Raw Pipeline	Floating mechanism, with makeshift pipe installations	The existing method of abstraction is a satisfactory and Climate Resilient solution. However, the system that is currently in place needs to be upgraded to allow for improved access to the float and screens before the pumps.
3	Water Treatment Plant (WTP)	Water treatment plant of conventional design and basic treatment processes	Upgrade treatment plant in phases to meet the estimated 2036 demand. Connect existing OHT to distribution system and construct new backwash OHT at WTP.

	Component	Existing status	Intervention
4.	Ground Level Storage	Chlorine contact tank approx. 120 m³	Capacity can be increased to provide 24 hours storage based on current demand. Future phases should provide additional storage capacity to match demand.
5.	High Level Distribution system storage	50 m³ OHT in system	Upgrade to 3 h system storage
6.	Distribution System	Branch Main, Gravity Flow	Upgrade bulk pipelines and increase distribution capacity within the network.

Design criteria for the proposed water supply system

Four distinct components of the water supply system need to be upgraded, namely:

- Water abstraction system;
- Water Treatment
- Storage facilities; and
- Distribution system.

The design philosophy of 'Low Mechanical Content' LMC is incorporated throughout the designs for both water supply and sewerage projects, but due to the rolling hill topography of Chirundu there is a requirement for some mechanisation within the system.

The population projection for Chirundu District by 2036 is 45,535 people (**Table 1**). The average daily demand of water for Chirundu District by 2036 is 5,094 m³/d, inclusive 15% UFW reduced from the current 50% UFW (**Table 2**).

The feasibility design included calculating the water demand during the interim years to 2036 in order to understand the current system and to propose rehabilitation/expansion works to meet future needs of the town in a phased approach.

LWSC, ZEMA requirements together with national/regional regulations and international standards have been the basis for the water and sanitation conceptual designs. The main design criteria adopted is shown in **Table 6,** which is recommended as the basis of future phases to provide consistency within the water supply system.

Table 6 Water design criteria

Item	Component of the system	Proposed Design	Currently available
1.a.	Intake [Flow]	Floating Intake – Climate Resilient and animal resilient at existing up-stream location. Pump Capacity **260l/s** (16 h pumping)	16l/s [60hp]

Item	Component of the system	Proposed Design	Currently available
		+ Stand-by Pumps + Stand-by Generator	
1.b.	Raw Water Pipe Flow (2036)	**936 m³/h** (based on peak day and 16 h of functioning including losses)	36m³/h
1.c.	Raw Water Pipe	Static Vertical Lift. Source to WTP **50 m**	50m
1.d.	Raw Water Pipe	450mm dia	200/90mm dia
2.a.	Water treatment plant (2036)	**5,094 m³/day** - designed to produce this assuming a 16 hour working day [allowing for backwashing/breakdowns, etc.] 4 stage treatment to Zambian Water Quality Standards.	1,300 m³/day 4 stage treatment
3.a.	Treated Water Storage Reservoir	Upgrade Reservoir with 12 hour storage capacity **4,000 m³** (1.5 x avg demand). Material/construction to be evaluated at detailed design stage.	
3.b	Ditto at Water Treatment Plant	Introduce a backwash overhead tank to replace already existing which will become a system OHT.	
4.a.	Outlet Pipe /Ring Main	Flow **630m³/h** based on “peak hourly flows”	-
b.	Outlet Pipe / Ring Main	600 mm HDPE	Various, HDPE
5.	System Overhead Tank [OHT]	New 3 hour capacity OHT within the distribution system.	
6.	Bulk/DNI Zone Meters	Electromagnetic meters powered with Long Life Battery including Built in GSM Modem for wireless communication.	
7.	Customer Meters	As existing LWSC specification	
8.	Network	200mm – 75mm	110mm – 63mm
b.	Flow of distribution main	Peak hour flow	-
c.	Pressure in the network	6 bar maximum at public tap	-
d.	Velocities in the network	0.5 to 2.0 m/s	Less than 0.5 m/s
e.	Minimum diameter of distribution pipes	75 mm	63mm
f.	Minimum diameter of connection pipes	20 mm	20 mm
g.	Distribution Pipework	uPVC	Various.
h.	Fire Hydrants	To Fire Brigade Specifications	

Item	Component of the system	Proposed Design	Currently available
i.	Sluice Valves	Cast iron for uPVC	
k.	Air Valves	Cast iron for uPVC	
l.	Earth Cover over Pipes	Minimum of 1.0 m earth cover to be maintained over crown of pipe.	
m.	Pipe Bedding and Embedment	Sand	
n.	Washouts/Flushing Points	At low points in the area	

The design employs the concept of Distribution Network Improvement (DNI) Zones which divides the distribution system into bulk metered supply zones or DNI's. DNI's operate as mini demand centres and facilitate regular 'water volume' and 'revenue income' balances to ensure the commercial viability of each DNI. DNI's have at the centre of their philosophy: - "**If you can't measure and monitor you cannot manage**". A DNI zone can be isolated from the rest of the distribution network to facilitate effective and efficient 'Water Distribution Management' practices.

Customers within a DNI are metered and are billed on a volumetric basis. The volume of water entering the DNI zone is measured (bulk meter) and compared to the total volume of water consumed by customers within the DNI (summation of customer meters). A 'water balance' can be calculated where: Losses = Volume of Water Supplied - Volume of Water Consumed. Unexplained losses of water are investigated and resolved.

Distribution Network Design

Distribution Network Improvement (DNI) Zones

For Chirundu, four DNI zones have been proposed as shown in **Figure 9** for the water network in accordance with nucleated settlement patterns determined during a site visit by the design team.

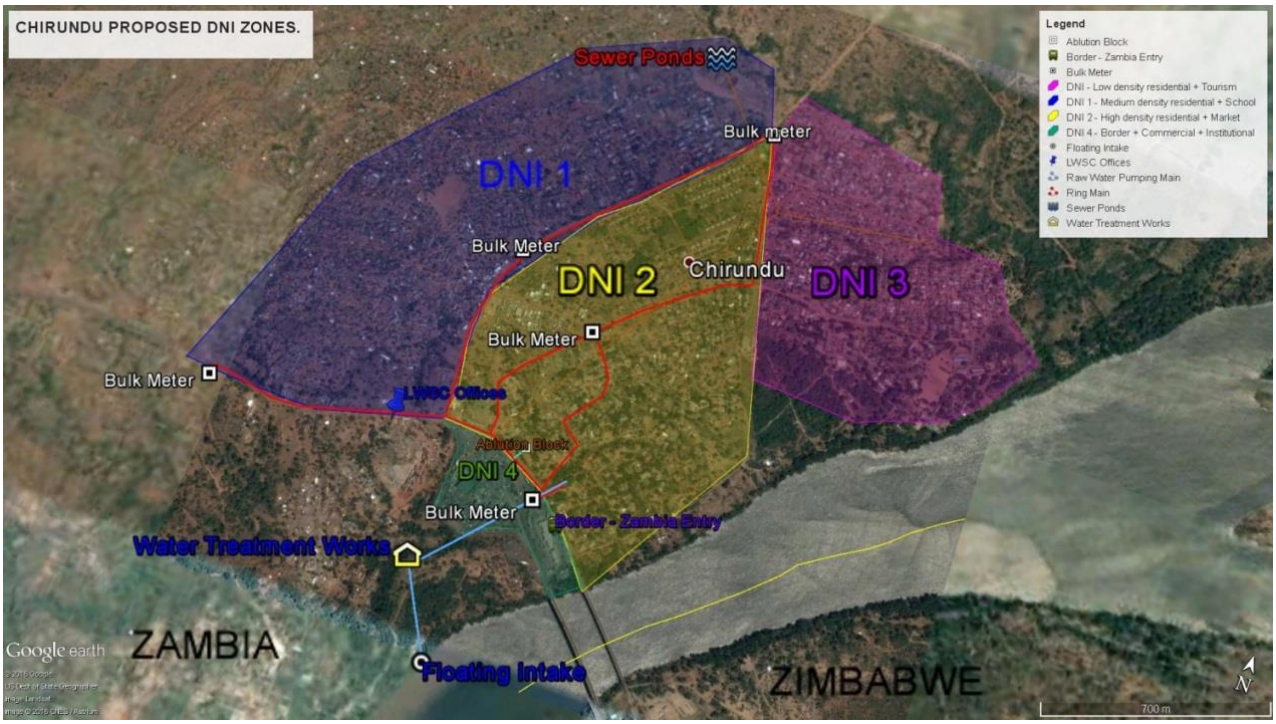

Figure 9 Chirundu DNI zones

The DNI zones are in no order of service provision but rather by land area usage, facilitating a means of water balancing within the demand service areas. The DNI's are described in **Table 7** below.

Table 7 DNI Zone Description and Components

DNI	Description	Components
Zone 1	Residential development area	43% of population, Low - Medium density residential Unserviced traditional land Hospital, School, Transit vehicles
Zone 2	Residential development area	Chirundu business market in built up area 32% of population medium – high density residential Transit vehicles
Zone 3	Residential development area	25% of population, Low density residential Small holding and tourism (lodges etc.)
Zone 4	Border and Commercial	Border, Institutional and Administrative and Commercial Development area

Development of the Proposed Water Supply system

It is proposed to develop a ring main network comprising a ring mains running along the T2 main road, RD491, along an unmarked feeder road and back to connect along the T2 main as it feeds the DNI zones via bulk meters. Water kiosks are proposed to cover all the main low cost residential areas but number and location will be determined and finalised after consultation with stakeholders at detailed design stage. The layout of the proposed network is shown in **Figure 10**.

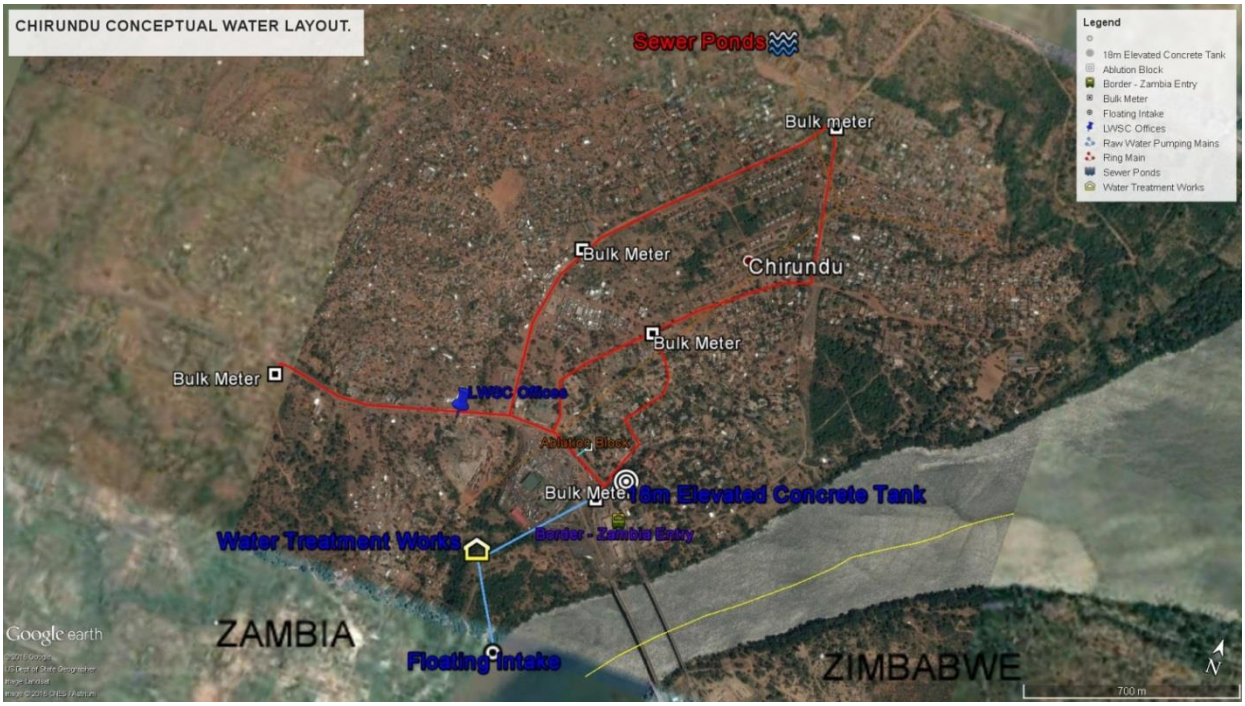

Figure 10 Proposed Ring Main Layout

Three residential demand centres have been identified comprising the two existing housing areas, and the new housing development area as shown in **Figure 9**. An additional DNI Zone 4 covers the border demand together with all commercial and industrial connections along the T2 main highway.

Peak day and peak hourly demand for each centre was computed by multiplying average daily demand for year 2036 by 1.5 and 3 respectively. The results for the 2036 peak water demand are summarised in **Table 8**.

Table 8 Chirundu Peak Water Demand by DNI zone for year 2036

	Peak Hour		Peak day (16 hour pumping)	
	m^3/day	m^3/hr	m^3/day	m^3/hr
DNI 1	5976	249.5	4482	186.8
DNI 2	4482	186.8	3362	140.1
DNI 3	3486	145.3	2615	108.9
DNI 4	994	41.5	497	20.7
Totals		**623.1**		**456.5**

The current distribution system has grown from a small network serving a limited number of connections incorporating private water sources (Apollo borehole) and water supply infrastructure (e.g. ZRA).

The proposed network has been designed to cater for future housing developments through infills and densification of existing residential areas.

Intake, Treatment and Transmission Mains

Water will be pumped to the WTP from the Zambezi River with pumps mounted on a floating pontoon, i.e. an upgrade of the existing system, including replacement or twinning of the raw water pipeline.

The raw will be treated through a four stage treatment process comprising flocculation, clarification, filtration and disinfection. The existing treatment plant is in reasonable condition and therefore the plant only needs to be upgraded in a phased approach to match the demand.

The treated water will flow into a new 12 h ground storage that will also provide contact time for chlorine disinfection. The treated water will be pumped to high level storage tanks for gravitation to distribution ring main. Components of the distribution network will include:

- 3 No. high discharge raw water pumps and motors with screens, mounted on climate resilient floating pontoon, well anchored with access from shore.
- 260 m long, 450mm diameter raw water pumping mains to WTP
- 3 No. horizontal booster pumps and motors in pump station
- 568 m long, 400mm diameter pumping mains to high level storage tank

Storage Reservoir

It is proposed to construct a 4,000 m³ ground sectional steel (Braithwaite) reservoir at the water treatment plant, to cater for 12 hour peak day storage requirements, based on the 2036 peak average water demand. Water will be pumped to a new 3 hour elevated storage reservoir on an 18 m high tank stand at a high level location as shown in **Figure 10**.

Distribution Mains

Water will gravitate from the elevated storage reservoir into a distribution network designed to cater for peak hourly demand. It has been designed to cater for expected growth up to 2036.

Components of the network include:

- 6,000 m long, 300 mm diameter class 16 gravity ring mains laid along the T2 and RD491 supplying the DNI zones via five (5) bulk meters as shown in **Figure 10.**
- Overhead system tank along RD491 before zone 3 bulk meter at the junction of RD491 and the feeder road.

- A 300 m long, 75 mm mains branch continues along the T2 from the junction with RD491 supplying truck stop owners and Institutional buildings along the T2.
- 50 m long, 40 mm diameter lateral pipelines supplying the main Market area and Truck stop ablution blocks. Other locations to be determined after detailed town planning and through stakeholder consultation during detail design.
- Secondary distribution pipelines (not shown) will be laid from the ring mains bulk meter to DNI Zone 1
- Secondary distribution pipelines (not shown) will be laid from the ring mains bulk meter to DNI Zone 2
- Secondary distribution pipelines (not shown) will be laid from the ring mains bulk meter to DNI Zone 3
- 80 m long, 250 mm diameter Secondary distribution pipelines will be laid from the ring mains bulk meter to the Chirundu Border

The design options were limited due to inadequate information and the existing situation and will need an extended investigation at the detailed design stage. The adopted feasibility design constitutes a 'preferred design', with further detail and motivation provided in Table 9.

Table 9 Summary of Water Supply Technical Considerations

	WATER SUPPLY COMPONENT	WATER SUPPLY DESIGN OPTION	REMARKS
	WATER SOURCE		
1		**Surface Water [Zambezi River]**	**Large prolific source Raw water quality is good. Used as source in most of Zambia's Southern Province towns. Appropriate – LWSC have good knowledge base of source and treatment required.**
2		Groundwater	Yield is unproven
	WATER INTAKE & RAW WATER PIPE		
3		Fixed Bankside	Not climate Resilient. Production unreliable. Construction costs are high
4		**Floating Intake**	**Climate Resilient. Production Reliable. Rehabilitation costs – moderate. As existing system - appropriate technology.**
5		**Raw Water Pipe**	**The existing varying diameter pipe is inadequate. The replacement pipe will be in the order of 450mm diameter.**
	WATER TREATMENT PROCESS		
6		**Expand Existing WTP**	**Existing WTP is in good condition and provides a significant portion of the current demand. Land is available at the WTP site with parallel trains for expansion already considered during original**

	WATER SUPPLY COMPONENT	WATER SUPPLY DESIGN OPTION	REMARKS
			design. Capital cost is high. **Treated water is to Zambian standards.**
7		New Package Plant	Can be mechanically complex with high maintenance cost and reliability issues. Parallel 'trains' easily installed to increase capacity and is more flexible than concrete structures. Long term operating success rate is typically low in similar contexts so 'appropriateness' is a factor. Capital cost is high Would require a different process or abandoning of the existing treatment train.
	GROUND LEVEL STORAGE		
8		**12, 18 and 24 Hour storage**	**Insufficient storage is a problem with the existing system and leads to water shortages during power cuts and mechanical breakdowns.** **New reservoir to be constructed and capacity increased in phases.** **Construction to be Steel or Concrete depending on capital cost and full assessment.**
	OVERHEAD TANK [OHT]		
9		Connect Existing OHT to distribution system	Low cost option but capacity is small – to supply WTP surrounding areas.
10		**New High Level Storage with 2, 3, 4, 8 and 12 hour options**	**Operationally preferred and provides the best level of service.** **Capital Expense is high.**
	DISTRIBUTIONN NETWORK		
11		Branch Main, Gravity Flow	Incorporating and upgrading the existing system as a branch of an extended water distribution system with basic improvements to provide the required safe water. Limited in design due to inadequate and inaccurate information on existing distribution pipelines.
12		**Ring Main, Gravity Flow (A)**	**All Zambian water quality standards and LWSCs target levels of service are fully met through the development of an entirely new water reticulation system using none of the existing infrastructure in Chirundu.**
13		Ring Main, Gravity Flow (B) - *using existing*	Provides an in-between scenario under which the existing system is upgraded to produce Zambian water

	WATER SUPPLY COMPONENT	WATER SUPPLY DESIGN OPTION	REMARKS
		infrastructure.	quality standards, but there is not enough information on the existing infrastructure.

Based on the numbering in **Table 9**, the proposed system would include 1, 4, 5, 6, 8, 10 and 12 (shown with bold text in table).

The technical options for all of the Chirundu water supply components follow traditional Zambian design parameters and lie within the conservative existing design. The only design departure from the existing is in the configuration of the Distribution system which is designed to introduce commercial practices specifically to improve services to customers and to support sustainability.

Sewerage and Sanitation Design

The Feasibility Study sanitation and sewerage design is based on a phased approach to the principles of Decentralised Wastewater Treatment Systems (DEWATS), i.e. the system utilizes various technologies to satisfy the local economic and social situation. Sanitation in the project area is catered for through a mixed technology combination of on-site systems (septic tanks, Ventilated Improved Latrines (VIP) and traditional pit latrines) and a waterborne system.

The proposed sewer network designs are based on the assumption that 70% of the water used within Chirundu Border post and other high water consumers enters the sewerage system by 2036 and is treated at the existing (although not operational) Sewage Treatment Ponds.

Proposed On-Site Intervention

The low to medium income residents will be encouraged to use onsite treatment solutions, especially to construct Ventilated Improved Pit (VIP) latrines instead of simple pit latrines. The basic concept and benefits of the VIP latrine is shown in **Figure 11**.

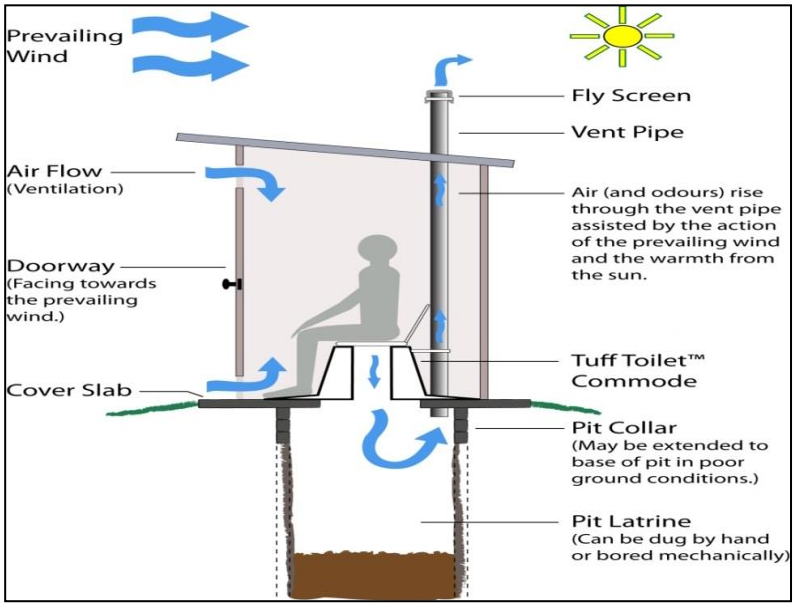

Figure 11 Improved VIP Latrines

It is proposed to construct public ablution facilities for use by travellers crossing the border and at the Local Business Market. The ablution block will consist of toilets, shower and laundry facilities, which will be separate for males and females (see **Figure 12**). Treatment of the wastewater generated in the ablution facilities will be by means of a septic tank, designed to be emptied every 3 years. The sludge will be discharged into sewage ponds located at the nearest town with sewage treatment facilities. In future, these facilities can be connected to the sewer network system.

The facility will be under delegated management. Charges will be levied for the use of the ablution facilities by travellers, as a cost recovery measure to fund cleaning and water supply services.

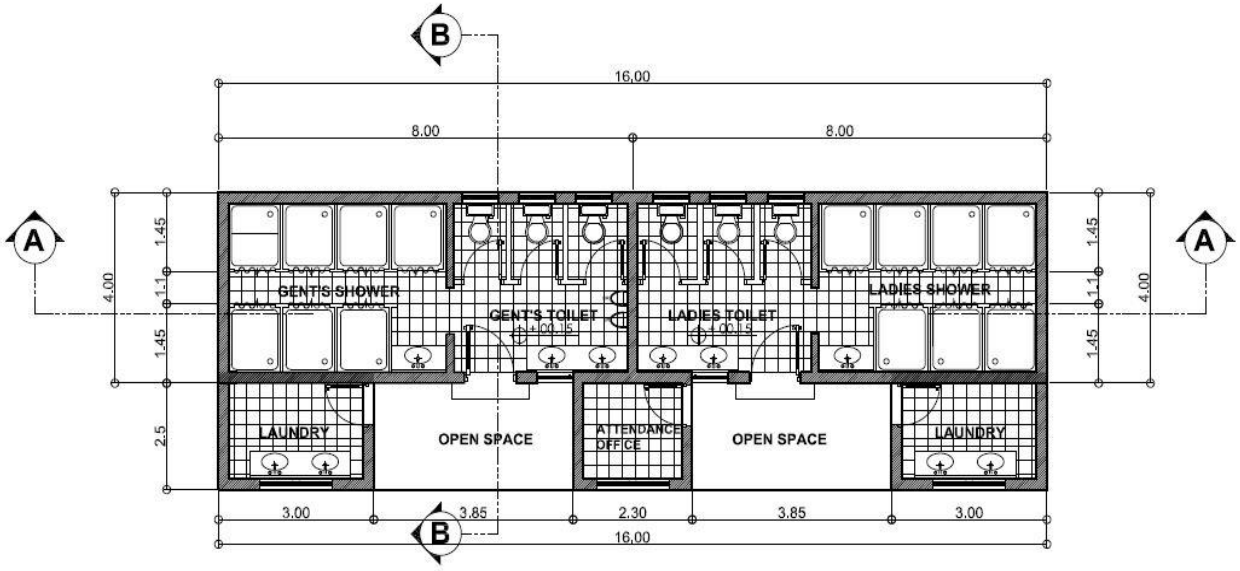

Figure 12 Proposed layout of ablution block

Proposed Sewerage Network Interventions

There is an existing sewerage system in Chirundu, however it was never commissioned after construction. Utilising the existing infrastructure, even though it has a rehabilitation cost attached, will be lower than the construction cost of new infrastructure. One aspect that needs to be considered is the position of the wastewater sewage ponds, because the site has been encroached by residential properties.

It is proposed that the existing sewerage system, including pump stations and wastewater sewage ponds are incorporated into the sewerage network. The following key interventions are proposed:

- A conventional sewer system to convey sewerage from the border post and surrounding commercial area to the sump at Pump Station 1
- A small bore sewerage conveyance system from other high volume water consumers (Lodges, hotels etc.) to Pump Station 2.
- Pump Station 1 and 2 convey sewerage to Pump Station 3 pumping to the Oxidation ponds.
- Allowance for other users to connect to the system.

The proposed interventions are shown in **Figure 13**.

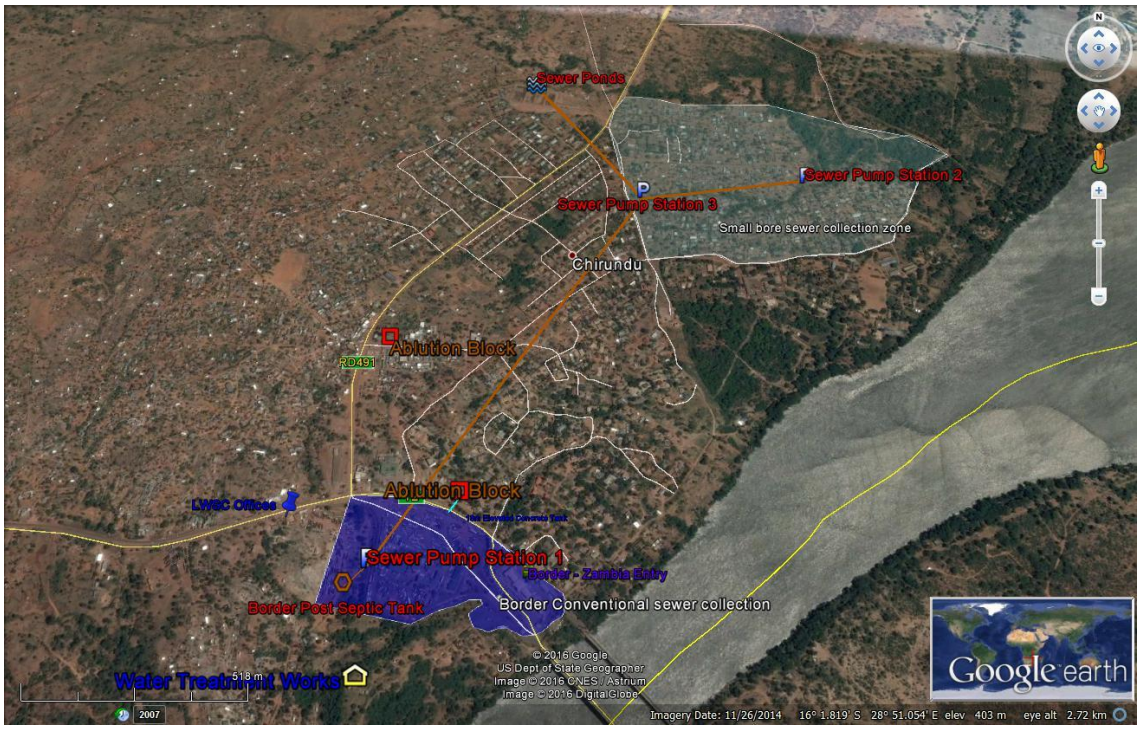

Figure 13 Proposed Sewer and Sanitation Interventions

Proposed operations and management structures for the systems

The facility will need to have an operations and maintenance plan in place to provide for daily maintenance and cleaning requirements as well as desludging when the septic tank fills up. It is therefore important that provision of these services is sustainable for the facility to operate to the satisfaction of the would-be users.

As the facility will fall under LWSC Limited, the sewerage section of the company should take up the operations and maintenance aspects of the facility. The utility should provide an attendant / attendants / vender to collect the user fees as well as to clean the facilities on a daily basis. The funds raised should be managed in such a way that there should be enough funds available to enable regular desludging of the facility.

Key attributes and operational features:

- The operations for the new facilities will fall in Chirundu services section of the LWSC
- The CU (LWSC) appoints a water vendor to manage the revenue and cleanliness of the ablution facility.
- The water vendor takes a percentage of the water used by the facility, currently kiosks are operated on the basis of 40% of total revenue.
- The water vendor pays for the water used by the ablution facility.

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 increased 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 10 and **Table 11** presents the level of the climate vulnerability indicators for the Chirundu 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 C2**.

Table 10 Chirundu WSS - Climate Vulnerability Indicators (from website[13])

Indicator	Outcome
Future risks to people	5. Moderately High
Water risk under climate change	5. High
Climate change pressure	4. High
Baseline risks to people	3. Medium
Resilient population	4. High
Population density	55 (people per km²)
Household and community resilience Groundwater stress	0.46 Moderately less resilient
Groundwater stress	1. Low (<1)
Upstream storage	1. High (>1)
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

Table 11 Chirundu WSS - Climate Vulnerability Indicators (From CRIDF Assessment Report[14])

Risk / Vulnerability	Indicator		Overall
Physical- Quantity	Baseline Water Stress	Low (<10%)	Low risk (0-1)
	Inter-annual Variability	Low to medium (0.25-0.5)	
	Seasonal Variability	Extremely high (>1.33)	
	Flood Occurrence	Medium to high (4-9)	
	Drought Severity	Medium to High (30-40)	

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

[14] CRIDF Report, 'Assessing the climate resilience impact of proposed CRIDF projects', Shehnaaz Moosa, 12 March 2014

Risk / Vulnerability	Indicator		Overall
	Upstream Storage	High (>1)	
	Groundwater Stress	Low (<1)	
Physical- Quality	Return Flow Ratio	Low (<10%)	Low risk (0-1)
	Upstream Protected Land	Medium to High (20 – 40%)	
Regulatory and reputational risk	Media Coverage	Extremely High (0.4 – 0.8%)	Extremely high risk (4-5)
	Access to Water	Extremely High (>20%)	
	Threatened Amphibians	Low (0%)	

The project area faces extremely high seasonal variability, with flood occurrence and drought severity medium to high risks. In addition to these factors regulatory and reputation risk is extremely high risks that could have an impact on the ability to supply services to the beneficiaries.

The development of a reliable supply through improving the abstraction system, the capacity of treatment and the reticulation will enhance inherent climate resilience of the community and surrounding area and allow for effective water services for the poor given the current level of climate change.

Regional Climate Projections

The project falls within Region 1 (refer Annex C), and the expected impacts associated with this region are presented in **Table 12**.

Table 12 Chirundu WSS - Climate projections for project area

Climate change trend / parameter	Impacts	
	By 2025	By 2055
Precipitation variability	Continuing trend of seasonal and inter-annual 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	Continuing trend of seasonal and inter-annual 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

Climate change trend / parameter	Impacts	
	By 2025	By 2055
	+10%. The possibility of increased rainfall rises with higher emissions.	(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.
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	Widespread health effects due to food/water insecurity,

Climate change trend / parameter	Impacts	
	By 2025	By 2055
	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.	availability of potable water, water contamination by runoff, and low water quality due to biological diseases, pollution/sewage runoff into rivers, 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 13** along with a series of risk management options.

Table 13 Chirundu 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, downstream of Lake Kariba and therefore flooding could have an impact.	**Medium**: Prolonged drought can impact on the water levels in the river, which could impact the intake. The existing intake has the ability to be moved further out into the river.	**Low:** Infrastructure will be provided within an urban area, with low vegetation cover.	The infrastructure will be place well above the flood level. The intake works will be a floating pontoon, which is applicable technology for both floods and droughts.
Water zoning and non-revenue water reduction	**Low**: Flooding is unlikely to impact water distribution network	**Low**: Drought is unlikely to impact water distribution network. Water zoning and reducing non-revenue water will reduce the	**Low**: Fire is unlikely to impact water distribution network, except at above ground infrastructure like the treatment works, reservoirs and	No mitigation required

Project component	Flood	Drought	Fire	Risk mitigation options
		impact of drought significantly	the intake, which is not relevant to this project component.	
Provision of water and sanitation facility for the cross border population (communal ablution building)	**Medium**: Flooding could damage the communal ablution building and could also flood the septic tank.	**Low**: Drought is unlikely to impact the communal ablution buildings.	**Medium**: Fire could destroy the communal ablution building.	The design of the communal ablution building will need to take flooding and fire into account, in terms of selection of materials, positioning away from flammable materials / bushes / trees and flood resistance of the septic tank.

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 the 'Climate Resilience Benefits Matrix' attached in **Annex C1**.

Conclusions

The 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 storm water run-off and secondly minimise the impact of flooding. This will improve the additional resilience of the community and surrounding area to future climate change.

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. This study will look at options to improve the additional resilience of the community and surrounding area to future climate change

Recommendations

The project should address the specific future changes in precipitation due to climate change as projected by climate models. Furthermore institutional strengthening of the water and sewerage supply company, which can address long terms aspects like water conservation, demand management and reduction of non-revenue water, could influence the volume of water required to supply the town. Climate projections should be shared and discussed with local stakeholders by the project team to explore future and alternative risk mitigation options.

Implementation Costs

The estimated implementation costs for the construction and expansion of the system, as proposed in this section, for Chirundu are summarised in **Table 14**.

Table 14 Estimated Project Implementation Cost

	Component	Preferred Solution / Design	Capital Cost US$	Capital Cost GB£	Remarks
1	Water Source	The Zambezi River	**$0**	**£0**	This is the existing source and is satisfactory.
2	Water Intake	Rehabilitate to Climate Resilient Floating Intake	**$212,500**	**£146,000**	This is the existing method of abstraction and is satisfactory.
3	WTP	Expand water treatment plant of conventional design [as existing].	**$1,255,000**	**£862,400**	To be constructed and expanded along the parallel train provision of the existing. Expands the plant to accommodate laboratories and administrative buildings
4	Ground Level Storage, Pumps and transmission	12 hour capacity.	**$780,000**	**£536,000**	Capacity can be reduced to 8, hours if 'Affordability' becomes an issue but with reliability of supply consequences. To be constructed in phases, additional storage capacity can be added in the future.

	Component	Preferred Solution / Design	Capital Cost US$	Capital Cost GB£	Remarks
5	High Level Storage	New 4 hour storage capacity within the system.	**$437,200**	**£300,400**	High Capital cost. Lower cost alternatives available but with service level consequences.
6	Distribution System	Ring Main, Gravity Flow	**$2,120,000**	**£1,456,800**	Provides best performance of all Options. All design criteria is achieved especially levels of service and sustainability.
7	Water and Sanitation centres	Water Kiosks + Ablution blocks	**$120,000**	**£82,500**	Provides water and sanitation services to the high volume of transit consumers moving between the town and border and business market areas.
8	Sewer Treatment	Rehabilitation of Oxidation ponds, chambers and administration structures.	**$850,000**	**£584,000**	Affordable and most appropriate solution as the works and siting are advanced. Operationally straightforward.
9	Sewerage Collection and conveyance and pumping	Simplified/ Small bore Gravity Sewer	**$2,250,000**	**£1,546,000**	Affordable and most appropriate solution than can be implemented for domestic discharge. Mechanisation cannot be avoided due to Chirundu's rolling hills topography
	TOTAL INTERVENTIONS COST		**$8,024,700**	**£5,514,100**	

Implementation Phasing

It is proposed that the project be split into phases to optimise the use of capital expenditure and ensure that capital expenditure matches actual growth.

The established phases for Chirundu are Short, Medium and Long Term, up to 2036. A summary of the objectives and main interventions per phase are described in **Table 15**.

Table 15 Planned Implementation Phases

Phases	Planning Horizon (Year)	Main areas of intervention	Implementation plan
Phase 1	Short Term (2021)	Upgrade intake pontoon Upgrade of treatment plant to 2ML/d Upgrade pumping system, pumps and pumping mains Upgrade bulk main pipelines Introduce bulk meters Increase storage to 2ML/day Construct new and refurbish existing ablution facilities	Design and construction before 2021.
Phase 2	Medium Term (2026)	Upgrade treatment plant to 6Ml/d (double from 2ML/day) Increase storage to 6ML/day (12hr) Upgrade secondary distribution network within DNI zones Refurbish sewer system and connect high water consumption users	Design and construction before 2026 – to be confirmed based on actual population growth.
Phase 3	Long Term (2036)	Expand secondary distribution network with increase in population	Design and construction before 2036 – to be confirmed based on actual population growth.

Preliminary Budget for Implementation

The following tables provide a breakdown of the preliminary budget for implementation based on the proposed phases.

The Total Implementation cost split into phases (corresponding with the total from **Table 14**) is provided in **Table 16**.

Table 16 Total Preliminary Implementation Costs - All Phases of Works

Total Capital investment 2016-2036			
Item No.	**Item Description**	**Amount US$**	**Amount GB£**
1	Short Term (Phase 1) – Water Supply	2,335,000	1,604,500
2	Short Term (Phase 1) – Sanitation	75,000	51,500
3	Medium Term (Phase 2) – Water Supply	2,388,600	1,641,300
4	Medium Term (Phase 2) - Sewer and Sanitation	3,029,400	2,081,600
5	Long Term (Phase 3) – Water Supply	196,700	135,200
	Total	**8,024,700**	**5,514,100**

Short Term (Phase 1) Implementation

The Short Term (Phase 1) Implementation consists of a water supply portion and a sanitation portion. **Table 17** and **Table 18** provides the estimated investment for this work, shown per individual item.

Table 17 Estimated Costs Short Term (Phase 1) – Water Supply

Item No.	Item Description	Quantity	Amount US$
1	**Short Term (Phase 1) - Water Supply**		
1.1	Floating Intake and Pump sets	1	170,000
1.2	Conventional Treatment plant expansion	0.6 Ml/d	80,000
1.3	Transmission and Storage Expansion	2 Ml/d	250,000
1.4	Booster Pumps Expansion		22,000
1.5	Ring Main Distribution network complete appurtenances	6,000 m	1,000,000
1.6	Distribution centre 50 m³ OHT complete appurtenances	2 No.	346,000
1.7	Engineering and Contingencies 25%		467,000
	Sub – Total 1		***2,335,000***

Table 18 Estimated Costs Short Term (Phase 1) – Sanitation

Item No.	Item Description	Quantity	Amount US$
2	**Short Term (Phase 1) – Sanitation**		
2.1	Ablution blocks	2	60,000
2.2	Engineering and Contingencies 25%		15,000
	Sub – Total 2		***75,000***

Medium Term (Phase 2) Implementation

The Medium Term (Phase 2) Implementation consists of a water supply portion and a sanitation portion. **Table 19** and **Table 20** provides the estimated investment for this work, shown per individual item.

Table 19 Estimated Costs Medium Term (Phase 2) – Water Supply

Item No.	Item Description	Quantity	Amount US$
3	**Medium Term (Phase 2) – Water Supply**		
3.1	Floating Intake and Pump sets		0
3.2	Conventional Treatment plant Expansion	4 Ml/d	1,000,000
3.3	Transmission and Storage Expansion	4 Ml/d	295,000
3.4	Booster Pumps Expansion		56,000
3.5	Ring Main Distribution network complete with appurtenances		0
3.6	Distribution centre OHT complete with appurtenances		0
3.7	Secondary Distribution complete with appurtenances	4,600 m	524,900
3.8	Water kiosks		35,000
3.9	Engineering and Contingencies 25%		477,700
	Sub – Total 3		***2,388,600***

Table 20 Estimated Costs Medium Term (Phase 2) – Sanitation

Item No.	Item Description	Quantity	Amount US$
4	**Medium Term (Phase 2) - Sewer and Sanitation**		
4.1	Sewer treatment works rehabilitation		680,500
4.2	Transmission pipeline	2,480 m	90,000
4.3	Small Bore Collection pipeline	4,000 m	1,583,200
4.4	Pump and lift stations	3	120,800
4.5	Ablution blocks		0
4.6	Improved latrines		40,000
4.7	Awareness, training and education campaigns		10,000
4.8	Engineering and Contingencies 20%		504,900
	Sub – Total 4		***3,029,400***

Long Term (Phase 3) Implementation

Phase 3 is an expansion of the secondary distribution network to unserviced areas of Chirundu that will in future fall with the Chirundu town boundary. **Table 21** provides the estimated investment for this work, shown per individual item.

Table 21 Estimated Costs Long Term (Phase 3) – Water Supply

Item No.	Item Description	Quantity	Amount US$
5	**Long Term (Phase 3) – Water Supply**		
5.1	Conventional Treatment plant Expansion		0
5.2	Transmission and Storage Expansion		0
5.3	Ring Main Distribution network complete with appurtenances		0
5.4	Secondary Distribution complete with appurtenances	1,500 m	171,000
5.5	Engineering and Contingencies 15%		25,700
	Sub – Total 5		***196,700***

Conclusions and recommendations

The following conclusions can been drawn from the above feasibility technical assessment of the status of water supply and sanitation services in Chirundu:

- The town planning structure for Chirundu Town is yet to be determined.
- The town has developed spatially, in the process creating numerous vacant lots and traditional land.
- The proposed water supply network will promote properly structured growth of the centre by creating a strong incentive to develop housing in existing vacant lots that are in proximity to water supply services.
- It is proposed that during detail design that LWSC develop drawings and layouts of the town's urban development and water and sewer networks. Once this is achieved, these drawings can be used to develop a hydraulic model of the network.
- The proposed water supply infrastructure will cater for growth within infill areas of the Town up to 2036.

In the medium term the following measures are recommended.

- Authorities should encourage the development of housing in existing infill areas that are covered by the network through densification, with spatial expansion of the housing area only occurring after all vacant lots have been filled, and even then preferably in fully planned areas.
- The Zambian Government authority responsible for urban and regional planning for the area should urgently develop an Integrated Development Plan (IDP) new housing areas. This will streamline the provision of water supply and sanitation services to cater for growth.
- The IDP for the growth of the border post should include a master plan for the provision of water supply and sanitation covering the planned development area.

Environmental Assessment

The following section provides a preliminary environmental assessment of the project and the expected impacts based on the proposed infrastructure described in the Technical Assessment.

The Surrounding Community

The surrounding community to the town is predominantly identified as a border town, with the sister town across the international border in Zimbabwe, known and called by the same name. The general development of the town is towards the north-east lying parallel to the Zambezi River. The northern and north-west areas comprise residential and service developments and further out are dotted peri urban settlements and agricultural fields as seen in **Figure 14**. These peri-urban settlements employ traditional methods of water supply and sanitation.

Figure 14 Chirundu Town Settlements and Main Roads

The Water Supply Infrastructure

This section briefly outlines the status of the conventional system that is currently in operation by the utility company for the supply of water to the consumers. A more detailed description is provided in **Annex B**.

Abstraction

The primary source of water in Chirundu is from the Zambezi River, where the LWSC abstracts water. The town of Chirundu abstracts 2,000 m³/d from the Zambezi River. The abstraction point is located about 300 m from the existing Water Treatment Plant (WTP) and just over 400 m south west of the upstream bridge as shown in **Figure 15**. There are no settlements within the vicinity of the abstraction point. The suction pump is mounted on a floating Intake pontoon, which requires refurbishment.

Figure 15 The location of the Floating pontoon Abstraction point

The water supply for the town has an alternative borehole supply from the 'Apollo' borehole and situated about 200 m south-west of the existing WTP. Due to the pump capacity, it is not pumped to the WTP for any treatment but is fed directly into the main distribution network.

Water Treatment System

The abstracted water is transmitted to the WTP about 25 m above the river level. The WTP comprises of the receiving reservoir, Treatment tank, Booster station and an Overhead tank. The abstracted water only receives drip-feed chlorination before being stabilized and pumped out into the distribution network. The chlorination is gravity operated and mounted atop the reservoir.

Storage Facilities

The current water supply system for Chirundu is provided with a number overhead tanks located at different places, e.g. the 80 m³ OHT at the WTP and the concrete OHT situated at Nyambadwe.

Water Supply and Distribution

The current water supply within the district has several challenges. Among others is the current pumping capacity, coupled with modest storage facilities that do not afford sustainability of supply whenever there is any eventuality such as interruption to power. The infrastructure is old in most sections and results into high

maintenance costs. The poor or non-existent supervision of citizens / residents building structures without the Council's Approval infringes on the distribution network. The distribution system is made up of pipes of various materials and various sizes. The approximate layout of the pipe network in Chirundu is shown in **Figure 5**.

The Sanitation Infrastructure

The district is currently faced with a challenge to provide sanitation services due to several factors. The principal one is the low financing meant for the establishment or maintenance of sanitation facilities. Associated to this is the low rate of payments for sanitation services by the consumers or residents. The nature of undulating topography for the town is unfavourable for gravity flow that favours establishment of the STP and the associated ponds.

Sewerage Reticulation system

The Chirundu town has a centralized sewerage system, which has never been completed or commissioned. Therefore, most of the residents within the high cost areas, offices and other such places employ on-site sanitation of septic tanks and soakaways. The initial investment required often times is the gap that discourages the majority of the residents to invest in these facilities.

The rest of the residents either use VIP toilets or pit latrines. A smaller number, those living further in the peri-urban area are reported to practice open defecation.

Sewerage Treatment Plant (STP)

As indicated Chirundu has a centralized Sewerage Treatment Plan (STP) with no reticulation system. The STP was never completed nor commissioned. Therefore no connections were made to the system.

The Biological and Geophysical Environment

The Physical Environment

Climate Conditions for Chirundu District

Generally, the Southern Province has typical Zambian climate that is described as sub-tropical although Chirundu town falls in the valley and has slightly higher temperatures and more humid conditions. There are three main seasons in this part of the country: **April to August** – cool and dry, with daytime temperatures of 20°C to 25°C and night-time temperatures as low as 4°C. **September to October/November** – hot and dry, with daytime temperatures rising to 40°C. **November/December to March** – warm and wet. When the rains come, the temperatures drop by several degrees, and the humidity rises. The Chirundu falls within Agro-Ecological Zone I which is characterised by rainfall of less than 800mm. The mean annual rainfall recorded at Chirundu station (12 km north) is 678 mm, and that at Kariba station (47 km south) is 767 mm.

According to the rainfall records at Chipepo meteorological station, annual rainfall can be as low as 350 mm in drier years and can also be as high 1200 mm (**Figure 16**). The average rainfall in the past 20 years has been 845 mm. The annual rainfall pattern is however consistent with the regional average of 800 mm or less.

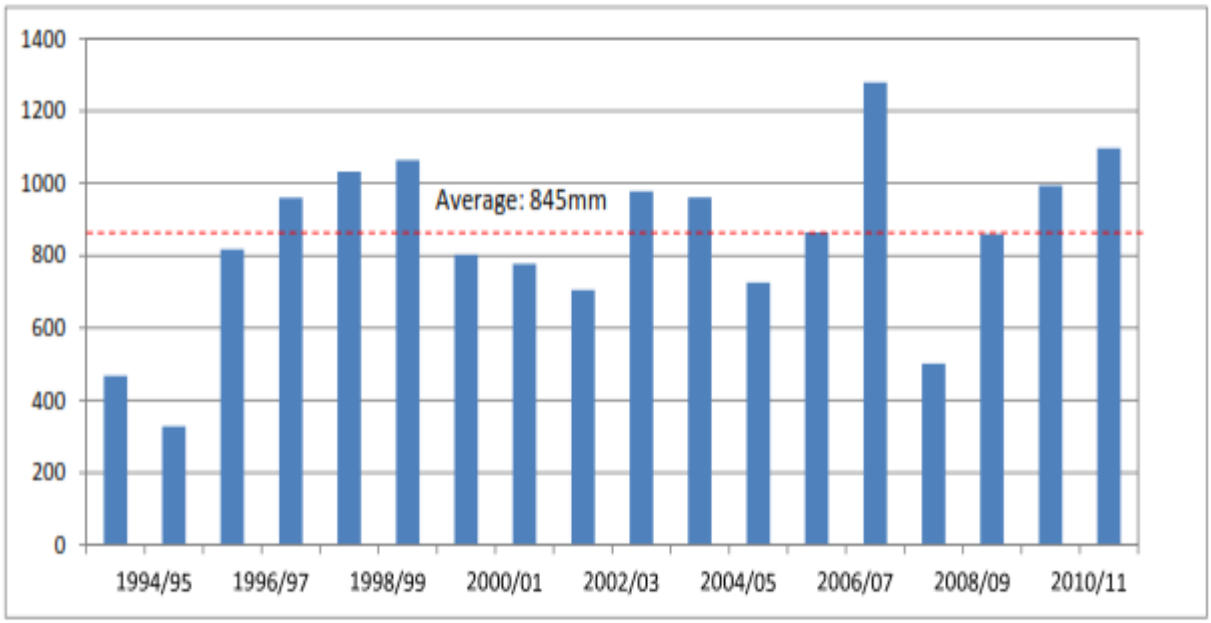

Figure 16 Annual precipitation for Chirundu District from 1994- 2010

Temperature

The mean monthly minimum temperatures recorded at Chirundu station range from 10.3 °**C** in July to 23.2 °**C** in October, and maximum ranges from 26.0 °**C** in July to 36.6 °**C** in October. It is a suitable area for frost-sensitive (sub) tropical crops like bananas, but the high evapo-transpiration levels (average 4.76mm/ day, 7.53 mm/day in October) mean that crop water requirements for crops are particularly high.

Hydrogeology and Geology

The project area lies entirely over the sedimentary rock formation which belongs to the Upper Karoo. According to the Geological map, the dominant rocks covering the Chirundu area are sandstones and inter-bedded mudstones and red sandstones. Most of the sandstones are calcareous and some contain pyritic concretions

The Chirundu area is covered by a moderately productive aquifer as shown in (**Figure 18**). The surrounding area has patches of unproductive aquifers to the south and south west. The surface hydrology for the area is characterised by the Zambezi River and the Kafue River, a major tributary. The minor tributaries are the Lusitu Mbendele, Mutulanganga and those from the Zimbabwean side (**Figure 17**).

Figure 17 The view of the Zambezi River as seen in Chirundu

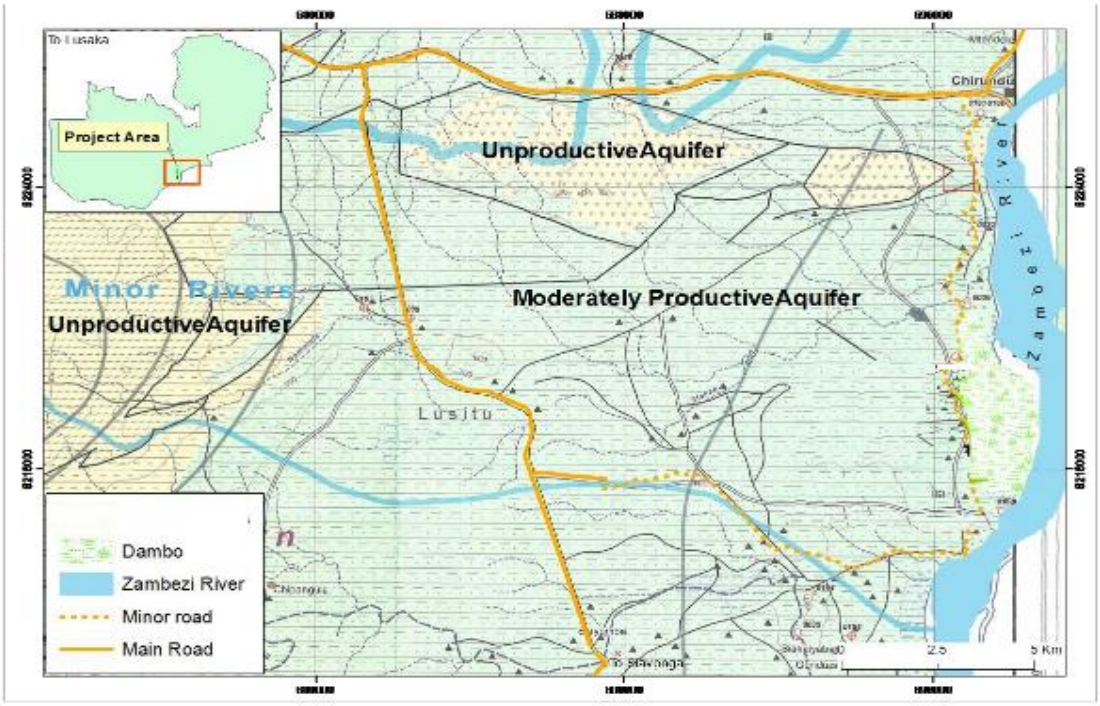

Figure 18 Hydrogeological map of Chirundu

Bio-Physical Environment

General Description of the vegetation

The land cover for the Chirundu area shows a heavily degraded character due to recent human usage (see **Figure 19**, where yellow: herbaceous savannah; Green: woodland savannah; White, light blue and red: bare land). The vegetation of Chirundu falls under Mopane vegetation, largely with Colophospermaum mopane as the dominant tree species. However, field surveys conducted in the area indicated that the area has mixed vegetation that included; riparian, open woodland with mixed tree species.

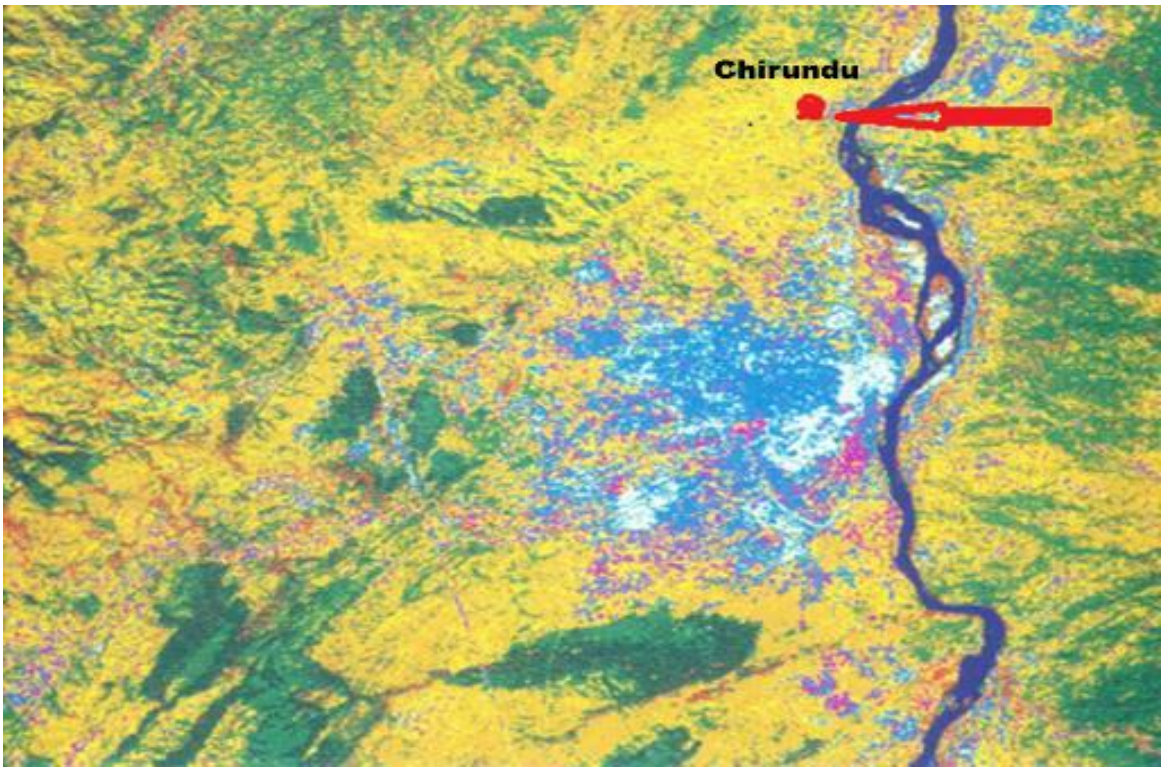

Figure 19 Chirundu Vegetation Cover

Riparian vegetation

Riparian vegetation was observed close to the banks of Zambezi River. The riparian band ranged between 3 m to 12 m with tree species that included; Diospyros sp, Tamarindus indica, Acacia nigrescens, Ficus niloticus, Lonchocarpasa capasa, Syzygium cordatum, Phoenix reclinata (Wild date palm), Hyphaene petersiana and some scattered Borassus aethiopum.

The river banks of the Zambezi River were found to be mostly lined with papyrus grass species with varying heights and densities depending on the a particular community. In certain instances continuous patches of highly hydrophilic grass species like Leptocchloa fusca (swamp grass, Echinochloa pyramidalis and Echinochloa colona were observed along the rivers banks. Also commonly observed was Arundinella nepalensis. Most areas of the riparian vegetation are currently under cultivation due to rich soils and availability of water.




Figure 20 The vegetation along the Zambezi River and near the abstraction

Open woodland

The open woodland in Chirundu area was observed to have scattered woody species arranged in two layers: old big scattered trees species mostly ranging from 4 – 8 m high and the shrubs constituting a different combination of plant species. Old tree species observed included Adansonia digitata, Accacia nigrescens, Lonchocarpus capassa, Acacia tortilis, Kigelia African, Kirkia accuminata, Sclerocarya caffra.

Figure 21 The Mungagane trees leaves and bark

Fauna

The data on Fauna was collected mostly by way of observations and verbal interviews with the locals during field visits to the project site. There is a substantial amount of wildlife in the area along the river, the team came across hippos and crocodiles which cross over from Zimbabwe. There is also an abundance of small wild life species such as the Grass cutters, squirrels and rodents.

Mammals

During the site visit we witnessed the presence and evidence of hippos along the Zambezi River Examples of small mammals found in the area are, Porcupines, Bush Babies, Squirrels, Rabbits, Rats, Bats spring hares, common Duiker, vervet Monkeys, chacma Baboons and the African civet. The locals people also noted that there are a lot of animals up north as you head to Chiawa (Game Management Area (GMA) and across the Zambezi on the Zimbabwean side.

Reptiles and amphibians

A wide variety of reptiles and amphibians occur within the area. Some examples of reptiles include: Crocodiles, Tortoises, Chameleons, Common Lizards, Monitor Lizards and Snakes such as Black Mambas, Pythons, Cobras and Vipers

Avi Fauna

The project area hosts common bird families such as; Doves, Pigeons, Owls, Nightjars, Swallows, Larks and Guinea Fowls (Nkanga). Other bird species in the area include Nkwale, Njiba, Sioma (weaver), Black Eagles, Vultures and Hawks. The greatest concentrations of birds are found in the riverine vegetation. **Table 22** provides a list of the common bird species found in the area.

Table 22 Common Bird species

No.	Bird Species	Scientific Name
1	African fish Eagle	Haliaeetus vocifer
2	Blue Waxbill	Uraeginthus angolensis
3	Common Bulbul	pycnonotus barbatus
4	Crowned Hornbill	Tockus alboterminatus
5	Little Bee-eater	Merops pusillus
6	Tropical Boubou	Laniarius aethioipicus
7	Tawny-flanked Prinia	Prinia subflava
8	Pied Crow	Corvus albbus
9	Red-eyed dove	Streptopelia semitorrquata
10	Paradise Flycatcher	Terpsiphone viridis

Figure 22 Paradise Flycatcher and bark Red-eyed dove

Figure 23 Tawny-flanked Prinia and Pied Crow

Figure 24 Little Bee-eater and Crowned Hornbill

Ecologically Important Areas

There are two wildlife areas close to the Chirundu area; the Zambezi Hunting area in Zimbabwe (just across the Zambezi River) and the Chiawa Game Management area on the Zambian side. Both areas are rich in wildlife species; elephant, warthog, buffalo, and hippopotamus are common. The two areas have been designated as hunting areas. The pressure from hunting wildlife causes animals to go in open areas where community settlements are found, which leads to frequent animal-human conflict.

The other protected area observed within the vicinity was Mutulanganga, Lusengazi and Ntobolole national forest.

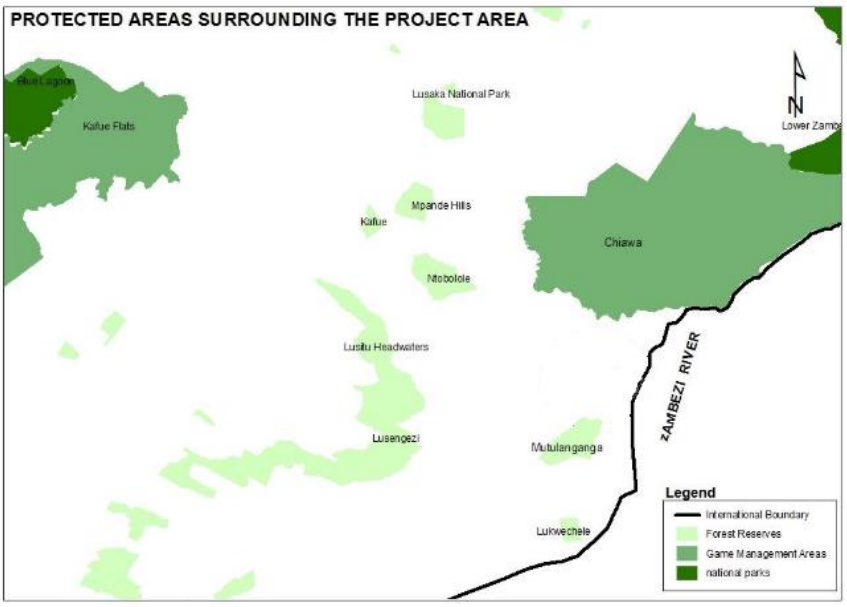

Figure 25 Location of Forests and National Game Parks

While the project is not a forestry based project, the utility company will be aware of the sensitivity or impact the proposed project may have on the nearby forested areas.

The forestry department is responsible for the conservation of National and local forests. The utilization of all the products from these conserved areas requires the authority of the department and the payment of the appropriate royalties. Their operation is enshrined by the Forest Act No.7 of 1999 CAP199 of the laws of Zambia, which repealed the act of 1973.

Active collaboration with the Forestry department will have to be pursued in order to achieve a holistic management of any potential impact arising from the implementation of the proposed project. This will be done in compliance to the Forest Act No.7 of 1999.

The Applicable Policy Framework and Legislation

Water Sector Policy and Reforms

The Water and Sanitation sectors in Zambia are implemented by several collaborative pieces within the legislative framework. These pieces of legislation are underpinned by two interrelated principal national policies (National Water Sector Policy and the Environmental Policy). The policies provide the foundations for the establishment of the associated regulatory authorities or agencies that provide overall oversight within the sector.

Zambia has for more than two decades implemented several water sector reforms to ensure economic and sustainable development. In 1994, the reforms resulted into Water Sector Policy. The Water sector policy was further subdivided into two main sections. The first one provides guidance in Water Supply and Sanitation, while the other one deals with countrywide Water Resources Management. This incorporates guidance on the interaction of the different subsectors vis-à-vis shared international waters resources.

These two policies have given rise to several associated legislation that provides for the establishment of the associated regulatory authorities, their oversight powers and the statutory instruments or guidelines for the implementation and operation of the various projects and entities in the related subsectors.

A developer of any water treatment and or sewerage 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.

The National Water Policy (2010), provides for 14 subsectors that include Water Resources Management, Water Resources Development, Water for Food and Agriculture, Water for Fisheries, Water for Tourism, Water Supply and Sanitation, Water for Wildlife, Water for Mining and Water for Industry. The others are Water for Environment, Water for Energy, Water and Land, Water for National Heritage and Water for Transportation. Two of these - Water Resources Management and Development and Water Supply and Sanitation are discussed in relation to this study.

Water Supply and Sanitation

The policy statement seeks to promote sustainable water resources management and development with a view to facilitate an equitable provision of adequate quantity and quality of water for water supply and sanitation in a timely manner.

The policy provides for the legal framework that establishes the National Water and Sanitation Council (NWASCO) that oversees the operation of the 11 Water Utilities and 6 Private schemes.

Water Resources Management & Development

The aspect on water resources management provides comprehensive framework for management of the water resources that takes into account catchment management of water resources, stakeholder consultation and involvement, assessment, monitoring, water conservation and preservation of its acceptable quality and quantity, efficient and equitable water allocation to all users and disaster preparedness. Among others, its main objective is to ensure inter-sectoral linkages in the management of the water resources so as to support cross-sectoral development needs and maximise the economic benefits accruing there to. The aspect on development seeks to achieve sustainable water resource development with a view to facilitate an equitable provision of adequate, quantity and quality of water for all competing groups of users at reasonable costs and ensuring security of supply under varying conditions. Among others, its main objective is to ensure that Zambia's water resources are developed to contribute to wealth creation through improved access to water, increased food production and food security for all Zambians.

The policy provides for the legal framework that establishes the Water Resources and Management Authority (WARMA) that oversees the identification, abstraction and use of the widespread water resources. The government oversees water resources development and management in Zambia through the Ministry of Energy and Water Development (MEWD), while the operations of the various water utilities spread over the country are supervised through the Ministry of Local Government and Housing (MLGH), whose various city and district councils are shareholders in the utility companies. The Chirundu Water Supply and Sanitation is under the water utility of the Lusaka Water and Sewerage Company (LWSC).

The Zambia Environmental Policy

The National Policy on Environment, 2009 was developed to safeguard the environment and to ensure the sustainable use of natural resources. The main purpose of the policy is:

"To create an umbrella policy for the welfare of the nation's environment so that socio-economic development will be achieved effectively without damaging the integrity of the environment or its resources".

The Policy expects to achieve increased economic growth that is not damaging to the environment and natural resources. Like its predecessor de facto 'policy' the National Environmental Action Plan (NEAP), the NPE is also founded on three fundamental principles. These are:

- The right of citizens to a clean and healthy environment;
- Local community and private sector participation in natural resources management; and

- Obligatory Environmental Impact Assessments (EIAs) for major project undertakings in all sectors of the economy.

This policy provides the basis for the management of environmental protection and pollution control. It also provided the basis for the legal framework that gave rise to the previous Environmental Protection and Pollution Control Act of 1997 and its various Statutory Instruments and the established the regulatory authority for the environment known as the Environmental Council of Zambia (ECZ). A further amendment to the Act resulted into its being repealed and replaced by the Environmental Management Act No. 11 of 2012 and the transformation of ECZ into the Zambia Environmental Management Agency (ZEMA). The Ministry of Lands, Environment and Natural Resources (MELNR) is the principal ministry that oversees the implementation of this policy through the ZEMA.

The Institutional and Regulatory Framework

The aforementioned policies provide the basis for the legislative and regulatory framework that has created the various institutions that provide oversight related to Water Supply and Sanitation and the environmental management.

Water Resources Management Authority (WARMA)

The Water Resources Management Authority was established to execute functions related the management, development, conservation, protection and preservation of water resource and its ecosystems. The Authority also monitors the sustainable utilization of the water resource and issues the right to draw or take water for domestic and non-commercial purposes. LWSC will therefore abstract water under license and specifications obtained from the WARMA.

National Water Supply and Sanitation Council (NWASCO)

The National Water Supply and Sanitation Council (NWASCO) is a statutory body established by the Water Supply and Sanitation Act Number 28 of 1997 to regulate water supply and sanitation service provision in Zambia.

In order to regulate the provision of water supply and sanitation services for efficiency and sustainability, its core functions are to:

- License providers;
- Advise the Government on water supply and sanitation matters;
- Establish and enforce sector standards and guidelines;
- Advise providers on procedures for handling complaints from consumers; and
- Disseminate information to consumers on water supply and sanitation issues.

In its pursuit to discharge these functions, the Council is guided by the following values.

- *Accountability* - to all stakeholders on our mandate
- *Legitimacy* - in operating within the confines of the law

- Transparency - work shall be executed in an objective and transparent manner in all regulatory functions while maintaining predictability, fairness and confidentiality.
- *Integrity and Professionalism* - in discharging responsibilities. We shall not allow bias, conflict of interest or the influence of others to override our professional judgment.

According to the Water Sector and Sanitation Report of 2015, the Council is currently overseeing 11 Commercial Utilities (CUs) and 6 Private schemes (Lafarge Cement, Kaleya Small Holders, ZESCO, Zambia Sugar Plc, KCM – Nampundwe, and Kafue Sugar Private Scheme). The CU's are shown in **Table 23**.

Table 23 Commercial Utilities in Zambia, 2015

No	Commercial Utility (CU)	Abbreviation	Commencement of Operations	No. of Towns/ Centres Serviced	Total Population in Service Area	No. of Connections	No. of Staff
1.	**Lusaka WSC**	LWSC	1989	**6**	2,246,825	94,184	889
2.	**Nkana WSC**	NWSC	2000	**3**	753,782	58,701	600
3.	**Kafubu WSC**	KWSC	2000	**3**	690,530	60,462	655
4.	**Mulonga WSC**	MWSC	2000	**3**	489,160	51,429	405
5.	**Lukanga WSC**	LGWSC	2006	**8**	419,081	23,550	237
6.	**Southern WSC**	SWSC	2000	**21**	396,335	45,626	412
7.	**Chambeshi WSC**	CHWSC	2003	**12**	331,308	19,294	255
8.	**North Western WSC**	NWWSC	2000	**8**	255,979	12,968	133
9.	**Eastern WSC**	EWSC	2009	**10**	276,840	17,301	146
10.	**Western WSC**	WWSC	2000	**10**	204,185	12,314	124
11.	**Luapula WSC**	LPWSC	2009	**7**	206,400	5,899	77

Zambia Environmental Management Agency (ZEMA)

The primary environmental law in Zambia is the Environmental Management Act No. 12 of 2011 (EMA). Since 1990, it originally existed as the Environmental Protection and Pollution Control Act, No. 12 of 1990 (EPPCA). It has since been repealed and replaced with the EMA. It is a superior piece of legislation for Environmental Management and regulation, and provides for the right to a clean, safe and healthy environment in Zambia. It provides for the establishment of the Zambia Environmental Management Agency (ZEMA), as a direct replacement of the former Environmental Council of Zambia (ECZ). This is the main body which implements and enforces the provisions of the law that deal with prohibition of pollution of air, land and water and protection of the environment. It further provides for the Environmental Inspectorate that conducts the whole scope of

Environmental Management i.e. environmental guidance, stakeholder interaction and feedback, projects inspection, regulation and monitoring.

The other sections of the law provide for the mandate for the ZEMA to maintain an environmental database and register with relevant information and conduct environmental awareness. The law also provides for the right for members of the public to participate in decision making in environmental matters through Public meeting participation, Reviews, hearings and a right to initiate review, appeal and litigation. The establishment of the Environmental Fund, its administration and application has been made possible through the enactment of this legislation. The ZEMA also acts as a secretariat for the Board (an independent authorising body comprising of various stakeholders, and responsible for final mandates.). As a secretariat, it provides the Licensing for the various permits and licences. This proposed project will seek the active approval of the Board through the ZEMA by way of conducting an Environmental Impact Assessment which one of the requirements for approval. The other sections and Statutory Instruments of the Act provide for regulations as they relate to Water, Air and Noise Pollution and management.

As part of the compliance to this legislation, this project will seek the active approval of the Zambia Environmental Management Agency, of which this Feasibility study report is the foundation for the affording the environmental impact assessment due to the proposed rehabilitation activities in Chirundu. The resultant impact's report will be submitted to ZEMA for review and compliance decision. Compliance to the other regulations as they relate to Water, Air and Noise.

The Chirundu District Council (CDC)

The district council is the body mandated to regulate and grant development permits for the district as part of the delegated planning responsibility of central government through the local authority. It is the administrative and implementation arm of the Local government for the district.

Meanwhile, like all local government agencies and departments, the Local Government Act, Cap 22 of 1991 (amended), established the council. Its principal function through the Department of District Planning is to effectively take care of physical planning matters of the district.

Additionally, the department ensures that planning permission is granted for all developmental activities in the district in accordance with the provisions of the Town and Country Planning Act, Cap 283 of the Laws of Zambia. The Works department oversees all infrastructure development for the council and in conjunction with LWSC will be responsible for the rehabilitation works for the Water Supply. As a body corporate and exercising its delegated authority from the central government through the Ministry of Local Government and Housing, the Chirundu Council is a shareholder in the LWSC Company.

The Regulatory and Legislative Framework

The following Acts provide the legislative framework within which the water supply and sanitation sector is operated.

The Water Resources Management Act, 2011

The Act provides for the control, ownership and use of all water resources in the country. The Act establishes the Water Resources Management Board and regulates the use of public water including protection against pollution. It also outlines 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 provides for the functions and composition of catchment councils, sub-catchment councils and water users associations. It also provides 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 Chirundu 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. Chirundu town is partly bordered by the international boundary with Zimbabwe, a member of SADC. As part of the compliance to this Act no permit will be necessary as the Zambezi river source is a shared water course and the abstracted water is for local consumption.

The Water Supply and Sanitation Act Number 28 of 1997

This act establishes the National Water Supply and Sanitation Council (NWASCO), a statutory regulatory body. Its principal objective through NWASCO is to regulate water supply and sanitation service provision in Zambia. 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 Chirundu that service more than 500 people.

The 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 Water Supply and Sanitation sector. The Department of Infrastructure and Support Services also assists in the mobilization and co-ordination of financial resources for infrastructure development by WSS providers.

Environmental Management Act and Licensing Regulations

This is the Principal Act on environmental management. That came into effect in 2011 and repeals and replaces the EPPCA Cap 240 of 1990. It provides for the whole spectrum of environmental management including protection, control of pollution and monitoring. Under the acts umbrella, various Statutory Instruments and Regulations are produced that address various project components. These are broadly outlined in its various Regulations contained in the Statutory Instrument No. 112 of 2013. These sections are listed below.

The Environmental Impact Assessment (EIA), Regulations, S.I No.28 of 1997

The Environmental Impact Assessment (EIA) Regulations, Statutory Instrument 28 of 1997, requires that an Environmental Impact Assessment is conducted before the implementation of projects that are deemed to have major potential negative impacts. This is done to facilitate the identification of possible mitigation and monitoring measures well in advance during the initial planning stages. This is done in conjunction with all the *Interested and Affected Parties* (IAP's) with the oversight of the ZEMA. The impact identification, proposed mitigation and monitoring plans are thereafter compiled and submitted to the ZEMA for review as either the Environmental Project Brief (EPB), for smaller impact projects or Environmental Impact Statement for larger impact projects. The Agency is also empowered to review Strategic Environmental Assessment (SEA) reports A Decision is made after consideration by the Council. The proposed water supply rehabilitation works will have to comply with the stipulations under this legislation according to the guidance related to the scope of works.

Environmental Management (Licensing) Regulations, S.I No.112 of 2013, PART II - Air Pollution Control

This SI provides for statutory discharge limits for the respective emission parameters and other pollutants into the atmosphere in order to safeguard the general health, safety or welfare of persons, animal or plant life. This includes property for the affected workers, industrial or business activities undertaken by a developer. The regulations provide for licensing of gaseous waste emission to the environment. The project is not anticipated to have air emissions other than vehicular fumes during the construction and operation period which will be minimal. Further guidance from ZEMA will indicate if the proposed project will require a permit or licence related to this regulation.

Environmental Management (Licensing) Regulations, 2013, PART II - Water Pollution Control

These regulations provide for the licensing of liquid waste discharge to the environment and also provides for statutory discharge limits for respective effluent parameters. They also provide for the installation of appropriate pre-treatment facilities and ensuring that the discharged effluent conforms to the conditions and standards for chemical, biological and physical parameters contained in the table of standards for effluent and waste water, set out in the Third Schedule of the regulations. This project will fully comply to this regulation as it only be dealing with the treatment and supply of raw water.

Environmental Management (Licensing) Regulations, 2013 PART III - Waste Management License

This regulation provides for licensing of solid non-hazardous waste transportation and operating or owning of a non- hazardous waste disposal site. There shall be no production of hazardous waste from the planned project components requiring transportation. It is thus expected that the project may not be *entirely be subject to this regulation for compliance.*

Environmental Management (Licensing) Regulations, 2013, PART IV - Hazardous Waste Management

These regulations provides for licensing of solid hazardous waste transportation and operating or owning of a hazardous waste disposal site. They also reinforce the EMA in the management of the wider spectrum of hazardous waste. This includes the control and monitoring of the generation, collection, storage and

transportation. The pre-treatment, treatment, disposal, export, and import over trans-boundaries are also covered under these provisions. This project will not be dealing in hazardous waste and thus may not be have to comply with this provision.

The Local Government Act, Ca0 282, 1991

This Act provides for the establishment of the local Councils and their functions. Some of these relate to pollution control and protection of the environment. The relevance of this ACT is that it allows for supervision of the local councils by the Central Government vis-à-vis city planning and pollution management and the implementation of infrastructure projects like Water Supply and Sanitation projects. The LWSC will comply with this Act through its close collaboration with the MLGH at the ministerial level and the Chirundu District Council for the actual implementation of the proposed water rehabilitation works. This constant liaison with the council has established its willingness and acceptance to the implementation of the project.

Public Health Act Cap 295 of 1978

This Act provides for prevention and suppression of public health hazards. It regulates all matters and activities that are connected to outbreak of diseases and pollution of drinking water sources and storage facilities. It ensures that these facilities are protected from harm that can harm human beings.
The Act also requires that councils fumigate households under their jurisdiction to control malaria by killing the mosquitoes in ponded or riverine areas. Councils implement provisions of the Act through licensing and inspections. Wherever human activities take place, issues of public health are critical. Environmental aspects of the project that shall require adherence to the Act include provision of waste management facilities, sanitation facilities, food, shelter for eating, drinking water storage and food storage facilities. The project proponent shall ensure that all issues of public health are understood, implemented and sustained during the rehabilitation works. The LWSC will have to obtain health permits related to water supply within the district

The Occupational Health and Safety Act (No. 36 of 2010)

This Act is enforced by the Occupational Health and Safety Institute, and provide for the health, safety and welfare of persons at work. The Act also defines duties of manufacturers, importers and suppliers of articles, devices, items and substances for use at work in relation to health and safety. It also imposes the responsibility of protecting persons, other than persons at work, against risks to health or safety arising from the employer's operations. It provides general guiding principles for occupational health and safety. The rehabilitation works will have to be managed in compliance with the Act and LWSC will have to put in place measures to ensure the safety and protection of both workers and the general public.

Disaster Mitigation and Management Act

The Disaster Management and Mitigation Unit (DMMU) is vested in the Office of the Vice President and was created in 1994. The following are the objectives of DMMU:

- To put in place appropriate preparedness measures in order to manage disasters effectively and efficiently
- To activate response mechanism for effective and timely search and rescue operations in order to save life and reduce damage to property.
- To put in place measures to restore livelihoods and other life support systems to affected communities.
- To mitigate the disruptive and destructive effects of hazards and all disasters in order to reduce their impact on vulnerable communities, assets and the environment
- To put in place preventive measures in order to reduce the negative effect of hazards and strengthen the national capacity for disaster management in order to avoid the adverse impact of hazards.
- To effectively co-ordinate disaster management activities through a body of procedures and practices in order to avoid duplication of efforts and resources at all levels.

The district of Chirundu is in the belt that is prone to both natural and man-made disasters. The company (LWSC) will coordinate with the unit in case of any such occurrence that may impact on the Water Supply Infrastructure including the proposed rehabilitation works.

The National Heritage Conservation Commission Act

This Act establishes the National Heritage Conservation Commission (NHCC), which is responsible for the conservation of ancient, cultural and natural heritage, relics and objects of aesthetic, historical, prehistoric, archaeological or scientific interest by preservation, restoration, rehabilitation, reconstruction, adaptive use and good management. The Commission also provides regulations for archaeological excavation and export of relics. If a development is unable to proceed without affecting an item of heritage, permission must be sought from the NHCC as outlined in Sections 35 and 36 of the Act.

This Act is relevant to the project in that the activities of the project will involve excavation which may in the process lead to the discovery of artefacts or objects of archaeological significance. These will need to be reported to the National Heritage and Conservation Commission (NHCC), the statutory regulatory body that oversees all matters related to the heritage conservation. Chirundu town is in the vicinity (20 km) of one such heritage area known as ‘In’gombe Ilede’.

It is an Iron Age prehistoric site on the highest point of a ridge of the same name, on the left bank of the Lusitu River, a tributary of the Zambezi River in southern Zambia. In the local Tonga language the name means “the place where the cow sleeps or lies down.

The International Conventions and Treaties

The regulatory framework within which this project falls is also governed by international treaties and conventions to which the country of Zambia is a signatory party or has acceded. Some of these are outlined below.

Convention on Biological Diversity (CBD)

This convention identifies the responsibility of states to conserve their biological diversity and use their biological resources sustainably. The convention has become an important framework for conservation related activities on the regional and international level. It requires that the contracting parties anticipate, prevent and address the causes of reduction or loss of biological diversity. To achieve this, the parties are required to among others:

- Establish a system of protected areas where special measures are taken to conserve biological diversity.
- Develop guidelines for the selection, establishment and management of protected areas.
- Regulate or manage biological diversity within the protected areas with a view to ensure sustainability.
- Promote the protection of ecosystem, natural habitats and maintenance of viable populations of species.
- Promote environmentally sound and sustainable development in areas adjacent to protected areas.
- Rehabilitate and restore degraded ecosystems and promote the recovery of threatened species, inter alia, through the development and implementation of action plans or other management strategies.
- Prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species.

Zambia ratified the CBD in May 1993, and as part of the compliance highlighting the relevance of this convention, the proponent shall strive to implement the proposed project within this framework, especially as it relates to the trans-frontier boundary for protected species.

The World Heritage Convention

This is also known as the Convention concerning the Protection of the World Cultural and Natural Heritage. It aims to protect areas of outstanding global cultural or natural value. The following are considered natural sites:

- Natural features consisting of physical and biological formations which are of outstanding universal value, aesthetic or scientific.
- Geographical and physiographical formations and precisely delineated areas which constitute the habitat of threatened species of animals and plants of universal value from the point of science or conservation.
- Natural sites or precisely delineated areas of outstanding universal value from the point of view of science, conservation or natural beauty.

These guidelines are there to enable the convention achieve its primary objective of the protection of habitats and ecosystems rather than the species. To achieve its objectives, developers are required to integrate heritage protection into comprehensive planning programmes, set up services for heritage protection, and develop scientific, technical, administrative and financial measures necessary for the identification, protection, conservation and protection. Zambia ratified the convention in June 1984 and the Victoria Falls is the only site to have been declared a World Heritage Site.

The relevance of this convention is appreciated as the proponent shall take cognizance of the presence of any site within the project area and avoid encroachment or any actions that may subtract from this establishment, though it not itself a selected heritage site.

Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES)

This convention aims to protect threatened species from the detrimental effects of international trade. Over 150 species have been identified due to their status as being threatened by extinction, are not allowed to be traded commercially, while another 150 species are only allowed to enter the international trade under specific controlled circumstances. Many threatened African species are covered and include all Raptors, Owls and Parrots. Zambia ratified and contracting party status entered into force in August 1981. The proposed project has as one its sites a local forest.

Compliance to this convention has been through investigating the presence of any endangered, threatened or endemic species. None of these were identified within or near the vicinity of the site.

United Convention to Combat Desertification in those Countries Experiencing Serious Drought and /or Desertification, particularly in Africa (UNCCD)

This convention aims to combat desertification and mitigate the effects of drought. Desertification is defined as land degradation in arid, semi-arid and sub-humid areas, resulting from factors such as climatic variations and human activities. The main tools are regional and national action programmes.

Article 8 of the regional implementation Annex for Africa demands the National Action Programmes to include measures to conserve Natural Resources by ensuring Integrated and Sustainable Management of natural resources, and training with regard to public awareness and environmental education campaigns.

The relevance of this convention is that Zambia ratified this convention as a member of the UN system, Adherence shall be through close collaboration by the proponents with the Ministries of Lands and Environmental Protection and Agriculture to ensure an effective implementation of the proposed project.

United Nations Framework Convention on Climate Change (UNFCCC)

This is one of the most widely accepted global conventions. Its ultimate objective is to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system. It is anticipated that such levels should be achieved within an agreed time frame to allow ecosystems to adapt naturally to climate change. The Kyoto Protocol contains the individual emissions limitations and reductions commitments for a range of developed -country parties.

Though, the convention has widespread acceptability, agreement on cap emission values has been virtually impossible as evidenced by the inconclusive Copenhagen and Doha Conferences on Climate Change in 2010 and 2012 respectively. The dispute was caused by a general lack of agreement between the developed and developing countries on the same cap values. The 2015 Paris Conference made some substantial progress, with the United States and China (major producers of Green House Gases (GHG), that contribute to Global Warming Potential (GWP) and Global Warming (GW)) agreeing that they will ratify and implement the provisions of the conference. Nevertheless, Zambia ratified the convention in May 1993 and signed The Kyoto Protocol in August 1998. Meanwhile, the new climate treaty was signed in the United States of America and

Zambia is one of the signatories to it, to ensure it implements the international guidelines that seek to implement sustainable climate resilient projects.

The relevance of this convention is that it provides a framework within which this project implementation may be undertaken as respects the compliance to climate change issues. The proposed project is being implemented to facilitate resilience of communities in light of climate change.

Identification of Potential Environmental and Social Impacts

The potential impacts, positive and negative, were evaluated for the project.

The Positive Impacts on the social-economic and cultural environment

Enhanced Economic Development

The rehabilitation of the water treatment plant in Chirundu will invariably result into improved water supply to newly created and rapidly growing district of Chirundu. The water supply will be supplied to both residential and industrial areas thereby enhancing economic and industrial development.

Increased Employment Opportunity

The rehabilitation will create increased opportunities for employment for the local residents and other qualified staff from its operations. There will be a more than 200 persons at the site during the construction of the civil works and installations. There will be a multiplier effects shall be created for the material suppliers, equipment and tank providers and other construction materials.

Improved Welfare of the Local Population

The proposed project shall provide an economic avenue for the local people. The resources obtained from the employment opportunity will not only enable the households to weather the difficult times but also increase the amount of disposable income into other sectors of the economy. This will ultimately uplift the welfare of the general local population

Increased Government Revenue

This project will result into more avenues for revenue collection by the Government of the Republic Zambia by increasing number of people accessing and paying for the water.

Impacts on Welfare of Women (Gender)

Water collection, storage, and treatment are predominantly perceived as women's roles across all income levels. In addition to physical stress, the mental anxiety due to unreliable water supply, and the pressure to manage their basic needs falls disproportionately on women. This project will ensure that it improves the welfare of women.

Impacts on Health

The project will have a massive positive impact on the health of the population by increasing the amount of people who are able to access clean and reliable portable water. This in essence reduces the amount of diarrhoea diseases thereby improving the health of the people.

The Negative Impacts on the social - economic and cultural environment

Impacts on Health and Safety

During the rehabilitation activities that shall be undertaken on site during the project construction and operation there is a possibility of accidents happening on site which may result in loss of limb or unfortunately life. The non-availability or proper use of personal protective equipment further compounds this risk and may expose workers to chest inhalations that may be damaging to their health.

Impacts on the Health (HIV /AIDS)

It is anticipated that the rehabilitation project will be affected by the prevailing HIV/AIDS epidemic in Zambia. The estimates are that urban areas are typified by higher HIV prevalence (20 percent) than rural areas (10 percent). Coupled with higher illiteracy levels and poverty, the rate is anticipated to increase. According to the National Aids Council / United Nations AIDS - Zambia country report for 2012, under its epidemiological synthesis of the epidemic, it was estimated that most of the new infections among adults were in individuals whose partners had casual heterosexual sex (37 per cent), followed by individuals reporting casual heterosexual sex (34 per cent), those reporting low risk heterosexual sex i.e. mutual monogamy (21 per cent), and clients of female sex workers (4 per cent). One per cent of new infections were estimated to occur in sex between men through unprotected anal sex and 3 per cent from other causes. The project will provide employment during the construction and operation phase as skilled and unskilled. Short term relationship between men employed to rehabilitate the treatment plant and women in nearby communities may result in an increase in STIs and HIV/AIDS in the area. This situation will be compounded by Chirundu being a border town with slightly higher STIs and HIV/AIDS incidence rates.

Social and Cultural Settlement Impact

It is anticipated that the project will bring about an influx of people from outside the project area in search of jobs. The Contractor is also expected to come with a team of skilled personnel for various specialized tasks during the entire construction phase.

Experience derived from past projects, shows that most of the construction workers leave their spouses in their respective places of residence as it is assumed to be burdensome. Arising from this, some workers develop the tendency of getting women from the areas where they have camped.

This could create conflict between the villagers and the construction workers, which could even culminate into social strife leading to delays in work schedules. The influx of people into the project area may breed social problems such as theft, prostitution and drug abuse. This impact will be localized, have a short duration expected to be related to the duration of the construction.

Health facilities

The mild increase in the local population due to the proposed project will create some pressure on the existing health facilities in the local areas. With the increase of people in the areas it can be expected that the workers would have to use the local health facilities. The severity of this impact is localized.

The Negative Impacts on the bio physical environment

Impacts on Flora and Fauna

The risk of adverse impact on flora and fauna will be minimal as the rehabilitation will be of the existing network and infrastructure. As described in the section for biophysical assessment, local flora exists in interspersed sections and small sized fauna and birds exists, there is also the presence of hippos and crocodiles along the river where the abstraction points are located. There are no protected or vulnerable species.

Air Pollution during construction

Construction unavoidably creates dust during the course of site works due to material and vehicle movement and construction activities. Fine particles may also be lifted from exposed surfaces by the action of wind, although the extent and nature of the generated dusts is dependent upon the materials to be used. Dusts, particularly finer particulates, can present respiratory problems when inhaled, as well as potential allergic reactions. In addition, dusts can cause nuisance problems when redeposited. It established that no air quality monitoring data is available for the area however, given the absence of any significant industrial and commercial processes to be implemented, it is considered that the air quality will be minimally impacted.

Noise and Vibration during construction

Noise can have a significant effect on the environment and on the quality of life enjoyed by individuals and communities. The perception of noise may be reflected by many factors (acoustic and non-acoustic) but in general the impact in response to a noise depends on the level of noise, the margin by which it exceeds the background level, its spectral character and temporal variation.

Other factors may also be important including time of day, day of the week, duration and other acoustic features. Vibrations, even very low magnitude, may be perceptible to people and can interfere with the satisfactory conduct of certain activities. Noise will be generated during the construction works by both the use of machinery, movement of materials and the movement of vehicles, and could cause a nuisance to local residents.

Impacts due to Solid Waste

Generation of waste materials during site preparation and installation of tanks and pipes could lead to pollution of surrounding environment. Throughout construction, the workforce will generate general refuse comprising food scraps, waste paper, empty containers etc. The storage, handling and disposal of general refuse have the

potential to give rise to some environmental impacts if not properly managed. These include odour if waste is not collected frequently, windblown litter, water quality impacts if waste enters water bodies, and visual impact.

Rapid and effective collection of site wastes will therefore be required. With the implementation of good site practices and the recommended mitigation measures on disposal arrangements, adverse environmental impacts are not expected to arise during the construction works.

Pollution of Surface water

A number of activities associated with the rehabilitation of the water reticulation system plant will generate pollutants that may contaminate surface water resources. These include:

- Sediment and other pollutant loaded run off from the surrounding area.
- Sediments and run-off from loosened soil on land clearing
- Sediment loaded run-off from earthworks during construction

It is important to put in place management structure because if unchecked the severity of this impact is high and tends to have a wide spatial extent due to the stream or channel flow and direction.

Water and Sanitation

The project will likely create demand for water and sanitation facilities in Chirundu. This will be as a result of the mild increase in the population during the construction phase. It is envisaged that appropriate and adequate sanitary facilities like pit latrines and places to bath shall be constructed for the workers to address the situation. Domestic waste generated at the camps for workers could adversely affect the sanitation in the area. Domestic waste such as leftover foodstuffs and human waste could pollute the environment if not well managed.

Mitigation for Negative Impacts

Table 24 provides mitigation actions and approaches for the identified negative impacts.

Table 24 Mitigation of Negative Impacts

No.	Activity/Impact	Mitigating Actions and Approaches
1.	Spills or leaks of fuels, lubricants or chemicals from machinery and vehicles may **contaminate groundwater**	• Spill control measures will be implemented to prevent spills from infiltrating into the groundwater table. The Measures will include appropriate materials handling and storage procedures, and • development of contingency plans in the event of a spill
2.	**Noise pollution** during construction	• All machinery and vehicles will be operated efficiently and according to the manufacturers

No.	Activity/Impact	Mitigating Actions and Approaches
		• specifications, by trained and qualified operator • The activities likely to cause adverse noise impacts will be timed to have least impact on • surrounding land users and other site activities (such as the schools and the hospitals) • Make sure all personnel are issued with hearing protection and are advised of its proper use • Consultation of earthwork hours with affected residents and nearby sensitive receivers
3.	Inadequate storage and management of litter, **construction waste and liquid wastes** prior to disposal	• Waste management measures will be implemented to prevent litter and debris and liquid wastes from entering soil excavations
4.	**Effluent** from construction workers' temporary amenities leaching into groundwater, carrying nutrients and micro-organisms	• Provision of temporary amenities for workers were appropriate. • The existing sanitary facilities on the WTP will be availed to the construction staff during the construction period.
5.	**Contamination of the storm water** from litter and construction wastes	• Waste control measures will be implemented to prevent litter and construction waste from • infiltrating into the groundwater table • Provision of suitable workers' amenities facilities. If possible, effluent should be disposed of off-site at nearby STP
6.	**Odour** generated from sewer of worker's amenities	• Provision of suitable workers' amenities, located within the construction area and, if possible, downwind from residential areas
7.	**Traffic congestion**	• The construction management team shall install warning signs and specified speed limits (site roads will reduce traffic speeds to 20 km/h) areas • The construction activity shall be timed, such as restricting construction traffic to designated roads during designated times, avoiding peak hour traffic

No.	Activity/Impact	Mitigating Actions and Approaches
8.	**Exhaust and Dust emissions** generated from earthworks due to loading and unloading of materials on site and from uncovered truckload in addition to the potential dust emissions that could occur as a result of excavation for the water supply network	• The height of the slope of stockpiles shall be minimised to ensure erosion of unconsolidated • materials during rainfall events does not occur • Dusty vehicle loads transported to, from and within the Project site will be covered by sheets and should not be overloaded • The use of water sprays to decrease dust generation will be undertaken • Regular maintenance and inspection programs will be implemented • Proper and efficient operation of construction machinery and vehicles by qualified workers • Regular maintenance and inspection program for all vehicles
9.	Inadequate storage and management of litter, **construction waste and liquid wastes** prior to disposal	• Waste management measures will be implemented to prevent litter and debris and liquid wastes from entering soil excavations
10.	**Effluent** from construction workers' temporary amenities leaching into ground water organisms	• Provision of temporary amenities for workers were appropriate.
11.	Potential **Public Safety Concerns** associated with the excavation works for the installation of the water supply network	• The area surrounding the excavations will be fenced off or otherwise restricted from public access to prevent injury or accident due to entry onto a construction site

Impact Assessment Matrix

Definition and criteria of the Impacts Significance

In this assessment we made use of qualitative risk assessment whereby the impacts are rated as 'low', 'medium' or 'high' according to two parameters – the severity of the impact (Consequence) and the likelihood of its occurrence. The severity depends on the nature and size of the activity/aspect and the environmental and social sensitivity/value of resources/receptors, while the likelihood depends upon the nature of the activity/aspect and the control/mitigation measures in place.

Evaluation criteria of the Impacts Significance

Nature of the Impact

This is an appraisal of the type of effect the proposed activity would have on the affected environmental component. Its description includes what is being affected and in what way. This includes both the positive and negative.

- **Direct Impact -** This is an impact that appears immediately as a result of an activity of the project. For example, the loss of ecological habitat is a direct impact. The direct impacts would be experienced mainly during the site preparation and clearing, and include effects on the physical environment, health and safety of the workers during the operation phase.
- **Indirect Impact -** This is an impact that is related to the project but it's of secondary nature and presents itself in an indirect way. The indirect impacts are primarily socio-economic and extend beyond the project implementation. Unlike the direct impacts, which occur in the immediate environment, the indirect impacts would be felt in the adjacent regions.

Spatial Extent

The physical and spatial size of the impact. It is a description of whether the impact would occur on a scale described as follows:

- **Site -** the impact could affect the whole or measurable portion of the site. Whether it is limited to the immediate area of the proposed project
- **Local -** the impact could affect the extended area adjacent to the site perhaps a neighbourhood or small town. Whether it would affect environs up to 15km outside the immediate environment
- **Regional -** that impact could affect the area including the outlying areas of the city, the transport routes and the adjoining towns.
- **National -** the impact could be as far reaching international boundaries.

Duration of the Impact

The lifetime of the impact; this is measured in the context of the life-time of the proposed development.

- **Short term -**the impact will either disappear with mitigation or will be mitigated through natural process in a span shorter than the construction phase.
- **Medium term-** the impact will last for the period of the construction phase, thereafter it will be entirely negated.
- **Long term-**the impact will continue or last for the entire operational life of the development, but will be mitigated by direct human action or by natural processes thereafter.
- **Permanent-** the only class of impact which will be non-transitory. Mitigation either by man or natural process will not occur in such a way or in such a time span that the impact can be considered transient.

Intensity of the impact

A description of whether or not the intensity (magnitude) of the impact would be high, medium, low or negligible (no impact). An attempt will be made to quantify the impacts on components of the affected environment will be described as follows: Is the impact destructive, or benign? Does it destroy the impacted environment, alter its functioning, or slightly alter it? These are rated as follows:

- **Low**,- where the impact will not have significant influence on the environment, and this will not be required to be significantly accommodated in the project design or implementation; the impact alters the affected environment in such a way that natural processes of functions are not affected in any significant way.
- **Moderate-** where it could have an adverse influence on the environment which would require modification of the project design or alternative implementation schedules; The affected environment is altered, however, function and process continue, albeit in a modified way.
- **High**- where it could have significant influence on the environment but cannot be mitigated or be accommodated by the project environment by introducing alternative mitigation measures such as realignment at a particular stretch or adoption of different design measures. Function or process of the environment is disturbed to the extent where it temporarily or permanently ceases. This will be a relative evaluation within the context of all the activities and the other impacts within the framework of the project. Note that some impacts have a high intensity and a short duration with no permanent effects.

Determination of Significance

Significance is an indication of the importance of the impact in terms of physical extent, intensity and time scale, and therefore indicates the level of mitigation required. Usually the community is involved in provision of information and determination on the characteristics of the impacts and the significance is determined based on this information.

Probability

This describes the likelihood of the impacts actually occurring. The impact may occur for any length of time during the life cycle of the activity, and not at any given time. The classes are rated as follows:

- **Unlikely -** the probability of the impact occurring is very low, due to either the circumstances, design or experience.
- **Possible -** the impact could possibly happen, and mitigation planning should be undertaken.
- **Probable -** it is most likely that the impact will occur at some or other stage of the development. Plans must be drawn up before the undertaking of the activity.
- **Definite -** the impact will take place regardless of any prevention plans, and only mitigatory actions or contingency plans can be relied on to contain the effect.

Environmental Risk quantification

Environmental risk is the chance of something happening that will have an impact upon environmental objectives or performance. Environmental risk is measured in terms of consequence (severity) and likelihood

(probability) of the event happening. As part of a risk identification and prioritization process undertaken during the preparation of the *Environmental Assessment* for the project, all potential environmental impacts were identified and each potential impact allocated an environmental risk rating based on the potential consequences and likelihood of occurrence.

Table 25 Qualitative Likelihood Rating

Level	Descriptor	Description
A	Almost Certain	Is expected to occur in most circumstances.
B	Likely	Will probably occur in most circumstances.
C	Possible	Could occur.
D	Unlikely	Could occur but not expected.
E	Rare	Occurs only in exceptional circumstances.

The allocation of a consequence rating is based on the definitions contained in **Table 26**. It is noted that the assigned consequence rating represents the highest level applicable, i.e. if a potential impact is assigned a level of 4 - Major based on impact to the environment and 2 - Minor based on area of impact, the consequence level assigned would be 4 - Major.

Table 26 Environmental Risk Rating

Likelihood	Consequences				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
A - (Almost Certain)	H	H	E	E	E
B - (Likely)	M	H	H	E	E
C - (Possible)	L	M	H	E	E
D - (Unlikely)	L	L	M	H	E
E - (Rare)	L	L	M	H	H

The four risk aspects are defined as follows:

Low (L): Requiring a basic assessment of proposed controls and residual impacts. Any residual impacts are unlikely to have any major impact on the local environment or stakeholders.

Moderate (M): Requiring a medium level assessment of proposed controls and residual impacts. It is unlikely to preclude the development of the Project but may result in impacts deemed unacceptable to some local or government stakeholders.

High (H): Requiring in-depth assessment and high level documentation of the proposed controls and mitigation measures. Ultimately, this level of risk may preclude the development of the Project.

Extreme (E): Requiring in-depth assessment and high level documentation of the proposed controls and mitigation measures and possible preparation of a specialized management plan. Unless considered to be adequately managed by the controls and/or management plan, this level of risk is likely to preclude the development of the Project.

The risk associated with each environmental impact was assessed without the inclusion of any operational controls or safeguards in place and based on the qualitative assessment of consequence and likelihood, an environmental risk ranking of either; low, medium, high or extreme was assigned to each potential impact based on the matrix. The assessment of environmental impacts and residual risk after mitigation is provided in **Table 27** (Construction) and **Table 28** (Operational). The tables summarize the impacts for each activity related to the project and presents the magnitude, likelihood and consequence of each impact.

Table 27 Analysis of Residual Risk – Construction Phase

	Potential Environmental Impacts	Level/Scale of Impact	Unmitigated Risk Rating	Consequence of Occurrence if Mitigated	Likelihood of Occurrence if Mitigated	Residual Risk Rating
Air Quality						
A	Nuisance- deposited dust	Deposited dust levels attributable to the Project during the construction phase	M	2	D	L
Erosion and Sedimentation						
B	Soil erosion	Minor gully erosion of drainage lines, stockpiles or created slopes	**H**	**2**	**D**	**L**
C		Minor sheet or gully erosion of rehabilitated landform	**M**	**2**	**D**	**L**
D		Major gully or sheet erosion formation	**H**	**3**	**D**	**M**
Ground /Soil pollution of the project site						
E	General use of vehicles and machinery	Water for wash down of vehicles and machinery on site may contaminate groundwater	**L**	**2**	**D**	**L**
F		Spills or leaks of fuels, lubricants or chemicals				

	Potential Environmental Impacts	Level/Scale of Impact	Unmitigated Risk Rating	Consequence of Occurrence if Mitigated	Likelihood of Occurrence if Mitigated	Residual Risk Rating
		from machinery and vehicles	L	2	D	L
G		Source of noise	H	4	E	H
Threatened Flora and Fauna						
H	Loss of, or alteration to, existing habitats	Disturbance to native vegetation/ habitat within the project area	L	2	E	L
I	Reduced biodiversity	Local biodiversity	M	3	D	M
Noise and Vibration						
J	Increased noise levels associated with construction activities causing annoyance, distractions, i.e. Amenity impacts.	Occasional minor exceedance of noise criteria	H	2	A	H
K		Regular minor exceedance of noise criteria	H	2	D	L
L		Occasional marginal exceedance of noise	H	2	C	M
M		Regular marginal exceedance of noise criteria	H	2	D	L
N		Occasional major exceedance of noise criteria	E	2	C	M

	Potential Environmental Impacts	Level/Scale of Impact	Unmitigated Risk Rating	Consequence of Occurrence if Mitigated	Likelihood of Occurrence if Mitigated	Residual Risk Rating
O	Increased noise / vibration levels associated with Project traffic activities causing annoyance, distractions, i.e. amenity impacts.	Occasional minor exceedance of noise criteria	**M**	**2**	**D**	**L**
P		Regular minor exceedance of noise criteria	**M**	**3**	**D**	**M**
Q		Occasional marginal exceedance of noise	**M**	**2**	**E**	**L**
R		Regular marginal exceedance of noise criteria	**M**	**3**	**E**	**M**
S		Occasional major exceedance of noise criteria	**M**	**3**	**E**	**M**
T		Regular major exceedance of noise criteria	**M**	**-**	**-**	**N**
Cultural Heritage site						
U	Impact on identified sites of cultural heritage		**L**			**N**
Waste Management						
V	Contamination by waste oil	Contamination requiring minor recovery Works	**L**	**2**	**D**	**L**
W		Contamination requiring major recovery Works	**M**	**3**	**D**	**M**

	Potential Environmental Impacts	Level/Scale of Impact	Unmitigated Risk Rating	Consequence of Occurrence if Mitigated	Likelihood of Occurrence if Mitigated	Residual Risk Rating
Soil and Land Capability						
X	Reduced soil quality	Reduced soil quality	**M**	**2**	**D**	**L**
Y		Degradation of soil quality	**M**	**2**	**D**	**L**
Visual Amenity						
Z	Reduced amenity of altered land landform	Temporary disturbance to landform	**H**	**2**	**A**	**H**
AA		Marginally identifiable change to landscape	**H**	**2**	**B**	**H**
AB		Highly identifiable change to landscape	**H**	**2**	**D**	**L**
Landform , Biodiversity & Social structures						
AC	Damage to buildings / structures		**M**	**3**	**E**	**M**
AD	Impacts on surface and groundwater flows		**M**	**3**	**E**	**M**
AE	Excavations	Heavy noises near schools can affect learning	**L**	**2**	**E**	**L**

	Potential Environmental Impacts	Level/Scale of Impact	Unmitigated Risk Rating	Consequence of Occurrence if Mitigated	Likelihood of Occurrence if Mitigated	Residual Risk Rating
AF		Dust emissions generated from earthworks	**L**	**1**	**E**	**M**
AG		Contamination of water from exposed soils	M	2	C	M
AH	Health and Safety	Potential public safety concerns	M	3	B	M

Consequence of Occurrence: 1=Insignificant; 2=Minor; 3=Moderate;4=Major; 5=Catastrophic

Likelihood of Occurrence: A= Almost Certain; B=Likely; C = Possible; D =Unlikely; E=Rare

Risk Rating: E=Extreme , H=High; M=Moderate; L=Low; N =Nil.

Table 28 Analysis of Residual Risk – Operational Phase

	Potential Environmental Impacts	Level/Scale of Impact	Unmitigated Risk Rating	Consequence of Occurrence if Mitigated	Likelihood of Occurrence if Mitigated	Residual Risk Rating
Traffic Management						
A	Delivery of Water Treatment Plant supplies	Increase traffic of vehicles required to deliver materials and supply for the treatment processes	**M**	**1**	**D**	**L**
Surface water abstraction						
B	Water abstraction from the Zambezi River	Water drawdown	**H**	**2**	**C**	**L**
C		Unsustainable water use	**M**	**1**	**D**	**L**
D		Decrease in water available for existing flora and fauna in the river	**H**	**3**	**D**	**M**
E		Effects on the current fishing activities	**N**	**N**	**E**	**N**
Ground /Soil pollution of the project site						
F	Pump room operation	Halted operation due to electricity cuts	**L**	**2**	**D**	**L**
G		Pollution in case generators are needed	**L**	**2**	**D**	**L**

	Potential Environmental Impacts	Level/Scale of Impact	Unmitigated Risk Rating	Consequence of Occurrence if Mitigated	Likelihood of Occurrence if Mitigated	Residual Risk Rating
H		Contamination of water due to spills and propagation of chemical elements (e.g. PCB, oil, etc.)	**H**	**4**	**C**	**H**
I		Risk of leakage from fuel storage tanks	**H**	**3**	**C**	**H**
	Consequence of Occurrence: 1=Insignificant; 2=Minor; 3=Moderate;4=Major; 5=Catastrophic **Likelihood of Occurrence**: A= Almost Certain; B=Likely; C = Possible; D =Unlikely; E=Rare **Risk Rating**: E=Extreme , H=High; M=Moderate; L=Low; N =Nil.					

Table 29 summarize the impacts for each activity related to the project and presents the spatial extent and frequency, of each impact.

Table 29 Evaluation matrix for potential environmental impacts

Activity	Type of Impact	Spatial Extent	Frequency / Duration
CONSTRUCTION PHASE			
Site Preparation	Construction of the water network may cause increase in traffic in the area	Local	Short term
	Construction of a temporary site offices	Local	Short term
	Commercial activities hindered because of the difficulty of access	Local	Short term
General use of vehicles and machinery	Water for wash down of vehicles and machinery on site may contaminate groundwater	Significant	Long term
	Spills or leaks of fuels, lubricants or chemicals from machinery and vehicles	Local	Long term
	Source of noise	site	Short term
General labourers presence on site	Inadequate storage and management of litter, construction	site	Short term
	Effluent from construction workers 'temporary amenities leaching into groundwater, carrying nutrients and micro-organisms	Regional	Long term
	Contamination of the storm water from litter and construction wastes and untreated effluent from temporary workers' amenities	Regional	Short term
Excavation works	Heavy noises near schools can affect learning	Site	Short term
	Dust emissions generated from earthworks due to loading and unloading of materials on site and from uncovered truckload	site	Short term
	Contamination of storm water from exposed soils	Local	Short term
	Potential public safety concerns associated with the excavation works for the installation of the water supply network	site	Short term
Disposal of debris hauling to an approved location	Traffic congestion	Local	Short term
	Adverse impact on the health of the workers and residents in and around the due to deterioration of the air quality, increase of noise and traffic	Site	Short term
	Volatile emissions during earthwork phase from solvents and fuels stored or used on the Project	Site	Short term

Activity	Type of Impact	Spatial Extent	Frequency / Duration
	site		
	Exhaust and dust emissions from construction vehicles and machinery	Site	Short term
OPERATION PHASE			
Delivery of Water Treatment Plant supplies	Increase traffic of vehicles required to deliver materials and supply for the treatment processes	Local	Long term
Water extraction from the river	Water drawdown	Regional	Long term
	Unsustainable water use	Regional	Long term
	Decrease in water available for existing flora and fauna in the river	Local	Long term
	Effects on the current fishing activities	Local	Long term

Challenges and Anticipated Impacts

Challenges and Anticipated Environmental and Social Impacts

The feasibility study for the existing water supply in Chirundu has noted that the system will require rehabilitation that will involve the replacement of the dilapidated network parts and extension of the network in certain areas that are hitherto un-serviced by the current system.

The current water supply system is inadequate to meet the current and projected water demand. This scenario has been caused by several challenges that are existent within the district. They are summarised below:

- Inadequate and erratic provision of operational funds to the utility company to afford regular maintenance of the installed works.
- Low or erratic funding to the local authority that affects their service provision of supervision and inspections.
- Poor or non-existent supervision and inspections by the local authority of the building of residential, commercial and recreational structures within the district
- Failure to comply with the strategic development plans of the district by the residents resulting into encroachment on public utilities infrastructure and reserve land.
- Low or non-existent enforcement of the breach of council by-laws by the local authority due to the operational challenges and attendant litigation and compensation costs

Some of the effects are shown in **Figure 26** and **Figure 27**.

Figure 26 Encroachment of water utility lines by housing structures

Figure 27 Unplanned road network encroaching on the water supply network

It is anticipated that these challenges outlined above have resulted into an unmitigated development status quo, which will be impacted by the proposed rehabilitation works for the water supply. While positive environmental, public health and economic benefits will accrue from proposed project, negative environmental and social impacts are anticipated.

The principal ones will include, but not exclusive to the following:

- Potential demolition of some housing and commercial structures due to realignment of existing network or establishment of the new extensions.
- Potential disruption of the road network thus impacting on the smooth flow of the local and international traffic.
- Loss of business due to the negative impact on the flow of local and international traffic

Recommendations

The feasibility has established the need for the rehabilitation of the water reticulation in Chirundu due to the various factors outlined in the foregoing sections. Undertaking the proposed water supply rehabilitation works

will require the development of an implementation plan that is informed by the results of the feasibility study, current district status and awareness of the anticipated impacts from the proposed development.

- From the anticipated major environmental and social impacts due to the laying of the extension network and rehabilitation, it is recommended that a full environmental and social impact assessment is undertaken to take stock of all the attendant issues and identify the appropriate mitigation measures.
- The rehabilitation and laying of the network extension lines will result in disruptions to the road network, demolition of housing structures and the related infrastructure. This will result into major social and environmental impacts that will require the development of the related management plans for the anticipated compensation and relocation issues.
- The undertaking of a comprehensive impact assessment and the associated development of the Resettlement and Compensation Action Plan (RCAP) will enhance for the smooth management of the anticipated environmental and social impacts.

Chirundu is a critical international border for the north south corridor linking a large number of countries in eastern and southern Africa. The transport corridor linking South Africa to its northern countries is the busiest regional transit transport link in eastern and southern Africa, carrying 5.8 million tons of cross-border traffic. The corridor extends over the territories of three regional and economic groups, COMESA, SADC and SACU (See **Figure 28**).

Figure 28 International Traffic at Busy Chirundu Border

It is anticipated that the proposed water supply rehabilitation works will greatly impact on this international traffic flow, thereby affecting trade, movement of people and the associated economic gains. Undertaking a comprehensive a comprehensive impact and traffic assessment will enable the development of the related management plans that will mitigate this disruption and thus reduce any lead times that may inadvertently be introduced by the proposed works.

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

This section of the report outlines the Cost-Benefit Analysis (CBA) assessment, which forms an input to the feasibility study of the Chirundu project.

It is anticipated that a project of this nature is unlikely to attract private-sector investors due to limited returns and the risks associated with water supply; however, its broader public-good nature is likely to increase the welfare of the population significantly. CBA is a useful approach in demonstrating this as it is able to weigh up future project costs and benefits in a present value approach, thus helping to give direction as to whether the project is desirable and should be implemented.

The main elements of this report 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 the 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 prevailing local socio-economic conditions, a **sustainability analysis** provides an assessment of the on-going financial and economic sustainability of the project, primarily from the perspective of the affordability of the project to the local community. 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.

Key CBA Assumptions

The CBA analysis is premised on a number of key input assumptions. The assumptions are drawn from the technical report, observations by the project team in the project area, and peer-reviewed publications/international benchmarks. The tables below provide the detail of the assumptions that frame the CBA analysis. The details underlying some of these assumptions are provided in **Annex D1**.

Table 30 Financial assumptions

Item	Assumption
Financial Discount Rate	10%[15]
Exchange Rate	ZMW 1.00 = GBP 0.067[16]
O&M Costs	5% of capital costs[17]
Constant Versus Current Prices	All prices are given in constant 2016 terms

Source: CRIDF CBA

Table 31 Revenue generating assumptions

Item	Assumption
Number of households (2016)	3,774[18]
Household size	5.1[19]
Population size	19,246

[15] A real interest rate of 10% was used in the financial analysis, suggested by the AfDB in their 2011 study of the Kazungula Bridge Project. African Development Bank (2011) Kazungula Bridge Project. Appraisal Report. Online: http://open_jicareport.jica.go.jp/pdf/11649951_03.PDF

[16] Oanda Currency Converter. Online: https://www.oanda.com/currency/converter/ [accessed 25 May 2016]

[17] A rate of 5% is suggested by the Swiss Resource Centre for Development (2008), as sufficient for a water supply system. See SKAT (2008). Operation and Maintenance of Rural Water Supplies. Online: www.rural-water-supply.net/_ressources/documents/default/208.pdf

[18] Section 1: Social Assessment

[19] Calculated as total population (2010) divided by the number of households (2010), i.e. (14,864/2,915). The Census of Population National Analytical Report, 2010, suggests a household size of 5.2 for the area.

Item	Assumption	
Annual population growth	4.4%[20]	
Proportion of household types[21]	• High-cost: 30% • Medium cost: 30% • Low cost: 25% • Low cost (kiosk): 15%	
Per capita water consumption	• High-cost: 150 litres/capita/day • Medium cost: 100 litres/capita/day • Low cost: 40 litres/capita/day • Low cost (kiosk): 25 litres/capita/day	
Domestic water tariffs[22]	*Per m^3*	*GBP*
	0 – 6	0.17
	6 – 30	0.25
	30 – 100	0.3
	100+	0.4
	Kiosk	0.25
Commercial water tariffs[23]	0 – 30	0.37
	30 – 170	0.43
	170+	0.53
Sewerage charges	GBP/m^3	
% of domestic water	30%	

[20] Section 2: Social Assessment
[21] Section 3: Technical Assessment
[22] Approved NWASCO Tariffs, 2016, Chirundu Border Town
[23] Approved NWASCO Tariffs, 2016, Chirundu Border Town

Item	Assumption	
% of commercial/industrial water	40%	
Sanitation charges		
% of water bill	2.5%	
Ablution tariffs (GBP)[24]	Toilet (per entry)	0.134
	Shower/laundry (per entry)	0.334
Number of truck passengers per day	700[25]	
Number of bus passengers per day	560	
Annual growth in truck traffic	5%[26]	
Non-revenue water	20%	

Source: CRIDF CBA

Table 32 Project phasing

Phase	Years
Phase 1a and b – Water and Sanitation	2016
Phase 2a – Water	2021
Phase 2a – Sanitation	2021
Phase 3	2026

[24] Based on current payments in the informal market
[25] Site visit, 2016
[26] http://www.afdb.org/fileadmin/uploads/afdb/Documents/Multinational__Malawi-Zambia__-_Nacala_Road_Corridor_Development_Project_-_Phase_IV_-_Appraisal_Report.pdf

Table 33 Economic assumptions

Factor	Discount/conversion factor	
Social Discount Factors	3.5%	10%
Tradable goods	0.8	
Unskilled labour	0.5[27]	
Skilled labour	1.00	
Non-tradable goods	1.00	

Source: CRIDF CBA

The CBA is carried out within the context of a with- and without-project basis, and hence includes only incremental values for the costs and benefit inputs. This is in an effort to include only the incremental costs and benefits of the project, including variables such as additional water supplied to the town and time spent collecting water in the current system versus time spent in the new system. Operation and maintenance (O&M) costs for the proposed design only are included, and revenues from water tariffs are included only when they are associated with additional water supply. In terms of the sanitation facilities in the town, including the two ablution buildings, as well as the sewerage system, the costs and benefits are included in their entirety as there are no such facilities at present.

In the economic appraisal, incremental values are important in calculating the health, time, efficiency and ecosystem benefits. In other words, it is unlikely that the project will result in all water-related health concerns being addressed, while there will still be some residual time spent by rural households in collecting water from kiosks or yard taps. These incremental benefits will be discussed in more detail under the section Economic Appraisal.

Options Appraisal

The project has been designed to account for the current needs of the town – increasing water supply and sanitation, catering for a large border population, town residents and businesses – as well as for the significant increase in the town's population over the next 20 years.

[27] Asian Development Bank (2011). Financial / Economic Analysis and Shadow Pricing. Online: http://www.adb.org/sites/default/files/page/149401/financial-economic-analysis-shadow-pricing-mar2012.pdf

Table 34 Population and household projections for Chirundu Border Town

Item	2016	2021	2026	2031	2036
Population	19,246	23,869	29,604	36,715	45,535
Truck drivers and passengers per day	700	851	1,140	1,455	1,857
Other border crossers per day[28]	560	560	560	560	560

Source: CRIDF CBA

One of the complexities of the town is the dual operation by LWSC and the District Council for water supply. While LWSC is mandated to provide water to the urban areas of the town, at present their reach is relatively limited. At present, despite a total population of the town being close to 20,000, LWSC currently supplies 2,062 households with water, roughly 45% (928) of which are household connections.

The existing water supply system thus has inadequate capacity to meet current demands of the town, and will require expansion and full replacement of some components to meet projected 2036 demands. The proposed system accounts for all residents of Chirundu Border Town (that is, not including the rural areas around the town), a large expansion of water supply to existing households and the potential for growth in the population.

Water Supply and Treatment

Residents currently access water from LWSC which extracts water from the Zambezi River, or from the river itself when supplies are insufficient to meet demand. It provides generally good quality water to the town, with reliable supply. Where boreholes have been sunk in the town, water quality is a concern, and Key Informant Interviews (KII) mentioned that salination is a challenge in the town. Therefore, water from the River is suggested as the most optimal water source for the project.

In terms of the water intake, currently the system is a makeshift pipe structure. This system requires upgrading to ensure it is climate proof – a floating mechanism should still be used to ensure its climate resilience as the water levels in the Zambezi River change. The water treatment plant meets only half of the current water demand in the town. The options analysed were to build a new package plant, or to expand the current plant. It was found that land is available around the existing plant, and that the expansion of the existing plant would be the most cost-effective means of meeting the needs.

Water Storage and Distribution

Currently, there is insufficient water storage to service the existing population of the town – resulting in frequent water cuts and an unstable supply. Water storage can be capital intensive, and it has been suggested that

[28] It has been conservatively assumed that passenger vehicle traffic stays constant over the project's life cycle

storage is done in phases so as to provide what is necessary and expand as populations grow. There are a number of options for the rehabilitation and expansion of the distribution system. These include a branch main or ring main, and varying levels of expansion to the current system (refer to the Technical Report for more detail on these alternatives). The final preliminary design makes use of the Distribution Network Improvement Concept which divides the ring main distribution system into measured bulk metered zones. This will allow LWSC a means to monitor water losses and introduce demand management efficiencies in the town and to ensure the commercial viability of each zone.

Financial Appraisal

The purpose of the financial appraisal is to identify the financial return to the project investment and the operational sustainability of the infrastructure. The financial appraisal is conducted from the perspective of Lusaka Water and Sewerage Company (LWSC), who will be the project owner, and will be responsible for the operation and maintenance of the infrastructure. LWSC will also be the direct recipient of the water and sewerage service tariffs and charges.

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 systems. The revenue considered includes the expected water tariffs that will be charged to domestic customers and the border patrons. Assessing the financial return of the project over its lifespan against the capital and operational costs yields a financial return to the project. The following indicators represent the key outputs of the financial appraisal:

- Financial Net Present Value – the discounted flow of expected investment and operating costs deducted from expected return
- Financial Internal Rate of Return – the financial return on the project. The financial rate of return should be above the cost of capital (discount rate)
- Financial Net Benefit Cost Ratio – the ratio of the present value of the returns on the project set against the project's costs.

Importantly, should the project not be financially viable on its own, the financial appraisal will set out the amount of subsidisation the project will require to make it financially viable and sustainable. The project's costs and revenues are set out below, before the financial appraisal results are outlined.

Project Costs

The project is divided into three phases, Phase 1 (short-term), Phase 2 (medium-term, which includes both water supply and sanitation components) and Phase 3 (long-term). Phase 1 - the upgrading of the current system as well as the introduction of bulk water meters and increased storage. Phase 2 - the upgrading of water treatment, distribution, and storage, as well as the refurbishment of the sewer system and connection to high water consumption users. Phase 3 - the expansion of the distribution system in-line with population growth.

The total cost of the project over the three phases is GBP 5,514,100, broken own as follows:

Table 35 Water supply capital investment requirements (GBP)

Item	Description	Amount
Phase 1	**Upgrading, metering and storage**	**1,604,500**
1	Floating Intake and Pump sets	
2	Conventional Treatment Plant Expansion	
3	Transmission and Storage Expansion	
4	Booster Pumps Expansion	
5	Ring Main Distribution network complete with appurtenances	
6	Distribution centre 50 m³ OHT complete with appurtenances	
7	Engineering and Contingencies 25%	
Phase 1	**Sanitation – Ablution Blocks**	**51,500**
Phase 2	**Water Supply**	**1,641,300**
1	Conventional Treatment Plant Expansion	
2	Transmission and Storage Expansion	
3	Booster Pumps Expansion	
4	Secondary Distribution complete with appurtenances	
5	Water kiosks	
6	Engineering and Contingencies 25%	
Phase 2	**Sewerage**	**2,081,600**
7	Sewer treatment works rehabilitation	
8	Transmission pipeline	
9	Small Bore Collection pipeline	
10	Pump and lift stations	

Item	Description	Amount
11	Improved latrines	
12	Awareness, training and education campaigns	
13	Engineering and Contingencies 20%	
Phase 3	**Expansion of distribution system**	**135,200**
	TOTAL PROJECT COST	**5,514,100**

Source: CRIDF CBA

Annual Operation and Maintenance Costs

O&M costs for the scheme are separated into those for the water supply and sanitation system, and those of the ablution blocks. In the former, O&M costs include electricity to pump water from the river, chlorine to treat the water and labour. Operation costs for the ablution block include electricity costs of running the building, cleaning materials, labour and regular desludging. It is envisaged that the ablution blocks are operated by an outsourced company in much the same was the flush toilets situated at the border post operate currently – where the operating entity keeps 40% of the revenue and absorbs the costs of the facilities on-going maintenance. The cost of large upgrades to the system would be borne by the water utility, but are not included in the financial appraisal as the useful life of the facility is limited to 20 years and these costs are not expected to occur in this time period.

O&M costs for the water supply and sanitation infrastructure amounts are estimated to be 5% of the capital costs annually, increasing in-line with the phasing of the project. O&M costs are assumed to be constant across the project life span as inflation is excluded from the financial appraisal.

Table 36 Capital and O&M cost phasing (GBP)

Year	0	1 - 5	5	6 - 10	10	11 - 20
Capital - Phase 1a	1,604,500					
Capital – Phase 1b	51,500					
Capital - Phase 2a			1,641,300			
Capital - Phase 2b			2,081,600			
Capital - Phase 3					135,200	
O&M (per year)		78,163		266,889		273,645

Revenues

Revenue streams are expected to flow from the three groups of users – households, including high, medium, low costs households, as well as those that access water from communal kiosks, businesses and border patrons. These will be discussed separately below.

The revenue analysis for household use is based on estimations of water demand by high, medium, low cost and kiosk users and the corresponding tariffs charged per usage. Tariff rates are based on the NWASCO 2016 approved domestic block rates for the Lusaka Province, and vary from low cost per unit charges at low levels of consumption and then escalate to higher charges at higher levels of consumption. Mapping demand over the project's lifespan is derived from population growth figures and the evolution of consumption patterns between communal water kiosks and household connections.

Based on information gathered during site visits, and from input from the Technical Report, it is assumed that out of the current population, 30% of households are considered high cost, 30% medium cost, 25% low cost and 15% are assumed to access their water from communal water points (kiosks). Each of these groups of users have varying levels of daily water consumption, as demonstrated in **Table 37**. In-line with the Technical Assessment, these proportions are assumed to stay constant throughout the 20-year life-span of the project.

Table 37 Daily water consumption per household classification type

Household type	Proportion of population	Water consumption per capita per day (litres)
High	30%	150
Medium	30%	100
Low	25%	40
Kiosk	15%	25

From discussions with the LWSC representative in Chirundu, current water supply is known. LWSC supplies approximately 2,000 m^3 of water per day to the town, but only half of this is considered revenue supply due to high Non-Revenue Water (NRW) of 50%. In calculating revenues from each user group, a number of steps were followed:

- Firstly, given that the current system is not able to supply the current demands of the town, it is assumed that no further water supply by LWSC is possible without the proposed intervention. Thus, as population grows and demands more water, an incremental increase in water supply supports the implementation of the scheme.
- Applying the respective proportions of households in **Table 37** to this incremental water supply, water demand per month and year can be calculated per household type.

- Calculating the average household use per month per household type allows one to identify the appropriate tariff, which is to be multiplied by this demand, deriving the incremental revenue created through the implementation of the scheme.
- Using these figures, sewerage and sanitation charges can be calculated, assuming 70% of the water in the system is returned by 2036 (and applying straight-line increases in water returned until then).

An additional revenue source is created through the construction and operation of the two proposed ablution facilities that provide truck drivers and other patrons with toilet, shower and laundry facilities. These facilitates are expected to operate similarly to the flush toilet facility that already exists at the border-post, where patrons pay a fee for the use of the facility. Based on the prices currently charged at the facility which are ZMW 2 (GBP0.13) and ZWM 5 (GBP 0.334) for the use of the toilet and shower/laundry facility respectively, and assuming that 20% of the truck drivers use the one facility, and 20% of the other border patrons use the other facility, revenues from the use of these ablution facilities can be calculated. The proposed operational scheme sees the outsourcing of their operation to a private party who keeps 40% of the total revenue and provides staffing and daily maintenance of the system. LWSC will collect the additional revenue and provide water to the facility, as well as long-term O&M. Only the revenue collected by LWSC is included in the financial appraisal below.

The project is highly dependent on the revenue that is derived from these ablution facilities, providing approximately 20% of revenue to the scheme in the first year that the ablution facilities open (year 6 of the project). This is an important finding as the sanitation facilities make up a small component of the capital investment requirements but provides an important source of revenue to LWSC.

The project also proposes a number of interventions that will help LWSC with its efficiency and decrease its NRW. It is suggested in the Technical Assessment that NRW will change from 50% to 35% in the fifth year of the project, and decrease further to 20% by the 10th year and 15% by the end of the project's lifecycle. These efficiency gains have direct impact on the revenue generating potential of LWSC as they increase the amount of water that LWSC can charge for in Chirundu.

In order to calculate the financial inflow associated with the efficiency gains of the project, the incremental efficiency gains (i.e. a 15% saving after the fifth year of the project and so forth), is multiplied by the total current annual loss in the system, estimated to be 1,000 m^3 per day, and by the appropriate tariff. In order to keep this estimate conservative, the lowest tariff rate for domestic consumers is applied and it is assumed that efficiency gains only occur after the 5th year of the project.

Table 38 Projected incremental revenue from water tariffs (GBP)

Revenue category	Year 0	Year 5	Year 10	Year 15	Year 20
High-cost (metered access)	0	55,360	79,124	108,587	145,150
Medium cost (metered access)	0	36,845	52,688	72,337	96,705
Low cost (metered access)	0	8,208	11,729	16,095	21,511
Low cost (kiosk)	0	4,615	6,579	9,016	12,038
Commercial	0	11,583	16,556	22,724	30,373
Sewerage revenues	0	14,921	18,334	22,568	27,818
Sanitation revenues	0	1,234	1,528	1,881	2,318
Sanitation facilities	0	0	50,353	61,098	74,812
Efficiency savings	0	13,814	27,628	32,233	32,233
Total	**0**	**146,591**	**264,521**	**346,548**	**442,958**

Source: CRIDF CBA

NRW has already been accounted for in the above tariff calculations, equal to 50% of current water supply by LWSC. The table indicates additional revenue to LWSC as a result of the implementation of the scheme.

Financial Appraisal Results

The results of the appraisal indicate that the project as a standalone entity is not financially viable: at a 10% discount rate the FNPV is negative (-GBP 3.8 million); and the FIRR (-13%) 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 and that current tariff design in Zambia does not account for full cost recovery.[29] Since 2000, water tariffs in Zambia have not kept pace with inflation of around 20 percent.[30] This means that effectively the true value of tariffs has declined, and do not represent the actual cost of providing the service. USAID (2014) suggests that as a result, Zambia's water utilities are able to generate sufficient revenue to cover their costs,

[29] USAID (2014) Cost Recovery for Urban Water Services. Online: http://usaid-suwasa.org/index.php/projects-and-activities/zambia/item/44-economic-regulation-of-zambian-urban-water-services
[30] USAID (2014) Cost Recovery for Urban Water Services. Online: http://usaid-suwasa.org/index.php/projects-and-activities/zambia/item/44-economic-regulation-of-zambian-urban-water-services

and rely on government support for on-going sustainability. KII with LWSC in Chirundu indicate that their current O&M costs are high and that they rely on subsidisation for their current operations. While they do some minor repair in the town, they rely on LWSC head office in Kafue to do the larger repairs to the system.

Table 39 provides a summary of the financial appraisal, while the table 'Financial Appraisal' in **Annex D2** contains a full summary of the results.

Table 39 Financial Appraisal Results

Indicator	Results (10% discount rate)
FNPV (GBP)	-3.8 million
FIRR (%)	-13%
FBCR	0.32
N/K Ratio	0.32

Source: CRIDF CBA

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 GBP 216,638 and a BCR of 1.2, implying that over the project life, cost recovery for LWSC is positive. This implies that the project infrastructure will be financially sustainable should external grant/concessional financing be found for the required capital investments. The FIRR indicator is not suitable for projects with a non-typical distribution of cash-flows[31] (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.

Funding Scenarios

Table 40 indicates the financial return on the project investment when varying degrees of external grant funding are leveraged. An external grant for the entire capital investment results in a stronger financial outlook, with an IRR of 7%, but because this is lower than the discount rate of 10% the FNPV still remains negative.

[31] 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]

Table 40 Project funding scenarios

Description	FNPV (GBP)	FIRR (%)
Project alone	-3.8 million	-13%
Full grant funding	-1.6 million	7%

Source: CRIDF CBA

These project scenarios demonstrate a weak financial outlook for the project relative to its costs. The project is not financially 'bankable', meaning it does not deliver high enough risk-adjusted returns to attract private-sector equity or debt. This is not unique to this project– all middle and low-income countries face challenges at providing bankable water supply projects. Not only do they often lack project-development resources, but their governments also may not be able to afford the funding commitments required or cannot offer sufficient guarantees to mitigate the perceived risk of the project.[32]

Despite these financial outcomes, the project does provide a sustainable means of providing water supply to an increasingly important border town in Lusaka Province – with long run operational revenues higher than operational costs.

Sensitivity Analysis

A sensitivity analysis is an important way to analyse whether the key input assumptions for the project have a material impact on its outcomes, particularly those of its overall viability. The objective is to identify the factors that have the biggest impact on the project's sustainability and returns. The sensitivity assessment looks at the main factors that could impact the project's costs, as well as the factors affecting the project's revenue generation.

The project's operational sustainability is impacted by the significant upfront costs, leading to a poor overall financial outlook. Increasing the upfront costs and O&M costs of the project by 10% sees a material impact on the project's NPV from -GBP 3.8 million to -GBP 4.2 million. The associated change in the FIRR is from -13% to -14%.

Decreasing the capital costs and their associated O&M costs by 10% results in an increase of the NPV from -GBP3.8 million to -GBP3.4 million, while the BCR changes from 0.32 to 0.34. A decrease in capital costs by 50% does not elicit a positive NPV for the project.

While capital costs play a role in determining the overall financial viability of the project, it is also necessary to do a sensitivity analysis on the operational sustainability of the project. This is particularly the case for project's which are funded by an external source but which will need to rely on operational sustainability for their on-going

[32] Development Finance (2016) How to plug the gap in water investments. Online: http://alliance4water.org/resources/Development-Finance-03.pdf

success. In the case of Chirundu, a sensitivity analysis was carried out on the operational flows of the proposed intervention in isolation of the capital costs.

Looking only at the operational costs (O&M costs) and revenues of the project, two variables investigated in this report are the population of the town, as well as the border patrons. The sensitivity analysis cost parameter results are shown in **Table 41.**

Table 41 Sensitivity Analysis – Cost Parameters (GBP)

Parameter	Change	FNPV before change	FNPV after change	BCR before change	BCR after change
Increase in population	+10%	216,638	456,542	1.2	1.5
Decrease in population	-10%	216,638	23,265	1.2	1.0
Increase in trucks	+10%	216,638	237,799	1.2	1.2
Decrease in trucks	-10%	216,638	195,477	1.2	1.2

Source: CRIDF CBA

From the table above it is evident that the population plays a larger role in determining the outcomes of the project. Future work on the project should ensure that population figures are correct, particularly as the District Council releases updated District Plans for the town.

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 aims to do so at prices equal to their real value to society rather than financial/market prices.

Project Costs

It is necessary to convert financial prices into economic prices. This removes any market distortions (such as taxes or import duties) and presents the true capital cost of the project to Zambian society. In many cases, market prices do not reflect the opportunity cost of inputs and outputs and items in the financial analysis must therefore be adjusted. The methodology used in the economic analysis thus applies ‘conversion factors’ to market prices to correct for market distortions and attain relevant ‘shadow prices’ of inputs and outputs.

If a conversion factor is less than one it indicates that the true value of that price is less than its market price, and vice versa. An example would be an imported product which is subject to exchange rate commissions and VAT. These are transfers within the economy and not true indications of value – hence they should be removed from its market price. If a market price is higher than 1, it indicates that the true value of that price is higher than its associated market value, such as due to government subsidies.

Capital Costs

Through a discussion with the technical logistics team, it was noted that most of the inputs for the construction of the project and supply of associated materials, machinery, and equipment during construction and operations of the hostel can be sourced locally. A conversion factor of 20% was thus applied to the capital costs of the project to remove import duties from any costs in the economic analysis, along with the proportion of low-skilled labour included in these costs.

Price of labour

The cost of labour is included in the financial analysis in both the construction of the project facilities and during its operation. This is the financial price for the use of labour. In the economic analysis, however, it is necessary to consider the social opportunity costs of labour; that is, be aware that market prices for labour may not embody its true value. This is done by looking at the alternative use of labour in the absence of the project and valuing the substitute used for labour, what is known as the 'shadow wage'.

Two assumptions are therefore made given the project's context. First, the price of high-skilled labour is understood to reflect its true value given the shortage of readily available skills in the country.

For labour classified as low-skilled, however, the situation is different. Not only might there not be another job available, but it is likely that workers will be willing to work for a wage that is lower than the market wage, if given a choice between being unemployed and accepting a lower paying job. Therefore, in cases with involuntary unemployment, the shadow wage will be lower than the financial wage. In line with the Asian Development bank's guideline for the conversion factor for low-skilled labour in labour surplus countries, a conversion factor of 0.5 is applied.[33] This is in line with that applied in other Zambian border town projects, where a rate of 0.4 was applied in Kazungula, and 0.6 in Mwami and Chanida. The higher the conversion factor, the lower the opportunity cost of low-skilled labour.

In order to calculate the economic O&M costs, the O&M percentage of 5% applied in the financial appraisal is used on the economic costs of the project. Additionally, O&M costs are allocated between the following inputs, and the conversion factor of 0.4 is applied to O&M staff costs.

[33] Asian Development Bank (2011). Financial/ Economic Analysis and Shadow Pricing. Online: http://www.adb.org/sites/default/files/page/149401/financial-economic-analysis-shadow-pricing-mar2012.pdf

Table 42 Economic O&M costs

Item	Proportion of Cost	Conversion factor
Fuel costs	6%	1
Chemical costs	11%	1
Electricity costs	12%	1
Maintenance costs	23%	1
Lab costs	6%	1
Staff costs	38%	0.4
Other costs	4%	1

Source: CRIDF CBA

Table 43 Economic costs

Component	Financial Cost (GBP)	Conversion factor	Economic cost
Phase 1	1,656,000	0.8	1,324,800
Phase 2	3,722,900	0.8	2,978,320
Phase 3	135,200	0.8	108,200

Economic Benefits

The economic benefits of the Chirundu water supply and sanitation project include impacts that can be quantified into monetary terms as well as those which can only be captured qualitatively. The CBA aims to capture both the quantitative and qualitative benefits which stem from the project.

Quantitative benefits

Financial revenues are a poor indication of the true value of water supply and sanitation infrastructure to the town of Chirundu. While they capture some of the willingness-to-pay for these water services, financial values are often moderated to account for the human rights-to-water, incentive structures and affordability concerns. Essentially, the tariffs charged for water in Zambia do not reflect the full associated costs of providing sustainable services.

The real value of water supply and sanitation is commonly estimated through an estimation of the maximum willingness to pay (WTP) of consumers for the service rather than the market tariff. WTP includes the full benefit of water and sanitation to a consumer – in terms of health, time savings, productivity, preference of supply, etc.

It is usually assessed through stated preference (contingent valuation) methodologies, which can be resource intensive and misleading where there is significant asymmetry of information.

In this economic appraisal (in lieu of a WTP survey and analysis), the following expected project benefits are assigned a monetary value in order to estimate the real (economic) value of the project:

- Health benefits
- Time savings
- The economic value of water not lost to inefficiencies
- Ecosystem improvements

Health improvements associated with water supply and sanitation

The World Health Organisation (WHO) (2004) asserts that 1.8 million people die every year from diarrhoeal diseases; 90% of which are children under five, mostly in developing countries. The National Environmental Health Policy (2001) estimates that up to 80% of the preventable diseases in Zambia are related to poor sanitation. The proposed interventions for Chirundu will directly and indirectly contribute to the reduction of a range of water and sanitation related diseases, such as cholera, dysentery and trachoma. 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.[34]

Chirundu border town suffers from a number of water and sanitation-related challenges. These include inadequate water supply to the current population – KII indicated that there is often only two hours of water supply provided by the utility, most of which occurs at night. Water is therefore heavily rationed in the town, with impacts on sanitation and hygiene practices. When there is no water in the taps, the community must resort to fetching water from the Zambezi, with risk of crocodile attacks, or else rely on water from boreholes which is of inadequate quality. Significantly limited water supply as currently provided in the town reduces the amount of water available to grow gardens, with implications on household food security, as well as on the levels of erosion and dust in the town. Chirundu suffers from high levels of dust particulates in the air which are said to lead to rhinitis, bronchitis and pneumonia.

Additionally, the town does not have a sewerage system, and residents rely on pit latrines, most of which are not improved. Open defecation is still practiced by some residents living in the peri-urban areas of the town.[35] These sanitation practices, coupled with a lack of water supply and a large, mostly unserviced border population, have resulted in a tenuous situation in which outbreaks of diarrhoea are common. [36]

[34] 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
[35] KII, site visit 2016
[36] KII, site visit 2016

The World Bank Water and Sanitation Program (WSP) has calculated the economic costs of poor sanitation in Zambia[37]; and found that Zambia loses USD 194 million annually – or GBP 11.27 per person annually – due to poor water supply and sanitation, which include health impacts of poor water supply and sanitation, the cost of premature death due to illness caused by diarrhoea and the cost of productivity losses while sick or accessing health care. Inflating this value to current prices using the average inflation rate of 9.5% between 2005 until 2016[38], the per capita cost of inadequate water supply and sanitation is estimated to be GBP 16 per person.

The economic cost estimate of poor sanitation is used as a basis to estimate the health benefits (or avoided cost) of the project on the resident population. In line with the estimates from the Centre for Disease Control and Prevention (CDC) which estimates that adequate sanitation and hygiene have the potential to prevent at least 9.1% of the global disease burden, health savings are calculated as a proportion of the total water-related health costs to the town for the first 5 years of the project. After Phase 2 these benefits are assumed to increase by a further 45%. This estimate is based on the analysis of the WHO and SIWI finding 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.[39] 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%.[40]

Chirundu's one-stop border has decreased the time trucks spend waiting at the border, However, truck drivers still currently rely on an informal pit latrine system in the town. They are also vulnerable to health risks associated with unprotected water as well as inadequate supply of water and sanitation. In order to calculate the total cost savings from this segment of the population, it was conservatively assumed that the implementation of the two ablution facilities, with adequate water supply, would decrease water-related health impacts by 9% in the truck population. Health impacts for other border patrons were not included due to the fact that flush toilets exist at the border offices for this population, and health impacts were thus assumed to be negligible.

Table 44 Health savings (GBP)

Annual value of health savings	2016	2021	2026	2031	2036
Health savings	**0**	**515,567**	**872,582**	**1,104,324**	**1,397,848**

[37] 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
[38] Trading Economics (2016) Zambia Inflation rate. Online: http://www.tradingeconomics.com/zambia/inflation-cpi
[39] WHO & SIWI, "Making Water a Part of Economic Development", Government of Norway & Sweden as input into Commission on Sustainable Development (CSD) (2004-2005)
[40] Ibid.

While the health benefits estimated in this CBA are calculated on the quantifiable health savings due to the proposed intervention, it is expected that they are significantly less than the full cost to society. This is because they ignore a number of benefits that are difficult to quantify and monetise. These are listed below:

- The cost of reduced long-term cognitive development which is a result of early childhood diarrhoea and associated under-nutrition, stunting and wasting;
- 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;
- 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. Chirundu is particularly vulnerable to epidemic outbreaks due to the large number of border patrons that pass through the town on a daily basis. An epidemic outbreak of cholera would pose a severe cost to the economy due to productivity losses, premature death, diversion of expenditure to health, and losses in trade and tourism;
- Increasingly poor health due to climate change impacts, namely more frequent occurrences of drought, rainfall variability and temperature increases.

Time savings

At present, Chriundu has a mixed system of water supply which includes some household connections and communal water points spread across high, medium and low cost households. A lot of households have graduated to household connections, often being yard taps, but the town is still faced with serious water supply challenges. Because the current system lacks adequate water storage and suffers from frequent power cuts, water supply is unstable and sometimes is only provided for two hours per day. In the absence of water supply through the current system, residents are forced to either purchase water in the informal water market that exists in Chirundu, where vendors sell water collected from the Zambezi River for ZMW 2 (GBP 0.13) or ZMW 5 (GBP 0.33), depending on how far the sale occurs from the river, or walk to fetch the water themselves. Fetching the water from the river is dangerous due to crocodiles, and can take over an hour to fetch 20 litres because of the distance.

KII indicate that at communal water points slow yields and a limited supply of water result in long queues. Fetching water is predominantly a woman and children's role in Chirundu and long waiting periods are spent queuing at hand-pumps. The community asserted that some households can spend up to two hours per day collecting water.[41] Children are expected to collect water in the afternoon, upon returning from school, and can spend an hour fetching water.[42] Given that time has an opportunity cost, a benefit value can be placed on the amount of time saved in the Chirundu population due to the intervention. This opportunity cost might be

[41] CRIDF (2016) Chirundu Outline Business Case
[42] CRIDF (2016): Chirundu Outline Business Case

attendance at school for children and informal trading for women, both groups who are usually tasked with water collection in the household.

Time savings through the new system are expected to occur in two stages. The first stage, associated with Phase 1 of the technical design, sees the supply of water to existing household connections stabilise due to increased pump capacity and storage. High and medium cost households who only receive limited water supply are assumed to purchase at least one bucket of water through the informal water trade system in the town currently. Time savings for this period of the project are thus valued as the cost of this water which will no longer need to be purchased when water supply is stable and consistent.

The second stage of time savings span from year six of the project until the end of its useful life after 20 years. This corresponds to Phase 2 of the technical design, which sees a significant increase of water supply to households as well as communal water points. Assigning a monetary value to the time that can be saved for households collecting water for domestic purposes as a result of the project is subjective, given that it depends on how much time households currently spend fetching water and the expected time savings associated with the new project infrastructure. Time savings was thus broken down into the two types of households in the town, namely households which have household water connections and those who do not (i.e. those who fetch water from communal access points).

The monetary value of time savings can be calculated as the opportunity cost of the time spent fetching water. The economic value of one hour saved is expected to be less than the minimum wage per hour in the community due to the high levels of unemployment in the town, especially for women who are usually tasked with water collection for the household.

Time savings under this period of time are estimated in the following way:

- Assuming no new households could be connected to the water supply in the absence of the intervention due to capacity constraints, the total time taken to fetch water per additional household was calculated as the journey time (assumed to be 15 minutes per trip) multiplied by the number of households fetching water
- Dividing this figure by the number of work hours in the day (8 hours) gives an indication of the work-value of this time
- This time is then assigned its opportunity cost, being the minimum wage in the town (estimated to be ZWM600 per month[43]) and discounted in line with the low-skilled conversion factor discussed above in the Economic Appraisal
- To get the annual opportunity cost of time, this figure is then multiplied by 240 working days in the year

Metered households are expected to have the larger time savings of the two dwelling types due to the fact the entire time that was spent on fetching water is now avoided due to household water connections. They will no longer have to travel to fetch water nor wait for slow yielding hand pumps. The total opportunity cost of time for metered households is equal to GBP 33,029 in 2021.

[43] Household survey carried out for Mwami border town (2015). This wage is a monthly farm worker wage.

As this CBA includes only the incremental benefits of the project, only the additional savings brought about from the proposed intervention are included. In the current system, low-cost unmetered households collect water from communal stand pipes, whereas in the new system they will collect water from kiosks. It is assumed that these households will save only 20% of the current time taken to fetch water through the new scheme as a result of more kiosks being available, and shorter waiting times at kiosks. The total annual opportunity cost of time saved for households accessing kiosks is equal to GBP 3,303 in 2021.

The combined time savings is valued at GBP 56,524 in the first year of the project. Time savings is assumed to grow proportionally to the size of the population. The summary of time savings is presented in **Table 45**, refer to 'Time and Health Savings' table in **Annex D2** for a detailed breakdown of these calculations. Overall, metered households save more time per household at an individual level as well as at an aggregate level than communal access households.

Table 45 Time Savings (GBP)

Annual value of time savings	2016	2021	2026	2031	2036
High cost households	0	56,524	85,013	105,436	130,765
Communal access households	0	0	3,924	4,866	6,035
Total time savings	**0**	**56,524**	**88,937**	**110,302**	**136,800**

Source: CRIDF CBA

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 Chirundu. Such pollution is expected to become significant as the population and concentration of people in the border town increases rapidly.

WHO and SIWI[44] 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.[45] Moreover, poor segments of the population are disproportionately dependent on natural resources and ecosystem goods and services for their livelihood.[46]

[44] WHO & SIWI, "Making Water a Part of Economic Development", Govt Norway & Sweden as input into Commission on Sustainable Development (CSD) (2004-2005)
[45] WHO & SIWI, "Making Water a Part of Economic Development", Govt Norway & Sweden as input into Commission on Sustainable Development (CSD) (2004-2005)
[46] 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

The Chirundu border town is situated upstream from a number of important water users. Of direct importance are those of the National parks downstream of the town, identified in Figure 1 below. These important biodiversity areas which rely on clean water from the Zambezi, are negatively affected by pollution from the town.

Figure 29: Location of Chirundu

By improving water quality and ecological conditions in respective catchments, projects generate substantial social benefits and support a variety of Ecosystem Services. While many of these benefits are experienced outside of market systems and are difficult to value in their entirety, there is a large amount of literature available on the value of ecosystem services.

The infrastructure proposed by this project will have direct impacts on the ecosystem health of the Zambezi River. The project is expected to improve the quality of water in the river through sanitation interventions and better sewerage handling and treatment.

Vardakoulias and Arnold (2015) estimate that for each £1 invested in a river improvement project, between £1.9 and £4.5 are generated for downstream users, depending on the project location. Their research used extended Cost-Benefit Analysis (CBA) in order to estimate the socioeconomic and environmental returns generated by five projects that would positively impact watershed areas, and included an estimation of the potential environmental (ecological) impacts of these projects, the potential societal benefits supported by those ecological impacts, the value of those benefits, expressed in monetary terms and the Benefit-Cost ratios of the projects, i.e. the comparison between the investments and the wider benefits generated.

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 (GBP 1.2 million), as an investment in the protection of the Zambezi River and the surrounding environment. De Groot et al. (2013) suggest that river basin investments are usually only 75% efficient over a lifespan of 20 years (i.e. only 75% of the total cost of investment should be included into calculations of their impact). Thus, using the benefit-cost ratio of Vardakoulias and Arnold (2015) of 1.91, and attributing 75% of this value over the project's lifespan gives a total environmental benefit of GBP 1.4 million over 20 years.

Efficiency savings

Efficiency savings in the current system are also included as a small positive economic benefit of the scheme due to the fact that this water has a true value to society that is currently lost due to leaks in the system. While the value of this water is expected to be higher than its financial value due to the fact that water tariffs do not reflect scarcity of water or the willingness-to-pay of the population, in the absence of an economic cost, the financial price is included in the economic appraisal.

Quantitative results

The results of the quantitative economic appraisal, as summarised in **Table 46**, indicate that the project is economically desirable at both a 3.5% and 10% discount rate, with positive ENPVs and an ERR which is higher than both discount rates.

Table 46 Economic Appraisal Results

Indicator	3.5 % discount rate	10 % discount rate
ENPV (GBP)	7,6 million	2,7 million
ERR (%)	24%	24%
EBCR	2.21	2.52

Source: CRIDF CBA

Sensitivity Analysis

Two important factors in the estimation of economic benefits are: the length of time taken to fetch water and the percentage of diarrhoea-related illness cases avoided due to the intervention. The impact of these assumptions is summarised in **Table 47**.

Table 47 Economic Sensitivity Analysis – Time and Health (GBP, 10% SDR)

Parameter	Change	ENPV before change	ENPV after change	BCR before change	BCR after change
Increase in time taken to collect water	+10%	2,7 million	2,78 million	2.52	2.54
Decrease time taken to collect water	-10%	2,7 million	2.69 million	2.52	2,51
Increase in ability to reduce incidence of diarrhoea-related cases	+10%	2,7 million	3,36 million	2.52	3.08
Decrease in ability to reduce incidence of diarrhoea-related cases	-10%	2,7 million	2,12 million	2.52	2.31

Source: CRIDF CBA

Changing the impact of the intervention on the number of water-related health incidents in Chirundu has a proportionally larger impact on the economic results of the project than time savings. However, the project is not significantly affected by changes in either.

Qualitative Project Benefits

While the economic appraisal above aims to capture the main components of the economic benefits of the project, it is likely that they are an understatement of the true value of the water and sanitation services supplied by the project. Thus, the qualitative description of the full spectrum of benefits is an important aspect of this economic analysis. The likely qualitative economic benefits associated with improved water and sanitation includes: positive impacts on gender equality, educational outcomes, economic development, and regional dividends. In particular, regional development and climate resilience are particularly important to Chirundu and are discussed below.

Economic Development

The extent and speed of infrastructure expansion and economic development in Chirundu will be contingent on the supporting water supply and sanitation infrastructure. Water supply and sanitation is an enabling factor to

economic activity, by expanding the productive capacity of the economy – both by increasing resources, and enhancing the productivity of existing resources.[47]

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, the provision of roadside services, salaried workers, government officials in the new District Council offices and the general public. 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)[48] and WHO & SIWI (2005)[49].

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, for every GBP 1.00 investment in water and sewer infrastructure increases private output (GDP) in the long term by GBP 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 than it would be if infrastructure were inadequate[50] - the greatest economic benefits will be felt in countries with the greatest water challenges.[51]

Regional Dividends

Chirundu holds a strategic position on the trade route between Zambia and Zambia and has been identified for its strategic importunate to both Zambia and the SADC region in general. A total of 350 trucks pass through the border town each day, carrying a variety of commodities between the two countries. This substantial number of vehicles is expected to increase as trade within SADC grows. The number of truck drivers passing through the

[47] 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
[48] Ibid.
[49] WHO & SIWI, "Making Water a Part of Economic Development", Govt Norway & Sweden as input into Commission on Sustainable Development (CSD) (2004-2005)
[50] 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
[51] WHO & SIWI, "Making Water a Part of Economic Development", Govt Norway & Sweden as input into Commission on Sustainable Development (CSD) (2004-2005)

border depends on the amount of time that it takes to cross the border, as well as a range of other amenities available to them while they wait. Water supply and sanitation infrastructure is one of these basic and fundamental amenities.

Improved water supply and sanitation will enable increased and smoother regional connectivity, trade and ultimately regional integration. With a high standard of basic infrastructure, Chirundu will remain a primary conduit for traffic crossing the Zambezi on the Regional Transport Corridors.

Without water supply and sanitation improvements, truck drivers will continue putting strain on the town's already limited water supplies. The fact that Chirundu is a border town means that the chance of these epidemics spreading throughout the region is significant. The WSP[52] estimate that the cost of an epidemic outbreak – of which faecal contamination of the environment is the root cause – will cost Zambia approximately USD 2 million per year.

Climate Resilience

The compounding pressures of growing populations, increasing number of border patrons and climate change, which sees a decrease in the average rainfall[53] to the area while simultaneously more variable rainfall, suggests the urgent need for better water infrastructure.

The proposed scheme sees the introduction of a number of climate-resilient interventions, including increased storage, a floating intake, and better monitoring of water supply to reduce leaks in the system. These interventions are likely to increase the town's climate resilience and to avoid severe stress to the population of the town should there be any large climate shock.

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 the assumed current tariff levels. The remaining issue for a sustainability analysis is to assess the affordability of the project for its intended beneficiaries. The analysis assesses the affordability of the current tariff levels that will be charged for the services provided in the Chirundu project, based on the average monthly income of the population.[54]

Benchmarks are a useful source of affordability standards for water and sanitation services. Hutton (2012)[55] finds that in Africa, the affordability index for the monthly spend of median households on water is around 2.8%

[52] 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, July 14]
[53] CEEPA (2006). The economic impacts of climate change on agriculture in Zambia. http://www.ceepa.co.za/uploads/files/POLICY%20NOTE%2027.pdf [2015, July 14]
[54] We have assumed that tariffs will remain fixed at 2016 prices
[55] 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

of monthly income, and for poor households connected to public water supply can easily reach 7.5%. International agencies have provided their own affordability thresholds – UNDP (3%), World Bank (5%), OECD unofficial (4%), and African Development Bank (5%).

The average monthly spend for a rural household in Chirundu is equal to GBP 3 per month for high cost households (based on an average monthly water consumption of 11 m^3 and an associated tariff of GBP 0.25). For communal access households, the average monthly spend is GBP 0.5, based on an average monthly use of 2m^3. Using the average monthly wage in the agriculture of GBP 40 (600 ZMW), communal access households will spend roughly 1% of their household budget, assuming that only one household member works. For high-cost households, this equates to roughly 7% of their monthly wage, assuming only one member of the household works. At the current assumed income levels, the tariffs appear to be affordable for both rural and high cost households. Comparing these with the benchmarks outlined above, the project will be affordable to the Chirundu population.

As discussed in the Financial Appraisal section above, tariffs for border patrons are based on current charges in the informal market for water and sanitation services. They thus represent sufficient willingness to pay for the water supply and sanitation services proposed in the project design.

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 is expected to result in significant improvements to the health of Chirundu residents, as well as border patrons, along with time savings and ecological improvements, all of which indicate that the project should be implemented.
- 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, grant or subsidised funding are required to cover 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. 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; LWSC must adjust the phased investments as appropriate.

Institutional Assessment

Introduction

The purpose of this section of the Feasibility Study is to address the institutional component of the Chirundu project and in particular, the implications for the organisation responsible for management of the project once it is completed, namely; Lusaka Water and Sewerage Company (LWSC). Of particular emphasis is the sustainability of the current and future institutional arrangements. The Institutional Assessment was done on the basis of a strategic review due to being done at a high level, primarily consisting of a desk study. Only limited interaction with LWSC was possible. Within these constraints, the analysis attempted to be holistic in nature.

Legal and Policy Context

The Zambian water sector has been in a process of sector reform for the last two decades. One of the critical documents which sets out much of the vision and proposals for sector reform in the water services sector is a Discussion Document[56] produced in 1994. This document was far-sighted and wide-ranging and set out proposed objectives, sector principles and policies. It also covered the sector investment strategy, proposed organisational framework and transitional arrangements. At the outset it was very hard-hitting; “The Zambian water supply and sanitation sector is in considerable disarray. The sector is generally under-financed, under-staffed and unable to meet its service-delivery obligations.” This stark realisation set the scene for the wide-ranging scope of discussions in the rest of the Discussion Document. It emphasised that at the time the institutional framework was complex and fragmented and needed a major rethink. Core challenges[57] included the following:

- The lack of a sector policy or strategy.
- Potential conflict of interest in water resources management.
- Severe financial constraints.
- Lack of sustainability of water suppliers in small towns and in the rural areas.
- Scarcity of human resources.

The document set out a proposed overall goal for the sector as follows “Zambia’s water supply and sanitation policies and strategies are aimed at improving the quality of life and productivity of all people by ensuring the equitable provision of an adequate quantity and quality of water to all competing user groups and sanitation

[56] “Proposed Institutional Framework for the Water and Sanitation Sector: Final Discussion Document”. Water Supply and Sanitation Sector Programme Coordination Unit, Government of Zambia. 29 June 1994.
[57] Ibid.

services to all, at acceptable cost, on a sustainable basis". To support this, the following objectives[58] were set out:

- Service delivery levels and coverage appropriate to requirements of different consumer groups.
- Long-term sustainability of service delivery through financial viability and cost recovery policies.
- Provision of grants and subsidies designed to support investments to needy sections of the community until executive organisations achieve financial viability and, subsequently, the ability of sector organisations to support such investments through internal subsidies.
- Improvements in efficiency and service delivery and application of funds through an appropriate institutional legislative framework, clear definition of responsibilities, coordination with other organisations, coordination of activities with donors and NGOs.
- Community consultation and participation in project development, implementation, operation and maintenance as appropriate to local conditions and customs.
- Participation and regular consultation on future policy and organisation development.
- Use of technology appropriate for local conditions and operating and maintenance capacity and more effective development of both surface and groundwater resources for piped and point water supply.
- Increased emphasis on the provision of sanitation services to overcome past neglect.
- Improved efficiency in the use and re-use of scarce water resources.
- Development of human-resource capacity and capability in the sector.

In addition to the above goals and objectives, the sector reform approach was informed by the following sector principles and policies[59]:

- Principle 1: separation of water resource management from water supply and sanitation.
- Principle 2: separation of regulatory and executive functions.
- Principle 3: devolution of authority to local authorities and private enterprise.
- Principle 4: full cost recovery in the long run.
- Principle 5: human resource development leading to more effective institutions.
- Principle 6: technology appropriate to local conditions.
- Principle 7: increased Government of Zambia, priority and budget funding to the sector.

As was noted earlier, the issue of decentralisation was critical in the restructuring and the approach was relatively aggressive in this regard; "few executive functions remain at the national level". It was therefore

[5] Ibid
[59] "Proposed Institutional Framework for the Water and Sanitation Sector: Final Discussion Document". Water Supply and Sanitation Sector Programme Coordination Unit, Government of Zambia. 29 June 1994

foreseen that design and construction, operation and maintenance, commercial activities, contracting of services, purchasing of materials and equipment, and raising of capital will occur at the regional and local levels. It also set out the important principle that the operations, management and maintenance of the water services should be carried out either by the private sector or autonomous, corporatized utility-type bodies.

The Water Supply and Sanitation Act[60] sets out the enabling legislation for the establishment of the water services regulator, the National Water Supply and Sanitation Council (NWASCO) and the water utilities. There are a number of relevant pieces of legislation impacting on the water services sector in Zambia but undoubtedly this is the key one in terms of the scope of this study. It sets out the functions of the NWASCO which are as follows:[61]

(a) Advise the Government on water supply and sanitation matters.

(b) Advise local authorities on commercially-viable institutional arrangements for the provision of water supply and sanitation services.

(c) License utilities and other service providers, as well as other activities related to the provision of water.

(d) Develop sector guidelines for

  (i) Provision of water supply and sanitation services;

  (ii) Establishment of water supply and sanitation utilities;

  (iii) The technical and financial management of utilities; and

  (iv) The setting of tariffs for the provision of water supply and sanitation services.

(e) Establishment of standards for

  (i) Water supply and sanitation services;

  (ii) The management of utilities and other service providers;

  (iii) The design, construction, operation and maintenance of water supply and sanitation facilities.

(f) Advise utilities and other service providers on procedures for handling complaints from consumers.

(g) Disseminate information to consumers on matters relating to water supply and sanitation services.

(h) Carry out any other activities relating to the regulation of water supply or sanitation services which are necessary or conducive to the better performance of this function under this Act".

The Act also establishes the legal framework for the establishment of the water supply and sanitation utilities to be established by local authorities with three options given:

- As a public or private company

[60] "The Water Supply and Sanitation Act", Government of Zambia. 1997.
[61] Ibid.

- As a joint venture with an individual or any private or public company
- As a joint venture with another local authority or several local authorities.

It can be seen from this that the legislation is enabling in terms of potential private sector involvement at some stage in the future, though not much has happened to date. It does however indicate that the majority shares must be held by the local authority.

The Act defines that no-one may provide water and sanitation services unless they have a licence and this licence can only be given by NWASCO. The licence period is a minimum of ten years which can be renewable. The licence can also be withdrawn if the Regulator considers that the licence-holder is not carrying out their work in an effective manner.

Institutional Arrangements

The institutional landscape for water and sanitation services in Zambia is depicted in **Figure 30**. This highlights the fact that the Regulator reports to the Ministry of Energy and Water Development whilst the utilities report to the Ministry of Local Government and Housing. As was noted earlier this was done very specifically to ensure the impartiality of the Regulator. Though it sits under the Ministry of Energy and Water, NWASCO maintains a very close working relationship with the Ministry of Local Government and Housing.

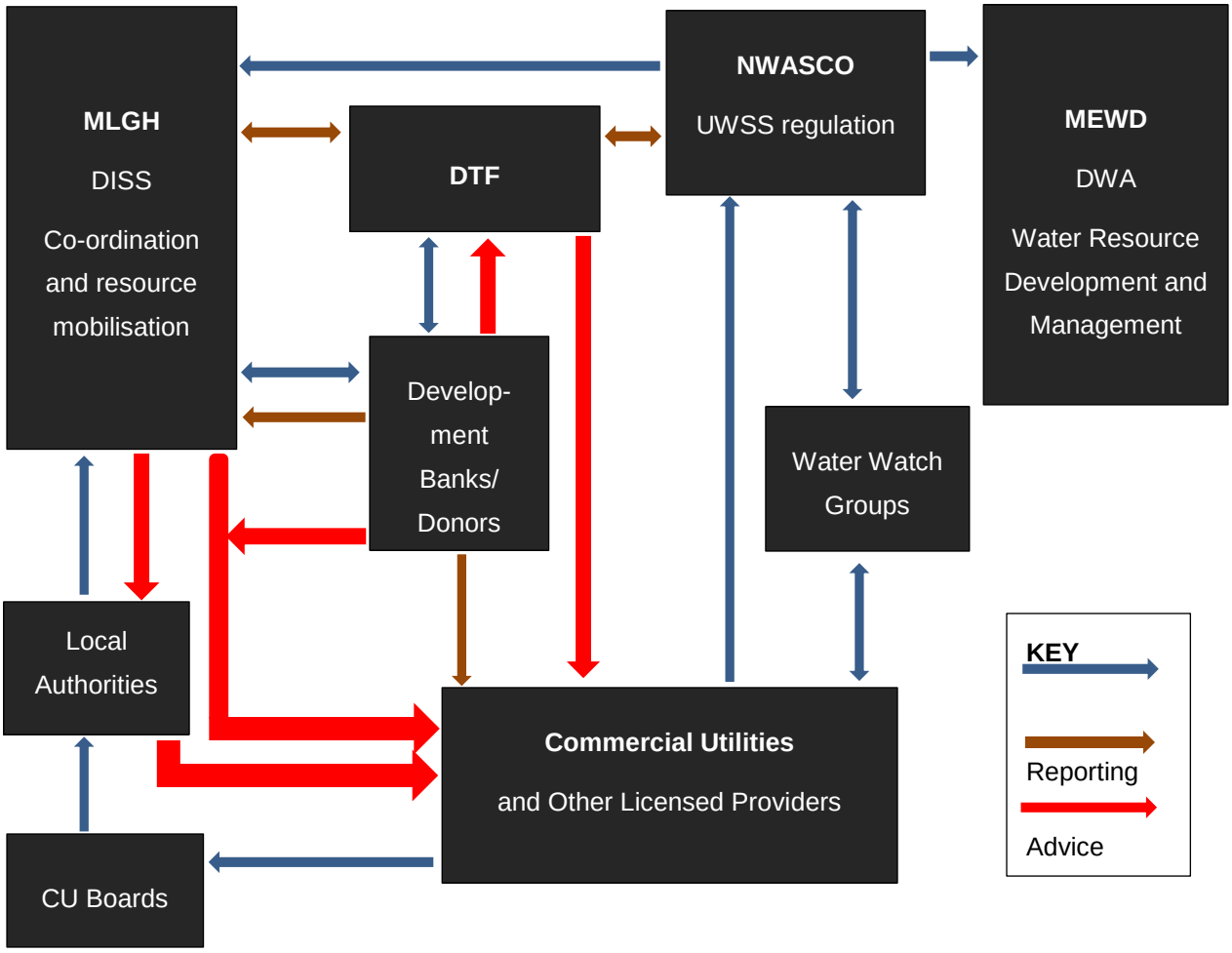

Figure 30 Institutional Landscape for Water Services in Zambia

The geographic areas of the Water and Sewerage Companies (WASCOs) are illustrated in **Figure 31**. These cover virtually the whole country however in practice they focus on the urban areas with the rural areas addressed by municipalities or district councils. The only exception is one or two smaller areas addressed by private companies supplying primarily to their employees. These are typically either mining or sugar companies. The population in each area varies dramatically from a high of approximately two million in the Lusaka Water and Sewerage Company area to 180 000 in the Western and Luapula areas.

The municipalities are the nominal owners/shareholders of the utilities and nominate representatives to sit on their boards. In practice however the municipalities appear to have little influence in terms of how utilities go about their business.

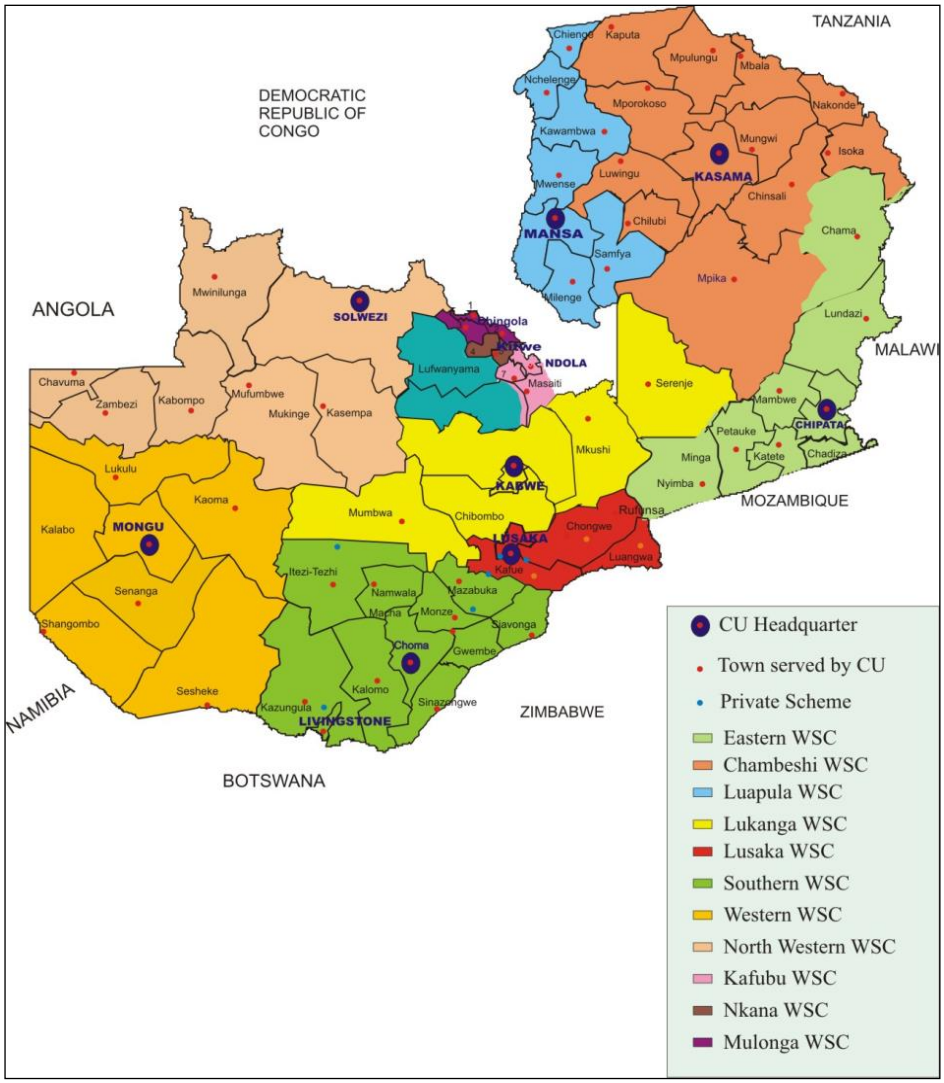

Figure 31 Area covered by Water and Sanitation Utilities in Zambia

Following a significant period of institutional reform between 2000 and 2010, the arrangements in Zambia with respect to water services are now quite well established and if anything, strengthening/improving. In this regard, NWASCO has played, and continues to play, an important role in terms of raising the bar with respect to the performance of the utilities as well as providing transparent information on their performance. There are, and probably always will be, debates and contention around some of the evaluation processes and systems however the support for the role of the Regulator in Zambia is nevertheless widespread[62]. The Regulator in Zambia also certainly does not play purely the role of policeman, and is involved quite significantly in capacity-building elements. It does this both by development of guidelines but also by making training available to the utilities in relation to these. This role of coach and supporter, as well as referee, while not necessarily a classical model of the Regulator, is not uncommon in developing countries and is probably appropriate in this context[63].

[62] "The Role of Regulation in Improved Water Services Management in Southern Africa", Wilson, A. and Pendley, C., African Development Bank.
[63] Ibid

There has been ongoing discussion for some while with respect to whether there is a need to move NWASCO from reporting to the Minister of Energy and Water Affairs, to the Ministry of Local Government in line with the utilities. Thus far this has been resisted by NWASCO and a peer review process carried out in 2015 by other regulators in Southern Africa confirmed that this was a best practice approach as it resulted in better model in terms of independence[64].

Another institutional issue which has been under debate in the water services sector in Zambia is where the Development Trust Fund should be located? This is a significant institution that provides substantial sums of capital in the form of grants to assist utilities, particularly with the provision of infrastructure to sub-economic areas but also in some cases to improve operational efficiency and refurbishment. This continues to be a critical role in Zambia in view of the fact that virtually all of the utilities, with the possible exception of Lusaka Water and Sewerage Company and Nkana WSC, are not what one could describe as being “bankable organisations” and therefore cannot go to the market to raise funding on a commercial basis. The DTF disperses funds sourced from the Regulator, from mechanisms such as the sanitation surcharge implemented some years previously and which was ring-fenced to facilitate sanitation. In addition, the DTF acts as a basket fund for funding coming from Co-operating Partners (CPs). The DTF has built up a solid track record of governance, financial management and project management over the years and this has established good credibility with CPs and with the national Government. In spite of this, the institutional design of the DTF has always been something of an anomaly as it reports directly to the Regulator (and even shares offices). Though there are undoubtedly very good historic reasons for this, probably related to the credibility of the Regulator as a whole, it is a somewhat unusual institutional design that in the author’s experience has not been replicated in other countries. For this reason therefore there is some support for proposals to relocate the DTF to another location, probably under the Ministry of Local Government and Housing. One school of thought is to set it up as a separate parastatal with a broader remit in terms of raising and dispersing funds for capital projects in the water sector. Either way, the ongoing credibility around governance, financial management and project management will continue to be crucial.

The commercial utilities in Zambia have generally improved significantly in the last 10 to 15 years across a wide range of relevant indicators measured by the Regulator. This is also the case with the Lusaka Water and Sewerage Company, which, as was noted earlier, is one of the best-performing utilities in the country. Given this background, it would appear that the current institutional arrangements are working adequately.

The Chirundu project is small in the context of the current operations of LWSC so there is no reason to believe that they would not be able to manage it adequately. Two possible areas of risk have been identified, first of all with respect to the financial position of the utility and secondly the remote location of the scheme relative to the City of Lusaka. With regard to the first issue; the organisation made a large loss in 2014 after virtually breaking even in 2013. This trend is clearly not sustainable in the long term unless the Government steps in but that would somewhat destroy the point of setting up commercial utilities in the first place. Having said this, the

[64] “Peer Review of Water Services Regulatory System in Zambia”, Wilson, A. Eastern and Southern African Water and Sanitation Regulators Association (ESAWAS)

history of the utility has shown that it is gradually strengthening over time and one cannot expect these issues related to institutional reform to be resolved overnight. In addition, the 2014 year was particularly difficult for LWSC with severe problems encountered with both the drought, unreliable electricity (in fact these two issues are related in Zambia because of the country's high reliance on hydropower generated at Kariba) and a big decline in the exchange rate. The combination of the first two adverse factors resulted in a major drop in water sales and hence financial losses. The latter had a major impact on the cost of servicing a dollar denominated loan from the World Bank. In spite of this, and based on the experience of the last decade, it can be expected that the organisation should continue to strengthen its financial position over time. In some respects the Regulator is likely to play a positive role in this evolution, while also balancing the interests of customers.

LWSC is currently the recipient of a major programme of institutional support from the initiative known as the Millennium Challenge Corporation, funded by the US Government. This is a very large programme with total funding of $354.8 million. It is addressing a wide range of issues but the core areas of support are as follows;

- Asset management
- Sanitation provision to peri-urban areas
- Reduction of non-revenue water
- Solid waste management
- Storm water management
- Gender mainstreaming
- Metering of unmetered connections
- Adding new connections

Some of these are more focussed on supporting the Lusaka City Council however the bulk of the funding is to support LWSC activities. The infrastructure components are focussed on Lusaka however the more cross cutting aspects such as asset management and NRW will quite likely have wider benefits in terms of fostering best practice that can be applied more broadly to other areas. In addition, since Lusaka provides by far the bulk of LWSC's income, an improvement in the performance there will probably have benefits to LWSC's wider area.

The MCC initiative operates according to strict timelines with any funding unspent by the Compact end date effectively being "handed back" to the US Government. Thus far the programme has been running behind schedule however almost all of the major contracts have now been awarded[65], so acceleration should be expected. With the extent of the funding injection, one would expect to significant improvements in the next few years in areas such as NRW and asset management. This clearly addresses some of LWSC's core weaknesses and is likely to have a residual/spin off benefit for Chirundu.

LWSC have informed CRIDF officials that the Chirundu scheme does not currently cover its O and M costs. This effectively means that operations there are cross-subsidised, which is not ideal for an organisation such as LWSC which seeks to have a strong commercial focus. The small size of the scheme and its remote location tend to make its "nuisance value" for LWSC potentially quite high. LWSC have also indicated that the staffing

[65] Mr. George Ndongwe, MD of LWSC, personal communication

levels/qualifications at Chirundu are currently inadequate and that these would be improved when the scheme is upgraded.

The fact that Chirundu is only a recently established District probably has something to do with the fact that the institutional arrangements in the area are still evolving and that LWSC and the local municipality share responsibilities. The delineation of the urban area would also appear to "be a work in progress". This may be why LWSC does not appear to have committed itself fully to management of the scheme as it stands. The upgrade of the scheme, formalisation of the town and growth in the area are highly likely to provide the impetus required for LWSC to commit additional resources to management of the scheme and hence to provide a high quality service to customers in the area.

Overview of the Lusaka Water and Sewerage Company

LWSC is an independent company owned jointly by Lusaka City Council (LCC), Chongwe, Luangwa and Kafue District Councils. LWSC owns and operates water and wastewater assets in the city of Lusaka and surrounding outlying areas. In recent times LWSC has had a good reputation for engineering, Operation and Maintenance and supporting service capability. As is common with a number of the water and sewerage companies in Zambia, they have been on an upward trajectory in the last decade with improvements in areas such as the number of water connections, water quality, operation and maintenance expenditure and cost recovery.

Key challenges nevertheless remain in aspects such as high levels of non-revenue water, reliability of the service and low levels of sewer connections. Their financial viability has also improved over the years to the point where they can now effectively break even. They are not yet what one would call a fully "bankable organisation" but should achieve this status in the short term if they can continue on their current positive trajectory (they have recently secured a loan from the World Bank).

The City of Lusaka is the core of LWSC's activities and functions. It has a population of approximately 2 million people, which represents approximately 20% of Zambia's overall population. The overall population growth rate is estimated to be approximately 4,5%. Only about 70% of Lusaka's residents have access to a treated water supply and 65% to waterborne sanitation[66]. This means that there are significant quantities of people without access to these basic services, with potential severe impacts on health. The city is located on a relatively flat plateau, which can result in flooding in the summer months leading to potential further health risks when linked with unsafe sanitation practices. At the same time, the city is unusual in that it is extremely reliant on water extractions from primary dolomitic aquifers. The latter are being severely impacted upon by on-site sanitation systems, which are having a negative effect on the water quality thereof. The water loss in the Lusaka system is currently estimated at 47% of the water delivered to the system[67].

Much of the sewerage network in Lusaka was constructed more than 40 years ago and has undergone little maintenance or expansion since that time. As a result, much of it is in a deteriorating condition and/or

[66] "Final Sanitation Master Plan, Lusaka, Zambia". The Republic of Zambia, Ministry of Local Government and Housing, Lusaka Water and Sewerage Company, Millennium Challenge. June 24, 2011.
[67] "Urban and Peri-Urban Water Supply and Sanitation Sector Report 2015", NWASCO

overloaded. In addition a large proportion of the waterborne systems discharge to septic tanks, which again have a negative impact on the groundwater. It is estimated that approximately 59% of households in Zambia use pit latrines[68] and this figure is likely to be similar in Lusaka.

Governance

The LWSC was officially established in 1988 and incorporated as a water utility under the Companies Act and the National Water Supply and Sanitation Act although full operations only started in 1990. It commenced functioning as a provincial Utility during 2008, with the Councils of Lusaka City, Kafue, Chongwe and Luangwa as the shareholders.

The LWSC has a clear mandate that requires it to provide water and sewage services in urban and peri-urban areas within the Lusaka Province. Local authorities are held responsible for delivery to rural areas. The various aspects related to its mandate are well integrated into its target levels of service and, while ambitious, are nevertheless appropriate and well defined.

The Company has taken the principle of subsidiarity as a basic point of departure with the devolution of a proportion of necessary functional aspects of the Company to each of its branches, with Kafue serving as the largest of these. The need to meet all commercial and operational requirements and to deliver water and sewerage services to all urban and peri-urban areas as mandated coupled with the need for devolution, exacts a price in respect of the management rigour that needs to be applied and the staff complement required to be in place.

It is subject to all legal rights and obligations set for a corporate persona as well as the Regulations pertaining to its functioning as required by NWASCO. All the NWASCO Corporate Governance Indicators were satisfied for 2015[69] (see further comment on this later).

In line with the regulations, the Board of Directors are drawn from various public stakeholder groups within the Province and appointed collectively by the local authorities. These appointments are ratified by the MLGH, which appoints an additional two members, one of whom is required to act as Chairperson. In the case of the LWSC, it is accepted that the individual identified by the MLGH to act as Chair will, in addition, be drawn from any of the participating Councils.

The position of Council Secretary is filled by an individual nominated into this position by fellow Town Clerks. One of the two representatives from the community is drawn from the commercial consumer category, whilst the other is drawn from the domestic consumer category.

It is uncertain whether or not gender equity targets are in place and/or applied within the context of the Board. At the same time, Zambia as well as the LWSC have a solid track-record of the need for gender mainstreaming.

The LWSC Board is (normally) comprised as follows:

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[68] "Final Sanitation Master Plan, Lusaka, Zambia". The Republic of Zambia, Ministry of Local Government and Housing, Lusaka Water and Sewerage Company, Millennium Challenge Corporation. June 24, 2011.
[69] NWASCO (2016) Urban and Peri-urban Water Supply and Sanitation Sector Report 2015

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

The Company operated without a Board of Directors for a period of time, with a new Board appointed in 2013.

Separate Board Sub-Committees were constituted during the 2013/2014 period as follows

- Audit Committee
- Works and Development Committee, and a
- Finance and Human Resources Committee.

In addition, the World Bank makes reference to a Senior Management, Works and Development Committee of the Board[70]. The Regulator notes the establishment of a Gender Committee that has been put in place[71].

There were four Board meetings held during 2015 and 98% attendance during this period[72]. In their 2015 Sector Report, NWASCO indicated a relatively high degree of satisfaction with governance matters in LWSC and they commented favourably on the strategic plan, approved budget, audited Annual Report and investment plan, which is probably an Infrastructure Master Plan or a multi-year Capital Expenditure Plan.

The LWSC Board has recently completed its term and the process of appointing new members is underway. A recent announcement from the Minister of Local Government regarding the appointment of Boards is indicative of the possibility of political interference in the governance of utilities in Zambia at various times (see **Figure 32**[73]). Both NWASCO[74] and LWSC[75] are engaging with the Minister to try and address this issue. They are placing a major emphasis on the need for strong governance and hence the quality, independence and qualifications of Board members.

[70] World Bank Urban Development and Services Unit (2013) Water Sector Performance Improvement Project Implementation Completion and Results Report
[71] NWASCO (2016) Urban and Peri-Urban Water Supply and Sanitation Sector Report 2015
[72] "Urban and Peri-Urban Water Supply and Sanitation Sector Report 2015", NWASCO
[73] *Zambia Herald*, 3 March 2016
[74] Mr Kelvin Chitumbo, Director NWASCO, personal communication
[75] Mr George Ndongwe, Managing Director, LWSC, personal communication

Kampyongo dissolves LWSC board

By Fredrick Misebezi

LOCAL government minister Steven Kampyongo has dissolved Lusaka Water and Sewerage Company's board of directors and has appointed his permanent secretary, Amos Malupenga, as interim board chairperson.

Last month, Lusaka Water and Sewerage Company workers petitioned Kampyongo and Malupenga to remove all the directors at the water utility for running down the institution.

And according to a statement by Malupenga, Kampyongo would soon appoint a new board of directors with a clear mandate to ensure that the utility continues to improve its performance by providing clean, safe and affordable water supply and sanitation services to its communities.

Kampyongo has also appointed Malupenga as interim board chairperson for Mulonga, Kafubu, Southern and Western water and sewerage companies.

And Kampyongo has also appointed a new board of directors for the Local Authorities Superannuation Fund (LASF), a move aimed at stirring the Fund to a position where it can meet its obligations of better serving retirees on one hand and to come up with strategies to revamp its financial position and compete with other Pension Funds on the other hand.

Figure 32 Dissolution of LWSC Board

Organisational Strategy

The organisational strategy as it stands would appear to contain most of the key elements that one would expect to see for an organisation of this nature. In addition, it appears to respond to the particular challenges that are facing LWSC at the current time.

The vision, mission and strategic objectives of the LWSC are shown below[76].

Vision

To be a world class company working together to change lives and bring pride to communities through provision of water and sanitation services.

Mission

To provide quality water and sanitation services at commercially and environmentally sustainable levels to the delight of our customers and other stakeholders.

[76] "Strategic Plan: 2014-2018", LWSC

Objectives for the planning period

In their most recent Strategic Plan, LWSC carried out a review of their performance for the previous planning period[77]. In this, they identified the following major challenges facing the organisation:

- Lack of capacity to meet demand for water
- Lack of capacity to meet demand for sanitation services
- High non-revenue water
- Inadequate resources for reinvestment
- Increasing operation costs
- The analysis also noted that these had not changed from the time when the previous strategic review had been carried out.
- LWSC have identified the following five major themes for the five year period 2014 to 2018:
- Financial viability
- Water supply and sanitation improvement
- Customer satisfaction
- Process re-engineering
- Motivated committed and highly productive staff

As can be seen, the objectives set out in the Strategic Plan speak for the most part to the strategic challenges identified by LWSC. It also addresses the weaknesses highlighted by NWASCO in areas such as non-revenue water and the provision of safe sanitation.

Often the most challenging thing about strategy is not the development of the strategic plan but the implementation thereof. In many cases this is where strategic planning succeeds or fails and speaks to the concept of "strategic management" as opposed to strategic planning. A key part of this is action plans/workplans to support the high level strategic plan that spell out the critical aspects such as "*what?*, *how much?*, *by when?* and *who?"*. In this regard, LWSC carried out a review of their performance against their strategic objectives in 2014. A summary of the results of this are given in Table 2 below. This highlights that 2014 was an extremely challenging year for LWSC on the financial front due to a number of (probably largely uncontrollable) external factors (see discussion under 5.3 below). NRW also suffered a decline but it is known that this is currently an area of enhanced focus for LWSC. An increase in NRW in such cases can sometimes be due to the process of improved measurement, which provides better quality information on the subject than what was available previously (where sometimes intelligent guesses were made). In other areas such as customer service the target was exceeded.

[77] "Strategic Plan: 2014-2018", LWSC

Table 48 Performance against the Strategic Plan

No.	Objective	Target for 2014	Status as at 31st December 2014
1	Improved profitability	Attain 3% return on capital employed (ROCE)	-8% attained. Affected by huge exchange loss and low revenue
2	Improved liquidity	95% collection efficiency 180 debtors days	-88% collection efficiency due water stress that made debt management exercises to be difficult and negatively impacted on the willingness to pay 228 days attained to convert receivables into cash to settle short term obligations when they fall due. This is in comparison with 225 days attained in 2013
3	To reduce non-revenue Water	35%	42% attained
4	Provide reliable water and sanitation services	Average daily supply of 22hrs	20 hours attained, affected by erratic water supply
5	Improved customer services No. of 100 connections	95% complaint resolution 25 complaints per 100 connections	96% attained 10 complaints per 100 connections achieved
6	Implemented quality and Environmental Management systems	Implementation of quality management system (QMS)	To date a total of 66 processes and procedures have been documented. Activities that have an impact were listed for each directorate and related environmental aspects identified
7	Improve staff productivity	At least 40% score on NWASCO productivity index	60% attainment affected by low collection and billing below target

Ideally progress on implementation of the strategy and related work plans should be discussed by top management on a regular basis, perhaps every one to two months with a major review annually. The 2014

review would suggest that LWSC have put the necessary systems in place to ensure that implementation of the strategic plan is monitored on an ongoing basis, but this could not be confirmed.

Financial

The latest financial statement that was accessed for the Feasibility Study was the draft for 2014[78] (see **Annex F3** and **F4**). The total income for 2014 was approximately 227 million Kwacha. LWSC had an extremely challenging year in 2014 due to the droughts and (related) increasingly unreliable electricity supply and the decline in the strength of the Kwacha against the US Dollar. LWSC's supply sources are primarily via the excellent underground aquifer located in the vicinity of Lusaka and the supply from the Iolanda Works at the Kafue River. Both of these sources have to be pumped, which emphasises just how dependent LWSC is on reliable electricity supply. The exchange rate impacted directly on a loan made by the World Bank that is dollar denominated. LWSC made a loss of 41 million Kwacha in 2014, after almost breaking even in 2013. This highlights the impact of the adverse external factors experienced in the 2014 year.

NWASCO[79] reported that LWSC were very successful in terms of revenue management with a collection efficiency of 96% in 2015. This resulted in an "O&M cost coverage" of 88%. The full cost coverage including aspects such as depreciation, pension allowances and servicing debt will have been substantially lower.

LWSC's current ratio for 2015 was 1.43, which is at a very acceptable level.

Tariffs

The tariff schedule for LWSC is shown in **Figure 33**. LWSC's tariffs are below the average for Zambia, though they do in theory have better economies of scale than any of the other commercial utilities. If however one does some benchmarking with other commercially viable utilities in Southern Africa, these tariffs are probably on the low side by a factor of perhaps 60-80%. This is indicative of why LWSC and other Zambian utilities are not yet truly commercially viable. That said, nearly all of the commercial utilities in Zambia have strengthened significantly in the last ten years and show signs of becoming viable in the not-too-distant future.

NWASCO typically carries out a comprehensive tariff determination for each utility every three years that covers the following three years. This includes an associated "Service Level Guarantee" (SLG) that sets out targets for the utility to achieve, if it is to obtain the tariff increases set out over the next three years. The assessment in 000 meters the intervening years is therefore less comprehensive in nature. In 2016 LWSC obtained a "no objection" from NWASCO for a 30% tariff increase. Selected conditions in the SLG include the installation of at least 15 000 meters in Lusaka and increase the number of connections by 5 000, both by the end of August 2015.

[78] "Lusaka Water and Sewerage Company Limited: Financial Statements 31 December 2014" Draft – 22 October 2015, Grant Thornton
[79] "Urban and Peri-Urban Water Supply and Sanitation Sector Report 2015", NWASCO

LUSAKA WATER AND SEWERAGE COMPANY – APPROVED TARIFFS 2016

Domestic Metered Customers					Current Tariffs	Approved Tariffs	% Change
LUSAKA					2015	2016	
1st block	-	to	6	K/m³	3.03	3.93	30.0%
2nd block	6	to	30	K/m³	3.63	4.72	30.0%
3rd block	30	to	100	K/m³	4.11	5.35	30.0%
4th block	100	to	170	K/m³	4.84	6.29	30.0%
5th block	170			K/m³	5.93	7.71	30.0%
KAFUE							
1st block	0	to	6	K/m³	1.94	2.52	30.0%
2nd block	6	to	30	K/m³	2.30	2.99	30.0%
3rd block	30	to	100	K/m³	2.54	3.30	30.0%
4th block	100	to	170	K/m³	2.78	3.62	30.0%
5th block	170			K/m³	3.15	4.09	30.0%
CHONGWE				K/m³			
1st block	0	to	6	K/m³	1.94	2.52	30.0%
2nd block	6	to	30	K/m³	2.30	2.99	30.0%
3rd block	30	to	100	K/m³	2.54	3.30	30.0%
4th block	100	to	170	K/m³	2.78	3.62	30.0%
5th block	170			K/m³	3.15	4.09	30.0%
LUANGWA				K/m³			
1st block	0	to	6	K/m³	1.94	2.52	30.0%
2nd block	6	to	30	K/m³	2.30	2.99	30.0%
3rd block	30	to	100	K/m³	2.54	3.30	30.0%
4th block	100	to	170	K/m³	2.78	3.62	30.0%
5th block	170			K/m³	3.15	4.09	30.0%
CHIRUNDU				K/m³			
1st block	0	to	6	K/m³	2.40	2.52	5.0%
2nd block	6	to	30	K/m³	3.60	3.78	5.0%
3rd block	30	to	100	K/m³	4.30	4.51	5.0%

Figure 33 Approved Tariff Schedule for LWSC for 2016

Revenue Collection

In spite of the 96% collection efficiency, the meter coverage figure is only 72% and this provides a lot of opportunities for enhancing revenue via this mechanism. Recently LWSC have commenced a fairly aggressive initiative to install pre-payment meters. The idea with this is to improve on non-payment problems and delays. Particularly problematic in this regard are government institutional and facilities. It will be interesting to see how this new strategy works. It is understood that the Compact Agreement signed with the United States Agreement, improvement of payment by government was a key condition. Early signs are that there has been an improvement in the payment of arrears.

It was reported that LWSC has a lot of old and faulty meters that need to be replaced. This may also speak to the issue of why the non-revenue water figure is so high at 47%.

Operation and Maintenance Costs

The breakdown of O and M costs is summarised in **Figure 34**.

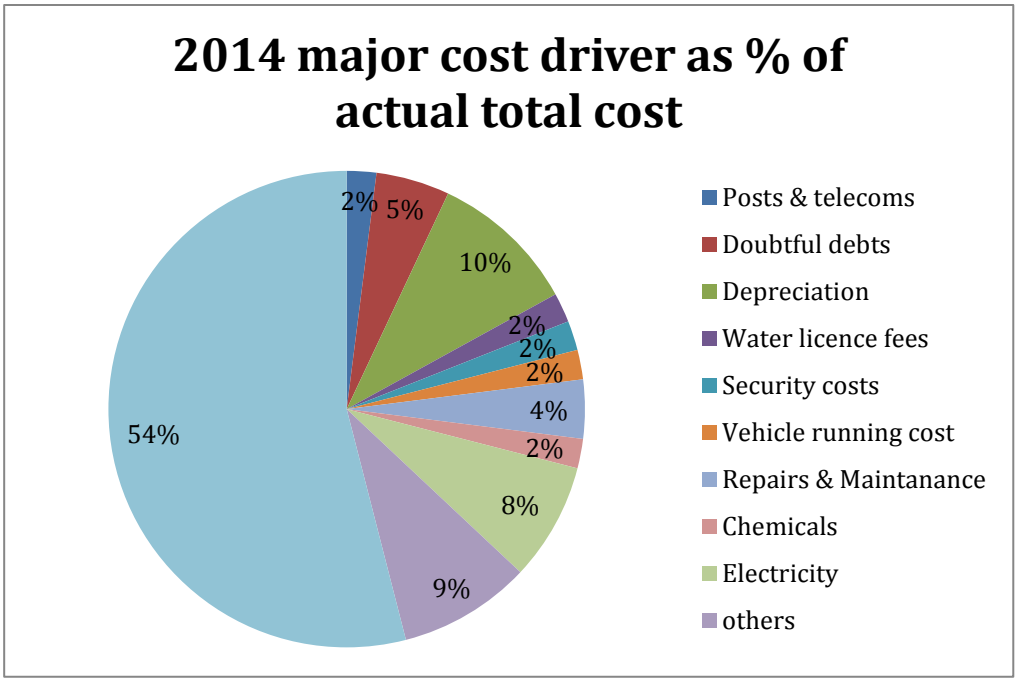

Figure 34 Operation and Maintenance Costs

This highlights that by far the biggest proportion of costs is taken up by staff. LWSC's figure for number of staff/1000 connections is below the average in Zambia, while the amount for billing/staff member is amongst the highest in Zambia. The average cost of staff for LWSC however by far the highest is in the country and is in fact 36% higher than the next utility. This may be due to higher salaries prevalent in the capital city.

The next most significant operational costs are for depreciation, electricity, bad debts and repairs and maintenance. Chemicals is a relatively low component at 2% though this will increase if raw water quality deteriorates significantly.

Debtors

In the LWSC strategic plan it was noted that debtors' days varied between 176 and 211 days from 2009 to 2013. This is a problematic and unsatisfactory figure and indicative of why LWSC are aggressively pursuing the strategy of installing pre-paid meters.

Financial Structure

Historically LWSC had little in the way of long-term debt. This was primarily due to the fact that the organisation could not be regarded as "bankable" i.e. its financial performance was not credible enough to be able to stand up to the rigors of the examination from lenders necessary to secure long term funding. This is not an ideal scenario for any commercial organisation as no debt is generally regarded as an inefficient structure because it does not allow "leverage" of the assets of the organisation. Long-term debt is useful as typically it is utilised to implement capital expenditure (and in fact should never be used to finance operating expenditure). In recent

years, LWSC's balance sheet has strengthened to the point that it has been able to secure long term debt funding, specifically from the World Bank. This has been utilised for a number of capital projects. LWSC's financial leverage (debt to equity ratio) was 1.05 in 2013. Sadly, the World Bank loan, which is dollar denominated, has coincided with a sharp decline in the strength of the Kwacha and this has had an adverse effect on the income statement in 2014 and 2015.

In spite of the recent problems, the strategy to increase financial leverage of the organisation is sound, as long as it is kept at manageable levels and is used for capital expenditure designed to enhance revenue collection and/or sales and /or reduce costs. This may lead to "short term pain but long term gain" for LWSC.

Organisational Design and Human Resources

Management Structure[80]

The Executive Management of the LWSC is constituted of a Managing Director, assisted by four Executive Directors, variously in charge of the Engineering, Finance, Commercial Services and Human Resources divisions.

Specific management functions have, as well, been put in place in respect of (i) Company Secretary and Legal Functions, (ii) Audit Services, (iii) Corporate Planning, (iv) Quality Control, (v) Purchasing and Supplies, and (vi) Non-Revenue Water. Each of these functional areas function under a specifically appointed manager.

Collectively they are tasked with the implementation of policy and strategic direction of the Company as determined by the Board. It is further expected that the Executive Management will ensure that the Board is well informed about the operations of the Company and supported in respect of strategic decisions.

The management team members have been screened with regard to academic qualifications as well as experience within the sector. However, the specific qualifications of each as well as the age and gender distribution has not been made available and can, therefore, not be commented on.

Management Functioning

The LWSC has a history of efficient and effective functioning and was ranked 2nd highest performing water utility in the Country by NWASCO in 2013 and 1st overall for the 2014 period, as measured against the various benchmarks set by the regulator. However, the ranking for the Company fell to 4th overall during the 2015 period[81]. The regulator makes it clear that a Utility "moving down in the ranking does not necessarily mean that

[80] Unless otherwise stated, the contents of this Section based on information obtained through a series of interviews with LWSC and other stakeholders undertaken for this assessment as well as for other studies such as the 'LWSC Sustainability Agreement Baseline Indicators and Annual Technical Audit' and the project to 'Develop a Detailed Framework and Workplan to Operationalise the Sanitation Connection Action Plan for Mtendere.

[81] NWASCO (2016) Urban and Peri-Urban Water Supply and Sanitation Sector Report 2015

it performed worse than the previous period, but it could also mean that it was outperformed[82]" (it could also have been impacted upon by adverse conditions out of its control).

Additional factors, outside the direct control of the LWSC include constraints such as electricity rationing and associated extended periods of low voltage as well as reduced water resources levels in a number of areas in the Province (e.g. the drying up of the Chongwe dam). The Regulator estimated that the LWSC "lost 10% of their production owing to load shedding and low voltage which resulted in reduction of hours and subsequently, revenue".[83] These factors have had a serious deleterious impact on LWSC delivery against the agreed targets set by the Regulator.

At the same time, the World Bank[84] states that "LWSC has good engineering, O and M and supporting service capability". As is common with a number of the water companies in Zambia, they have been on an upward trajectory in the last decade with improvements in areas such as the number of water connections, water quality, operation and maintenance expenditure and cost recovery.

Key challenges nevertheless remain in aspects such as high levels of non-revenue water, reliability of the service and low levels of sewer connections. Their financial viability has also improved over the years to the point where they can now effectively break even. They are not yet what one would call a "bankable organisation" but should achieve this status in the short term if they can continue on their current positive trajectory.

Based on discussions with stakeholders as well as the review provided by the Regulator, it may be concluded that the Company demonstrates solid management functioning.

Decentralised Service Delivery

Due to the size and nature of its operations, the LWSC structure is a combination of decentralised day-to-day delivery with aspects such as commercial services and engineering functions devolved to dedicated management units.

The following graphic provides an overview of this decentralised operational delivery structure[85].

[82] Ibid
[83] Ibid
[84] World Bank Urban Development and Services Unit (2013) Water Sector Performance Improvement Project Implementation Completion and Results Report
[85] Derived from composite information obtained through a series of interviews with LWSC and other stakeholders undertaken for this assessment as well as for other studies such as the 'LWSC Sustainability Agreement Baseline Indicators and Annual Technical Audit' and the project to 'Develop a Detailed Framework and Workplan to Operationalise the Sanitation Connection Action Plan for Mtendere

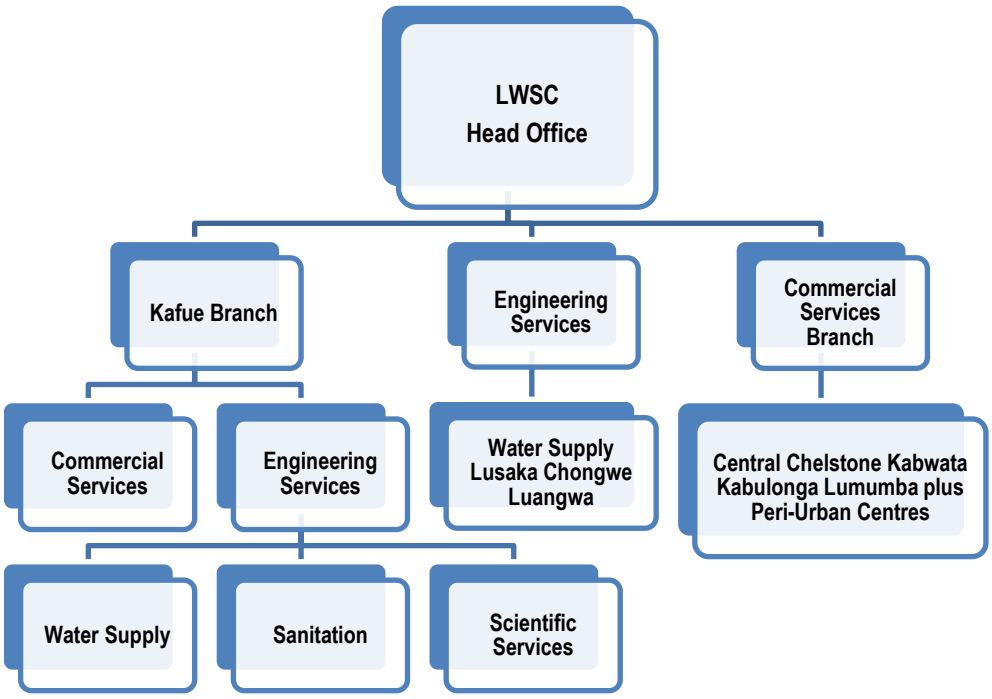

Figure 35 Overview of Decentralised Operational Delivery Structure

Based on service requirements, separate commercial as well as engineering capacity has been put in place within the Kafue District itself and run from the Kafue Branch Office. Kafue has, since 2013, been tasked with the management of the Chilanga boreholes distribution system. In addition, the Branch took over the Chirundu Treatment Plant and distribution system in 2014[86]. Services in respect of the other areas (Central, Chelstone, Kabulonga, Kabwata and Lumumba) have a dedicated Commercial Services related human resources base.

The Kafue Branch is discussed later in this section. This has been done to provide greater clarity about the capacity that exists at each level of the Company[87]. The proposed developments at Chirundu, envisaged by CRIDF, are expected to resort under the existing decentralised services to this area by the Kafue Branch.

The LWSC Engineering Services Division has allocated dedicated human resources to personnel specifically tasked with water supply duties, within the majority of the Districts within the Province. The following Table provides an overview of resource allocation per district, excluding the Kafue District but including water supply personnel allocations for the Lusaka District (more detail is provided in **Annex F5**)..

While it has not been possible to confirm, it is assumed that the water supply personnel allocation for the Chongwa District includes that for the recently proclaimed Rufunsa District which formerly formed part of Chongwa[88]. Unfortunately, no information has been provided as yet that allows a distinction to be made in respect of the specific categories of employment, the professional / technical qualifications of personnel, their

[86] World Bank Urban Development and Services Unit (2013) Water Sector Performance Improvement Project Implementation Completion and Results Report
[87] Ibid
[88] UK Zambians (2012) Sata Creates Rufunsa and Sibuyunji Districts accessed at http://ukzambians.co.uk/home/2012/07/09/sata-creates-rufunsa-and-sibuyunji-districts/

skills level and their age and gender distribution. It is also not known whether personnel are dispersed through each of the districts, or function from a central district office.

Table 49 Human Resource Allocations per District

DISTRICT	PERSONNEL NUMBERS[89]
Lusaka - Water Services (including Shikabet)	69
Chongwe - Water Services	9
Luangwa - Water Services	11

Human Resources Management Practices

Available information provides some insight into the full extent of the existing human resources management function and systems of the LWSC. The following could be ascertained[90]:

Specific steps are in place to strengthen the Company HR development function and there is an appointed Human Resources Manager.

A number of Human Resource Policies are in place, including for mainstreaming Gender and HIV/AIDS. It is believed that the following additional policies are in place although this has not, as yet, been finally confirmed:

- Occupational, Health and Safety and Environment,
- Performance Management,
- Disciplinary Code and Grievance Handling
- Recruitment and Selection, and
- Training and Development.

It appears that workforce data and information are routinely collected and used for HR planning, including for periodic staff projections. Key staffing information is said to be available and that reports are regularly prepared and, apparently, shared with management;

Workplace safety has been taken on board, specifically in respect of the fact that a Safety, Health and the Environment (SHE) Policy is in place. This is in place to protect staff and to ensure that the Company complies

[89] Derived from composite information obtained through a series of interviews with LWSC and other stakeholders undertaken for this assessment as well as for other studies such as the 'LWSC Sustainability Agreement Baseline Indicators and Annual Technical Audit' and the project to 'Develop a Detailed Framework and Workplan to Operationalise the Sanitation Connection Action Plan for Mtendere

[90] Derived from composite information obtained through a series of interviews with LWSC and other stakeholders undertaken for this assessment as well as for other studies such as the 'LWSC Sustainability Agreement Baseline Indicators and Annual Technical Audit' and the project to 'Develop a Detailed Framework and Workplan to Operationalise the Sanitation Connection Action Plan for Mtendere'.

with workplace safety procedures and health regulations, including the issue of Personal Protective Equipment (PPE) where necessary.

It appears that processes and procedures are in place that demonstrate an understanding of the need for training to improve work related competencies, job specific proficiency and the associated optimal utilization of personnel.

There appear to be policies, mechanisms, and practices in place or being put in place to ensure performance management, including Disciplinary and Grievance Procedures, Workforce Retention Strategies as well as processes for Succession Planning. Based on this, it is clear that there are job profiles, job descriptions and associated standards and performance expectations in place, which are clearly communicated. This would include a statement relating to the minimum academic and skill requirement for specific posts. It is understood that mechanisms for undertaking staff performance reviews have been put in place; that competence appraisals are undertaken; and that job specific competency development is enhanced through directed training. Where required, alternative staffing methods such as sub-contracting, outsourcing and temporary hires is used.

Training Programmes

The LWSC has indicated that the training needs of staff, as measured against job requirements, are addressed. As a result, training is structured to respond to specific gaps in work related competence, and based on the needs of the Company.

While it has been reported that significant resources had been allocated to staff training, showing in the order of a massive 350% increase in training provided in 2014 as compared to 2013, it is not possible to provide any indication of the specific training that has been undertaken by the LWSC. From information available, it may be concluded that such initiatives aimed at developing specific skills and competencies that will support work related performance.

The 2014 Performance Overview states that "During the period under review, various training programmes were conducted locally and abroad in various disciplines to build staff competencies and skills.[91]" It further states that:

- Six members of staff attended training programmes 'abroad/overseas' although it is uncertain what this training comprised of and where it was undertaken;
- A total of 62 staff members pursued part-time courses (subject and type unknown); while
- Five staff members were enrolled in full-time study courses, described as being approved in accordance with the Company's training objectives."[92]

It is assumed, but has not been confirmed that the LWSC participated in the WAVE Plus programme (an intervention of the German development cooperation partners) that serves as a regional multi-country learning and networking forum (comprised of Kenya, Tanzania, Uganda and Zambia) and that offers 'tailor made' capacity development initiatives aimed at improving water services provider functions, appropriate to the

[91] LWSC (2014) Company Performance Overview, January to December 2014
[92] "Company Performance Overview, January to December 2014", LWSC

specific water supply and sanitation needs and challenges of partner countries. The programme focuses on activities that promote "Networking and exchange (that will) enable participants to identify, transfer and adapt performance-related good practices either within a country or within the region and to implement them at their workplaces.[93].

It is noted that the LWSC attended the GIZ funded capacity building workshop aimed at strengthening the competence of utility gender focal persons to formulate gender policies as well as to ensure a coherent approach to assessing gender mainstreaming against an agreed checklist of indicators.[94]

General Aspects of Employment[95]

LWSC staff are free to take up membership with the Trade Union as appropriate for employees in the 7 to 10 grade band. The Trade Union Representative acts in the interests of Union members in terms of representation, conditions of service and issues related to discipline.

Employee contributions are paid to the National Pensions Scheme Authority and the Company has a Group Life Assurance (GLA) Policy in place.

LWSC ensures the payment of Workman's Compensation to the State Scheme for all employees in service, to ensure employee compensation should they be injured on duty.

It is not known whether or not succession planning is in place and, if addressed, how this is addressed.

Staffing Numbers[96]

The LWSC has a total staff complement of 903 persons, which provides a staff to connection ratio of 6.86:1000.[97]

No gender disaggregated data has, as yet, been provided in respect of staff members at the Head Office as well as across all Districts.

Currently no data is available that allows a breakdown to be provided in respect of the age, qualifications, level of appointment or (generally) geographic location of each of the various staff members. Whilst it is known that commercial services are provided in respect of the various districts, it is uncertain whether the Commercial Services branches function from the LWSC Head Office in Lusaka or from offices located within each of the districts.

The Table given as Annexure C provides an overview of personnel allocated to each of the various Divisions of the LWSC. The data provided exclude the staffing numbers in respect of the Kafue Branch Office as well as in

[93] http://www.wave-water.net
[94] NWASCO (2016) Urban and Peri-Urban Water Supply and Sanitation Sector Report 2015
[95] Derived from composite information obtained through a series of interviews with LWSC and other stakeholders undertaken for this assessment as well as for other studies such as the 'LWSC Sustainability Agreement Baseline Indicators and Annual Technical Audit' and the project to 'Develop a Detailed Framework and Workplan to Operationalise the Sanitation Connection Action Plan for Mtendere.
[96] Ibid
[97] NWASCO (2015) Urban and Peri-urban Water Supply and Sanitation Sector Report

respect of the Water Supply Services personnel in respect of each of the districts (including the Lusaka District[98]).

A total of 203 staff members are allocated to decentralised services delivery, bringing the total number of LWSC personnel to 911 persons[99].

Staff Turnover

It is not possible to comment on staff turnover, due to the fact that no data in this regard have been made available to date.

Organisational Structure[100]

The Company demonstrates a clear division of operational functions across different posts. Kafue, which accounts for the second largest water consumption after the Lusaka District itself, runs a separate branch office.

It has been stated that there has been a well thought through and structured translation of the Organisational Strategy into the Company's institutional management procedures and processes as well as its organisational structures and outputs.

Currently the Company is organised into four Functional Divisions that fall under the Managing Director. These are:

Financial Services, with its own Director, providing direct oversight in respect of the Financial Accounting, Management Accounting and Project Accounting functional management areas;

Commercial Services, with its own manager, providing direct oversight in respect of the Branches, the Peri-urban areas as well as the Marketing and Public Relations functional management areas. The Division deals with customer relations, marketing, credit control and billing. In addition, it takes responsibility for water supply technical operations (from the bulk service reservoirs to the customer connections) as well as that for sewerage (connection points through to the wastewater treatment plants); Technical operations are divided into five semi-autonomous branches (Central, Chelstone Kabulonga, Kabwata and Lumumba), each headed by a Branch Manager as well as in respect of four peri-urban areas (Centre, East, South and West) staffed by Development Officers, Plumbers and Customer Services / Billing staff.

[98] Derived from composite information obtained through a series of interviews with LWSC and other stakeholders undertaken for this assessment as well as for other studies such as the 'LWSC Sustainability Agreement Baseline Indicators and Annual Technical Audit' and the project to 'Develop a Detailed Framework and Workplan to Operationalise the Sanitation Connection Action Plan for Mtendere'.
[99] LWSC (2014) Company Performance Overview, January to December 2014
[100] Derived from composite information obtained through a series of interviews with LWSC and other stakeholders undertaken for this assessment as well as for other studies such as the 'LWSC Sustainability Agreement Baseline Indicators and Annual Technical Audit' and the project to 'Develop a Detailed Framework and Workplan to Operationalise the Sanitation Connection Action Plan for Mtendere'.

Engineering Services, with its own Director, providing direct oversight in respect of the (i) Sewerage and Sanitation, (ii) Technical Services, (iii) Maintenance, (iv) Asset Management, (v) Scientific Services – Water, (vi) Scientific Services – Wastewater, (vii) Water Supply (Lusaka, Chongwe and Lusangwa), (viii) the Project Implementation Unit, and (ix) the Kafue Office management focus areas; The Division is tasked with the functions of asset management, maintenance and technical services, water quality monitoring, and geographic information system (GIS). Apart from the bulk water operations functions in respect of Kafue, which is the responsibility of the Kafue office, this Division is responsible for bulk water supply (under the Water Supply Manager) from the Lusaka distribution node and boreholes to the various reservoirs in and around Lusaka as well as the Water Treatment Plants in Chongwe and Luangwa Districts. The Division is also responsible for ensuring bulk wastewater treatment operations and maintenance within Lusaka City and across all four Districts, under the Sewerage and Sanitation Services Manager.

Human resources, with its own Director, providing direct oversight in respect of the (i) HR operations, (ii) Strategy and Staff development, (iii) Training, (iv) Health and Safety, and (v) Security Services related management focus areas;

Separate Management Functional areas are in place in respect of (i) the Company Secretary/ Legal Functions, (ii) Audit Services, (iii) Corporate Planning, (iv) Purchasing and Supplies, (v) Quality Management, and (vi) Non-Revenue Water, each with its own manager. These functional management areas fall directly under the aegis of the Managing Director.

The Organogram[101], set out on **Figure 36** does not make specific reference to the detailed Organisational Structures for all posts resorting under each of the Divisions. As such, the structure does not reflect all positions in the organisation nor does it reflect the lower structures thereof.

[101] Derived from composite information obtained through a series of interviews with LWSC and other stakeholders undertaken for this assessment as well as for other studies such as the 'LWSC Sustainability Agreement Baseline Indicators and Annual Technical Audit' and the project to 'Develop a Detailed Framework and Workplan to Operationalise the Sanitation Connection Action Plan for Mtendere'.

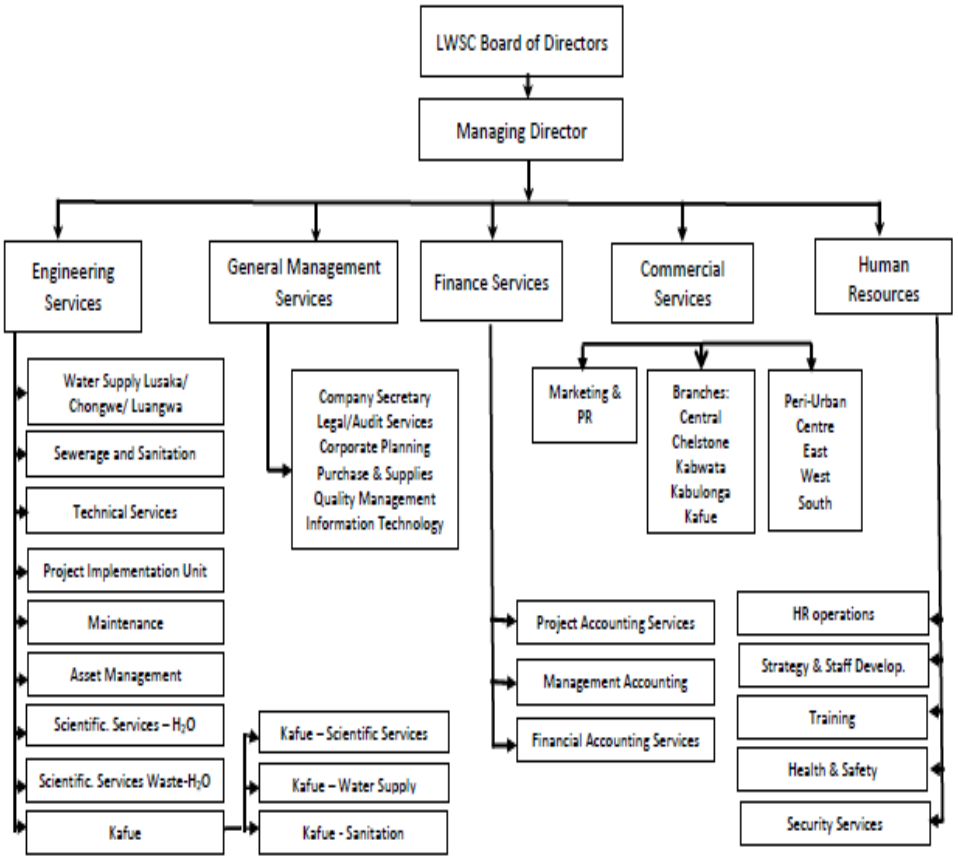

Figure 36 LWSC Organogram

Kafue District Branch - Organisational Structure and Functioning

The total population of the Kafue District is approximately 230,000 people.[102] The Kafue Branch Office has overall responsibility for managing the operations and maintenance of the system in the District, and for new connections. It further undertakes functions related to commercial services (billing, customer services, etc.) and human resource management for the District, overseen by the LWSC Head Office. While costs related to the provision of services are expected to be covered by service payments, operational shortfalls are covered by the LWSC.

[102] Genderlinks (2013) Kafue Becomes Gender Centre of Excellence. Report accessed at http://genderlinks.org.za/programme-web-menu/kafue-coe-2012-05-18/

The District is said to have abundant water resources, which include an estimated 800,000 million m^3 of groundwater (with an estimated recharge rate of approximately 160,000 m^3pa). It is also supplied by the Kafue as well as the Zambezi rivers[103]

The branch office is situated in Kafue town, just over 90 km from the Chirundu border, accessed via route T2, which serves as the main road link between Lusaka towards the north and Zimbabwe to the South-East via the town of Chirundu[104]. Services delivery to Chirundu has been undertaken by the Kafue Branch Office on behalf of the LWSC since 2012.

The Kafue Branch is comprised of an organisational structure that addresses both the commercial and the engineering aspects of delivery. The Kafue Commercial Branch resorts under the aegis of the Commercial Services Division of LWSC, whilst the Engineering Services (comprised of Water Supply, Sanitation and Scientific Services) resort under the LWSC Engineering Division.

Table 50 provides an overview of the staff complement of the Kafue Branch:

Table 50 Kafue Branch Staff Complement

BRANCH DIVISION	STAFF NUMBERS
Commercial Services[105]	21
Water Supply	46
Sanitation & Scientific Services	69
TOTAL (excluding commercial services)	115

The following Organogram (**Figure 37**) serves to provide an overview of the manner in which the Kafue Branch Office has been structured, and includes staff allocations in respect of Chirundu.

[103] Swedish International Centre for Local Democracy (2014) Local Government Partnership Profile – Kafue District accessed at http://www.icld.se/pdf/Kaufe_district_Council_profile.pdf
[104] http://distancecalculator.globefeed.com/Zambia
[105] Assumed to be situated in Lusaka and forming part of the LWSC personnel allocation to Commercial Services in the Western Zone (estimated to be in the order of 33% of the current 64 persons employed under this category

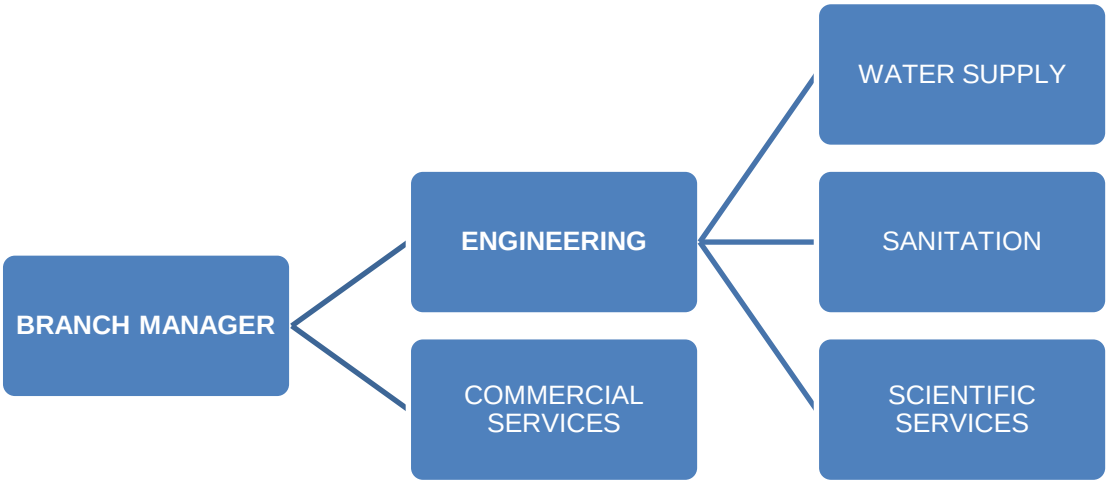

Figure 37 Kafue Branch Organogram

Chirundu

Although there appears to be some uncertainty as to the exact size of the Chirundu District population, it is close to 60,000 people,[106] residing in a geographic area of 6,693 km[2107]. More than 65% of the population resides in rural areas (engaged in commercial and subsistence agriculture), with an approximate 18,383 people residing within the urban areas of Chirundu[108]. Although current statistics are not directly available, it was reported that some 500 people were directly employed in the commercial agriculture sector, with at least an additional 2,000 agricultural workers being drawn into the sector on a seasonal basis[109].

Whereas much of the area around Chirundu town in Zimbabwe is set aside for wildlife, the rural areas surrounding Chirundu, Zambia, are used for commercial and subsistence agriculture. The farms outside Chirundu are large, employing more than 400 permanent workers and 2,000 seasonal workers.

Chirundu was declared a separate district during 2012 and realigned from the Southern Province to the Central Province. Prior to this its administrative centre had been located in Siavonga from where all government related activities were handled. Subsequent to the 2012 realignment, all government services (apart from those offered by the Department of National Registration, Passport and Citizenship) had been moved to Chirundu[110].

Chirundu border has a number of townships and residential areas, which include Appolo, Border, Chibaketi, the Mission and Zesco compounds, Mazyongololo, and the 'High cost' and government complexes. There appear

[106] CRIDF (2016) Chirundu Water Supply and Sanitation Project - Outline Business Case
[107] http://www.statoids.com/yzm.html
[108] CRIDF (2016) Chirundu Water Supply and Sanitation Project - Outline Business Case
[109] Family Health International (FHI) (2013) Corridors of Hope in Southern Africa: HIV Prevention Needs and Opportunities in Four Border Towns
[110] Zambia Daily Mail (20 October 2015) Chirundu: Border town on the move accessed at https://www.daily-mail.co.zm/?p=48347

to be a fairly 'well-established' informal settlements (Gabon and ChiBhaghedi) as well as informal houses dotted throughout the formal settlement[111].

Currently the Mtendere Catholic Mission Hospital, located in Chirundu town, is said to provide significant health facilities to patients from as far away as Kafue Town as well as from Zimbabwe. There are two smaller clinics in place and an additional government health centre is currently being constructed in Chirundu which will require access to water and sanitation related services.[112] Additional rural health centres are in place in the Chirundu District at Lusitu, Chipepo, Jamba, Chikanzaya and Ibbwe Munyama.[113]

Increasingly, access to Chirundu town is being facilitated through the development of infrastructure, including an 11-kilometre radius township road network as well as feeder roads, aimed at improving transportation in the area. In addition, a connecting 160-meter bridge has been put in place over the Kafue River, to allow greater access to services within Chirundu to the Chiawa rural population, who were previously obliged to use the Kafue River pontoon system[114].

Significant numbers of transient sex workers visit Chirundu at peak periods, particularly at month's end, when the border is deemed to be at its busiest and is reported to have increased as traffic load has increased. In addition, informal traders congregate at three designated market areas. Cross-border trading takes place on a regular basis[115].

The CRIDF OBC notes that approximately 2,440 people pass through the border post via light and heavy trucks, passenger busses as well as private vehicles per day[116]. According to a Study undertaken by the Zambian Government in collaboration with the World Trade Organisation, Chirundu handles an average of 270 trucks on a 'typical' day and that "the town has become the busiest port in Zambia and one of the most utilised inland border points in the eastern and southern Africa region"[117].

Water supply and sanitation services are a shared responsibility between the Chirundu District Council (mandated to ensure delivery in the rural areas of Chirundu) and the LWSC (mandated to provide services for urban areas). At the same time, it is noted that the LWSC delivery mandate is "limited to a relatively small population catchment area within the urban centre of Chirundu town. This mandate was established when LWSC took over operations during the creation of the new district, and has since not been expanded even as the size of Chirundu town has increased through urbanization and population growth."[118]

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[111] Family Health International (FHI) (2013) Corridors of Hope in Southern Africa: HIV Prevention Needs and Opportunities in Four Border Towns
[112] Zambia Daily Mail (20 October 2015) Chirundu: Border town on the move accessed at https://www.daily-mail.co.zm/?p=48347
[113] Ibid
[114] Ibid
[115] Family Health International (FHI) (2013) Corridors of Hope in Southern Africa: HIV Prevention Needs and Opportunities in Four Border Towns
[116] CRIDF (2016) Chirundu Water Supply and Sanitation Project - Outline Business Case
[117] Zambia Ministry of Trade and Commerce and the World Trade Organisation (2011) The One-Stop Border Post Concept – A Case of Chirundu Border Post Between Zambia and Zimbabwe
[118] CRIDF (2016) Chirundu Water Supply and Sanitation Project - Outline Business Case

Infrastructure Capacity and Coverage

One of the biggest challenges facing LWSC is a severe lack of capacity in relation to demand. This is most profound in Lusaka but also applies in the smaller towns such as Chilanga. Chongwe and Chirundu. The situation is not quite as critical at Kafue. In 2014 LWSC supplied on average 235 Ml/day, whereas the estimated demand was 411 Ml/day[119]. This means that the potential for additional customers and sales is huge however it also means that the capital expenditure needed to address the shortfall is massive. LWSC have projected a capital expenditure of Kwacha 4,3 Billion over the next 5 years. The bulk of this is earmarked for expansion of capacity.

Historically Lusaka made excellent use of the superb underground aquifer present in the dolomitic limestone beneath the City. Almost 200 Ml/day is drawn from this aquifer, which is quite remarkable for a groundwater source. This resource however reached its capacity some years ago and any additional draw on it is likely to lead to its premature decline. The second major source is from the Kafue River. This water is treated at the Iolanda Works located at the Kafue River. An upgrade of 50 Ml/day is currently being implemented, funded by the Government of Zambia[120]. This also requires a major upgrade of the pumping capacity. A further upgrade of the Iolanda Works to 600 Ml/day is being discussed with JICA and the African Development Bank. This will cope with demand at Lusaka for the foreseeable future. It is planned to start implementation of this well before 2020[121].

Accurate figures are not currently available however it is estimated that the existing Chirundu scheme supplies an area containing approximately 4700 people. The Chirundu urban area as a whole is estimated to contain over 17 000 people, so the potential additional demand is very significant, not to mention the wider rural and peri-urban areas. LWSC estimate the current shortfall to be about 7 ML/day but it is not clear exactly what catchment they have used to assess this.

There are currently two separate systems that are not interconnected. Both of these have their own river intakes and treatment works. The current scheme is plagued by interruptions due to significant problems with the current configuration and design. These problems are numerous however perhaps the most significant are lack of adequate storage, inadequate process control at the treatment works and inadequate river intake systems. Lack of storage means that there is no “buffer” to cope with operational problems of any nature and provides a situation where there is very little margin for error for the operators, inevitably more supply interruptions and hence inferior customer service (apparently even some of the existing storage is not connected for some reason). Neither of the river intake systems is adequate at present. Both function reasonably adequately in normal flow conditions but struggle when higher flows occur. The design of the two intakes varies somewhat but both are impacted by surface debris that is carried down by the river at higher flow levels. This results in extra

[119] “Company Performance Review: January to December 2014”, LWSC
[120] Ibid
[121] Ibid

load on the intake arrangements and often damage and malfunctioning. This again results in service interruptions.

Operations and Asset Management

LWSC are conscious of the need for improved asset management and most certainly improved management of NRW (see 5.5.3 below). In their most recent Strategic Plan, LWSC have identified the need to "implement asset management policy"[122] and have listed the following supporting strategies/plans:

- Develop and implement maintenance management policy
- Implement asset renewal policy
- Implement asset disposal policy
- Carry out condition monitoring

As always, a key building block for holistic asset management is the asset register. At this point it is not clear how far LWSC have progressed with this. It can be an extremely time consuming and lengthy exercise where there is a significant backlog in records as there are few short cuts when it comes to collecting missing information.

A highly effective GIS is also fundamental for effective asset management. It is understood that this is in place however its status is not known.

The importance of rehabilitation is a recurring theme in the strategic plan and a highly significant component in the capital expenditure plan. This highlights the neglect and lack of maintenance that occurred prior to the last ten years, which has resulted in significant backlogs in this area.

If anything, the condition of the sewer system in Lusaka is even more parlous with many years of neglect necessitating massive expenditure on rehabilitation. The sewerage works feature prominently in this. Historically NWASCO did not actively regulate these as this was the remit of ZEMA. However the latter was under sourced. Recently there are signs that these two regulatory bodies will work more closely together to address this problem. The state of the sewerage works and upgrades to elements of the sewerage system are focus areas of the MCC Compact Agreement. There is also currently work underway on the planning for a major upgrade of the Lusaka sewerage system as a whole.

Substantial investment was made in a water borne sewerage system in Chirundu by SWSC but for some reason this was never commissioned. Apparently as built information regarding this is not available. LWSC staff at Chirundu believe that this infrastructure is still in good condition but this will only be able to be determined once suitable testing of it has been carried out.

From an operational perspective, Chirundu falls under the Kafue region, with its offices located in Kafue. This office is also responsible for Chilanga, Chongwe, Luangwa, Kafue Town and the Iolanda Works. The latter is by far the biggest and strategic element of infrastructure in this region. LWSC have acknowledged that the current

[122] "Strategic Plan: 2014-2018", LWSC

operational regime at Chirundu is inadequate. This comment applies to the levels and qualifications of staff, water quality monitoring, reliability of supply and other aspects[123]. The implication is that these issues will be addressed when the scheme is upgraded. From a practical perspective, Chirundu is located in quite an isolated location some distance from Kafue, which adds to the logistical challenges. This would also tend to imply that a degree of autonomy will be necessary at Chirundu if the scheme is to be run effectively.

Non-Revenue Water

Non-revenue water is an endemic problem in Zambia with none of the commercial utilities achieving a figure better than 32% and most, much higher. As a result, it is one of the key indicators monitored by NWASCO. In spite of this, progress in the last 5 years has been slow and the current drought has highlighted the importance of addressing NRW more effectively. The problem has now reached the stage whereby GOZ have set up a task force designed to specifically target NRW. The results of this are not yet known to the author.

LWSC are experiencing severe problems with NRW throughout the systems that they manage. Their overall NRW figure for 2015 was 47%, which is widely considered to be an unacceptable level. Due to the configuration of their raw water supply systems, LWSC have to pump virtually all of the water that they supply so they also have a strong motivation to reduce NRW. There are of course wider additional benefits such as reduced chemical costs and deferment of capital works. Addressing NRW is one of the eight corporate objectives in the LWSC Strategic Plan viz. “To Reduce Non-Revenue Water from 42% to 25% by 2018”. While this degree of emphasis is laudable, the objective is far too optimistic in the view of this author. Meaningful reduction of NRW is generally only achieved after a sustained effort maintained over 5 years or more involving multiple techniques and strategies. It is known that LWSC have appointed a dedicated resource to oversee NRW but other details of the work undertaken is not known at this stage.

Apparently LWSC are not currently able to carry out a reliable water balance exercise at Chirundu. In view of the fact that every drop of water supplied at Chirundu has to be pumped, this provides a potent motivation to reduce it to low levels. It is also not clear at this stage to what extent LWSC have a system of district meters so that they can define zones and problem areas can be isolated and problems diagnosed and addressed more rapidly. With the current low levels of staffing and poor condition of infrastructure, it is unlikely that meaningful reductions in NRW will be made without a significant capital injection, as is contemplated by the CRIDF programme.

Service quality

A summary of the overall performance of LWSC in comparison to the other utilities in Zambia is shown the 'Sector Performance (2015)' table in **Annex F1**. This demonstrates that LWSC have performed well in the areas of water quality, water coverage and collection efficiency, while hours of supply at 17 and sanitation coverage at 74% are considered to be adequate.

[123] Mr Mwanza, Operations Manager, Kafue, personal communication

Areas where LWSC did not perform as well included non-revenue water at 47%, metering ratio at 72% and O and M cost coverage at 88%. They also had challenges in the areas of handling complaints from clients, interruption of water supply, sewer blockages, sewer flooding and the quality of sewage discharge.

The latest tariff determination carried out on LWSC by NWASCO in 2015 was not the comprehensive assessment carried out for a three year period but the so called “no objection” assessment. This resulted in an approved tariff increase of 30%. The conditions attached to this (Service Level Guarantee) included installation of an additional 15 000 meters and 5 000 new connections in Lusaka.

Conclusions

Interestingly, Technical Assessment for Chirundu has as many recommendations that speak to town planning issues as those covering technical water and sanitation elements. This is indicative of the fact that Chirundu is not only a “work in progress” but also a newly recognised urban area. Examples of this include the following:

- “The proposed water supply network will promote properly structured growth of the centre by creating a strong incentive to develop housing in existing vacant lots that are in proximity to water supply services
- Authorities should encourage the development of housing in existing infill areas that are covered by the network through densification, with spatial expansion of the housing areas only occurring after all vacant lots have been filled.
- The Zambian Government Authority responsible for urban and regional planning for the areas should urgently develop a combination master plan for the new housing if this has not already been carried out. This will streamline the provision of water supply and sanitation services to cater for the growth.”

These comments speak to the great potential the town has for further development and acknowledges the high growth of the town in recent years. It also highlights the catalytic potential of the proposed project to upgrade water and sanitation in the town.

From an institutional perspective, there is moderate to low risk with respect to this project. Partly this is because the size is relatively small and partly because LWSC, though it has its challenges, has demonstrated significant institutional capacity over the years. There are admittedly concerns regarding the ongoing financial viability of the utility and the draft financials for 2014 are disappointing in this regard. It is hoped that this is an anomaly, rather than a negative trend. In general however LWSC has demonstrated a trend over a number of years of gradually gaining institutional and financial strength. In view of the concerns, some consideration should perhaps be given to initiatives that further strengthen LWSC’s viability, in addition to delivering a high quality and sustainable project at Chirundu.

There is also some potential to foster initiatives that can benefit the other utilities that are implementing border projects i.e. EWSC and SWSC. Though there are differences in size, there do appear to be common challenges in areas such as asset management, NRW, revenue management and process control. CRIDF could consider an advocacy/facilitating role in this regard.

There is some risk that, with its remote location, and LWSC’s massive commitment to Lusaka, Chirundu could become something of a nuisance to LWSC. The location of this project is nevertheless of a strategic nature with

potentially positive spin offs in terms of enhanced commerce, trade and tourism. This can only benefit the local population and also, by extension, LWSC itself.

Recommendations

As part of the gearing up phase and before commencement of the formal project, these draft institutional strengthening proposals should be workshopped with LWSC and thereafter refined. These recommendations have also been formatted into a 'High Level Implementation Work plan', attached as **Annex F2**.

Institutional Arrangements

- Refine and confirm the institutional model for Chirundu – its remoteness may necessitate more creative options like outsourcing of some functions so as to manage operational costs.
- Liaise with other key institutions so as to align planning and effective implementation of the project. This is particularly crucial in this context in view of the early developmental stage of the urban planning for Chirundu. There is a real opportunity here to influence development of the town in a positive manner.
- Identify private operators for water kiosks and ablution blocks in conjunction with community structures and put in place supply/service contracts.

Governance

- It is assumed that both LWSC and NWASCO will continue to engage the Minister of MLGH regarding the skills make-up of the new Board so as to ensure that the fiduciary responsibilities of the new Board can be carried out effectively.
- Identify appropriate training for board regarding fiduciary responsibilities and conduct these courses.

Strategic Management

- Potentially use this new scheme to pilot new best practice approaches in areas like NRW, planned maintenance, process control and outsourcing.
- Investigate options of using local residents and entrepreneurs to perform outsourced functions, both to contain costs but also to foster community relations.
- In view of the strategic and international implications; consider giving the operation and maintenance of this scheme some degree of higher priority.

Financial Management

- Create a separate (ring fenced) profit centre for the Chirundu scheme (it is understood that this has already been actioned by LWSC).
- Provide guidelines to private operators regarding tariffs.
- Implement a programme to replace old and defective meters.

- Consider outsourcing to collect outstanding debt at Chirundu (this could also be a broader initiative designed to enhance LWSC's sustainability)

Organisational Design and Human Recourses

- Review LWSC organogram to determine optimum arrangements to manage the upgraded scheme. Implement changes as necessary.
- Undertake training of staff that will be responsible for operation of the upgraded scheme.
- Development of apprenticeship programme; possible broader initiative to be undertaken collaboratively with EWSC and SWSC.

Asset and Operational Management

- Put in place SOPs for the new scheme
- Put in place system to carry out water balance on a monthly basis
- Consider planning of systems so as to allow extensions to respond to the orderly expansion of Chirundu in line with urban planning proposals.
- Populate IAR with information on the new scheme (including all existing installations)
- Develop planned maintenance schedule
- Develop IAMP at Chirundu (potential broader initiative to strengthen LWSC)
- Develop and Implement a Water Safety Plan

Service Quality

- Ensure Chirundu is added to LWSC's (water quality) compliance monitoring programme
- Engage actively with local communities during planning and implementation process
- Undertake public awareness campaigns
- Design and undertake programme to promote safe sanitation, health, hygiene and water awareness in Chirundu
- Promote the use of private connections in Chirundu
- Consider option of additional (commercial) ablution blocks for tourists
- Consider use of mobile phone technology to enhance payment and customer experience

Risk Assessment

A high level risk analysis is outlined **Table 51**, reflecting possible technical, financial and operational risks that might impact on the project's viability or implementation.

Table 51 Identified project risks and mitigation measures

Risk	Level	Mitigation Level
A lack of understanding of the requirements of the project The level of data currently available is not commensurate with the capital project cost.	Medium	• The assumptions and limitations of the data has been stated in the Feasibility Study • Focus future actions and technical assistance on obtaining validated information and understanding of the system. • Involvement and consulting of all key stakeholders at all stages of the project formulation process. • Recognition of the roles and responsibilities of each stakeholder in the process
Varying the scope and or project objectives This can impact on the project cost and viability	Medium	• The objectives, scope and expected outputs and outcomes have been stated within the Feasibility Study. • Feedback to the stakeholders some of whom communicate the same to the beneficiaries. • Involvement and consulting of all key stakeholders at all stages of the project formulation process.
Capital Costs An excessive capital investment that is not appropriate to Chirundu and the resultant inability to fund the investment.	High	• The phased approach to the project aims to ensure that capital investments are fully demand driven by the growth and expansion of the town.
Domestic Demand Population may not grow as predicted. This will impact revenues generated by the project and thus its operational	Medium	• Ensure adequate collaboration with the District Council before project implementation. Stress the importance of town planning in collaboration meetings.

Risk	Level	Mitigation Level
sustainability. O&M costs will then be serviced by small number of persons which will challenge the affordability or cost recovery of the intervention. Additionally, if Chirundu's development happens outside of the proposed design, this will mean that the target population will not be served by the infrastructure. In turn this will result in the socio-economic benefits and financial revenues of the project not being realised.		• Ensure detailed designs are based on realistic projections of current and future water demand.
Domestic Tariff Rates Affordability constraints pose the risk of the average domestic tariff 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 system.	Medium	• A more detailed analysis of affordability should be conducted as part of project implementation (particularly because new populations migrating into Chirundu 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.
Cost Recovery in General 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 realized (billed for and collected).	Medium	• The technical design (DNIs) of the project aims to maximize 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 realize service revenues.
Vandalism of the system	Medium	• Facilitate establishment of community water supply committee(s) • Promote community education, awareness campaigns and promotion of social capital

Risk	Level	Mitigation Level
Sanitation facilities Border patrons unwilling to pay for ablution facility	Low	• Base tariffs charged in the ablution block on those charged in the informal market for water supply and sanitation as these represent observed willingness to pay in this market. • Keep ablution facilities functional and clean so that border patrons continue to value its services
Planning not in accordance with assumptions made This will not impact the bulk infrastructure, but could result in incorrect sizing of distribution infrastructure.	Medium	• Provide assistance with planning of the town • Obtain buy-in from stakeholders regarding the identified plan. • Undertake the project in phases, to optimize capital and match short term planning.
Operation and Maintenance	Low	• LWSC currently operates much larger schemes successfully • A risk is potentially ring fencing income from Chirundu, for Chirundu.
Buy-in from Government CRIDF has engaged the Ministry of Local Government and Housing from the onset and has had high level meetings	Low	• Full support from Government • Political interference is however a potential risk
Availability of Grant Funding The Chirundu project will require grant funding to proceed.	Medium	• Engage with funders at the earliest opportunity • Align the project with possible / available funding.

Conclusions and Recommendations

Chirundu is an important international border for the north south corridor linking a large number of countries in eastern and southern Africa. The transport corridor linking South Africa to its northern countries is the busiest regional transit transport link in eastern and southern Africa, carrying 5.8 million tons of cross-border traffic. The corridor extends over the territories of three regional and economic groups, COMESA, SADC and SACU.

The high volume of traffic has brought commercial opportunities to Chirundu, while at the same time placing the existing services under pressure. The pressure on services has increased the risk of waterborne diseases in Chirundu and the possibility of cross border infection. This is exacerbated by the high HIV infection rate that is experience in Chirundu, partially due to the high transient cross border population that spends time in Chirundu while completing the cross border formalities.

Chirundu residents clearly expressed their dissatisfaction with the current water supply and sanitation services as provided by the LWSC. Residents re-emphasised the need for adequate water supply and sanitation as they felt the high temperatures and low rainfall in the area has already compromised their quality of life.

No clear town planning has been completed for Chirundu, which is complicated by the ongoing negotiations to obtain a larger town boundary by obtaining a portion of surround customary land. It is critical that the planning of the town be undertaken, with the input from LWSC with regard to most efficient method of servicing the entire town.

The Feasibility Study has identified the capacity of the bulk infrastructure, including Water Treatment Plant, bulk distribution and storage, as the main water supply constraints that need to be addressed. A phased approach is recommended to optimise the available capital and match the population growth. The proposed implementation phases is shown in **Table 52**, however the phases would need to be prioritised with available funding. Furthermore the Medium and Long Term planning horizon needs to be implemented based on actual population growth.

Table 52 Planned Implementation Phases

Phases	Planning Horizon (Year)	Main areas of intervention	Implementation plan
Phase 1	Short Term (2021)	Upgrade intake pontoon Upgrade of treatment plant to 2ML/d Upgrade pumping system, pumps and pumping mains Upgrade bulk main pipelines Introduce bulk meters Increase storage to 2ML/day Construct new and refurbish existing ablution facilities	Design and construction before 2021.

Phases	Planning Horizon (Year)	Main areas of intervention	Implementation plan
Phase 2	Medium Term (2026)	Upgrade treatment plant to 6Ml/d (double from 2ML/day) Increase storage to 6ML/day (12hr) Upgrade secondary distribution network within DNI zones Refurbish sewer system and connect high water consumption users	Design and construction before 2026 – to be confirmed based on actual population growth.
Phase 3	Long Term (2036)	Expand secondary distribution network with increase in population	Design and construction before 2036 – to be confirmed based on actual population growth.

The estimated capital investment is shown in **Table 53**. The phases (Short, Medium and Long) are linked to the population growth, which should be used as the basis for future development, i.e. confirm the population growth is in accordance with the Feasibility Study.

Table 53 Total Preliminary Implementation Costs - All Phases of Works

Total Capital investment 2016-2036			
Item No.	**Item Description**	**Amount US$**	**Amount GB£**
1	Short Term (Phase 1) – Water Supply	2,335,000	1,604,500
2	Short Term (Phase 1) – Sanitation	75,000	51,500
3	Medium Term (Phase 2) – Water Supply	2,388,600	1,641,300
4	Medium Term (Phase 2) - Sewer and Sanitation	3,029,400	2,081,600
5	Long Term (Phase 3) – Water Supply	196,700	135,200
	Total	**8,024,700**	**5,514,100**

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.

The project is not expected to have significant environmental impact, as it is mainly within the urban area, which is already severely degraded. The intake may require special attention, as it is based in a lush riverine environment, close to a forest area. A detailed environmental assessment will be required, in accordance with the Environmental Management Act. Furthermore a number of permits will possibly be required before any construction project can be contemplated.

The project could actually be used to enhance certain environmental challenges, like improved sanitation in Chirundu, i.e. making Chirundu an open defecation free zone.

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 is expected to result in significant improvements to the health of Chirundu residents, as well as border patrons, along with time savings and ecological improvements, all of which indicate that the project should be implemented.

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, grant or subsidised funding are required to cover 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. 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; LWSC must adjust the phased investments as appropriate.

From an institutional perspective, there is moderate to low risk with respect to this project. Partly this is because the size is relatively small and partly because LWSC, though it has its challenges, has demonstrated significant institutional capacity over the years. There are admittedly concerns regarding the ongoing financial viability of the utility and the draft financials for 2014 are disappointing in this regard. It is hoped that this is an anomaly, rather than a negative trend. In general however LWSC has demonstrated a trend over a number of years of gradually gaining institutional and financial strength. In view of the concerns, some consideration should perhaps be given to initiatives that further strengthen LWSC's viability, in addition to delivering a high quality and sustainable project at Chirundu.

It is therefore recommended that this project should proceed, either through CRIDF support by taking the project to Financial Closure or for CRIDF to support the LWSC with obtaining grant funding for the project. It will be greatly beneficial to undertake some technical assistance work with the Chirundu District Council and LWSC to strengthen the institutional ability, review planning options and obtain verifiable data / information on the existing water supply network. Technical assistance could also be of benefit to the Chirundu District Council to finalise the town boundary, which will potentially increase the LWSC supply area dramatically.

Annex A - GESI Tables

Annex A1: GESI Analytical Checklist

Annex A2: GESI Action Plan

Annex A3: GESI Rating Operations Table

Annex B – Existing Infrastructure

Annex C – CCRA Tables and Explanation Notes

Annex C1: Benefits Matrix

Annex C2: CCRA Explanatory Notes

Annex D – CBA Assumptions

Annex D1: CBA Assumptions

Annex D2: CBA Tables

Annex E – Key Informant Interview (Meeting Notes/Record)

Institution Name	Lusaka Water and Sewerage Company Ltd.
Date of call/meeting	28th January, 2016, Kafue
Key contact	*David Ngenda*
	District Manager
	dngenda@lwsc.com.zm; +260968440153
Others present at the meeting	*nil*

Discussion detail

- *Current access to water supply in Chirundu is about 65%*
- *Population is growing very rapidly and Lusaka Water and Sewerage Company (LWSC) is not able to match growth rate*
- *There is a desperate need to expand and upgrade the existing network to meet demand*
- *LWSC does not provide sewerage services as infrastructure is incomplete e.g. the sewage ponds may even need to be relocated from their current proposed site (construction works incomplete)due to increased space requirements*
- *Population relies on on-site sewage disposal i.e. septic tanks and pit latrines*
- *No major disease outbreaks arising out of erratic water supply have been experienced by LWSC*
- *No topographical survey has yet been undertaken for the area*

Subject	**Key points arising**
Siavonga District	• Need for upgrading of infrastructure to meet current and future population levels • Need for detailed topographical survey to ascertain the sewerage network layout • Major risk of disease outbreak due to inadequate access to water and acceptable sanitation services

Actionable Steps
• *To seek further information on challenges in the Chirundu service area from the Area Foreman based in Chirundu* • *Topographical survey* • *Hydrological survey for raw water source*

Institution Name	Lusaka Water and Sewerage Company Ltd.
Date of call/meeting	29th January, 2016, Chirundu
Key contact	*William Kapya*
	District Foreman
	wkapya@lwsc.com.zm; +260977969015
Others present at the meeting	*nil*
Discussion detail	
• *Current access to water supply in Chirundu is about 65%* • *No of households (HH) approximately 2500 (2013 estimate) at an average 6 persons per households* • *928 connections including commercial* • *Most HH source their water from kiosks* • *There is a high demand for individual connections but this inhibited by poor network* • *Groundwater is very saline and unpalatable hence raw water from the Zambezi is preferred* • *There are 3 unused sewage pumping stations and 4 oxidation ponds that are unused as the works are not completed to date* • *There are 2 water treatment plants located 5Kms apart treating 1600m3 of water per day* • *There are 2 reservoirs of 50m3 each for storage of water* • *The 2 reservoirs are highly inadequate to meet demand hence the system operates such that the water is directly pumped into the network from the treatment process*	

- *Pipe network needs urgent upgrade as it is inadequate to meet demand*
- *Chirundu District Council needs to prepare a master development plan that will indicate the routes that the water distribution lines will take in relation to the locations of the storm water network, road network and plot boundaries*
- *Chirundu District Council has been allocated 600Ha of land for new developments in the north side of the district*
- *Chirundu District Council is currently legalising the unplanned settlements in the district*

Subject	**Key points arising**
Chirundu District	• Need for upgrading of infrastructure to meet current and future population levels • Need for detailed development master plan from Chirundu District Council to enable design process

Actionable Steps

- *To seek further information from Chirundu District Council on master plan*
- *Topographical survey*
- *Hydrological survey for raw water source*

Institution Name	Lusaka Water and Sewerage Company Ltd.
Date of call/meeting	11th February, 2016, Lusaka
Key contact	*George Ndongwe*
	Managing Director
	gndongwe@lwsc.com.zm; +260977688879
Others present at the meeting	*nil*

Discussion detail

- *Welcomes CRIDF's initiatives to undertake feasibility study of Chirundu border town*
- *Chirundu one of the most important entry points into Zambia, hence improved water and sanitation levels are a necessary imperative*
- *Current access to water supply in Chirundu is very low as infrastructure is old and inadequate to meet current and future demand levels*
- *Urgently require resources to upgrade infrastructure to meet current and future demand*
- *LWSC does not have the resources internally to address the problems at Chirundu*
- *Topographical survey required due to undulating terrain in Chirundu*

Subject	**Key points arising**
Chirundu District	• Need for upgrading of infrastructure to meet current and future population levels • Need for detailed development master plan from Chirundu District Council to enable design process

Actionable Steps

- *Topographical and hydrological survey required*
- *Hydrological survey for raw water source*
- *Estimated costs of network expansion required*

Institution Name	Lusaka Water and Sewerage Company Ltd.
Date of call/meeting	18th February, 2016, Chirundu
Key contact	*William Kapya – District Foreman*
	District Foreman
	wkapya@lwsc.com.zm; +260977969015
Others present at the meeting	*Kenny Sililo –Cashier*

	Michael Kambole- CRIDF Hydrologist *Mathew Chennils – CRIDF Socio-Economist* *Litumelo Mate – CRIDF Sociologist* *Ian Banda –CRIDF Activity Lead*

Discussion detail

- *Kiosk collections have dropped of late as large no of customers are migrating to household connections*
- *Collections will only improve with new infrastructure*
- *Water flow rates in the river Zambezi can be collected from the Zambezi River Authority*
- *Water testing is undertaken at the plant twice a month and a team from the headquarters conducts tests from time to time*
- *LWSC service newly opened up areas under customary land.*
- *The company has extended into peri urban areas served through kiosks*
- *Number of connections determined by the number of applications.*
- *Average household size is estimated at 6 members.*
- *Revenue raised at present is not adequate enough to cover costs of maintenance*
- *Cost of maintenance is supplemented by headquarters*
- *Company records 75% water fee collection rate with a billing efficiency of 90%*
- *The company has potential to collect enough funds to finance its maintenance but some of the constraints include the following:*
- *Production capacity – hours of supply are limited to about 19 hours due to low pumping capacity, however a few areas are on 24 hours service*
- *Tariffs are reviewed annually*
- *There a total of 9 kiosks in peri urban areas*
- *These are maintained by LWSC and managed through vendors*
- *All the 9 vendors are women, it was a deliberate decision to have women because they are seen to be users of water in the households.*
- *All the kiosks are metered to enable the company to charge for the water supplied.*
- *Each vendor receives 40% of the total water sales in a month.*
-

- *The company is encouraging household connections too this was in response to people's requests for household connections.*
- *However there is still a need for kiosks to serve households that are poor*
- *Response to pay is unusually overwhelming particularly when the supply is reliable and constant.*
- *CRIDF reminded the company of the need to consider the relevance of kiosks.*
- *Due to the climatic conditions of the area, residents are in need of water at all times for domestic use especially for personnel, hygiene. When the water supply is erratic residents seek other alternatives such as:*
- *Drawing water from the Zambezi River.*
- *Buying from residents with private boreholes*
- *The company reported that there is an existing sewerage system infrastructure whose pump station is not in use.*
- *There are plans to develop a sewerage department to revamp the operations given the district status and new urban centre development plans.*
- *In the meantime the centre is on onsite sanitation with the use of septic tanks, soak away for those with water supply connections*

Subject	**Key points arising**
Siavonga District	• Need for upgrading of infrastructure to meet current and future population levels • Need for detailed development master plan from Chirundu District Council to enable design process

Actionable Steps

- *To seek further information from Chirundu District Council on master plan*
- *Topographical survey*
- *Hydrological survey for raw water source*

Meeting 1

Institution Visited	**Ministry of Community Development Social Welfare – District Office**
Date of Meeting	18th February 2016
Name of Person Contacted:	Mr. Simuluwa– District Community Development Officer - +260 977662118

Issues / Aspects	Discussion	Follow up action / Information
General overview of the Department of Community Development	The department works with vulnerable and incapacitated households. There are a number of programmes such as gender, food and security, non - formal education and self-help. Due to decentralization they also work with markets and other urban issues.	
Women Department	This department is responsible for forming and registering clubs, training women in entrepreneurship, establish savings groups and empowering them with grants and village banking that provide soft loans. • 27 women's clubs have been formed, and 22 of these in Chirundu urban have formed a Women's Area Association.	
Self Help	In some rural parts of the district, some self-help programmes have been initiated e.g. construction of a community hall in Sikongo, establishment of Village Water Sanitation and Health Education (VWASHE).	
Non Formal Education	Vocational skills training offered in vocational skills, blacksmith, and instructors.	
Food relief	Vulnerable but viable households who can pay for goods at the cooperative are issued with a pack of fertilizer of 2x50kg and 10kg seeds. Whilst some are on food relief. These are reviewed after 2 years. • A vulnerability assessment is conducted prior to provision of respective packs.	

Issues / Aspects	Discussion	Follow up action / Information
	• Peer monitoring used to ensure payback • About 40% of Chirundu urban area population is food insecure because the area is arid and is a valley with very high temperatures.	
Water and sanitation related activities	• In sanitation women have been trained in sanitation to ensure that each household has a latrine and also every households participates in the 'Keep Chirundu Clean' • Women and men participate in the CLTS, which is mainly rural area programme.	
Employment	• Chirundu urban centre has no agricultural activities • Major income based activities include, clearing agents, public service workers, drivers, women in trading in the market. Those along the rivers are involved in gardening.	
Institutions available	Include mainly government departments such as Chirundu District Council, Ministries of Home Affairs (migrations), Works and Supply, Education, Community Development and Social Welfare, Labour, Agriculture, Lands, Natural Resources and Environmental Protection Zambia Revenue Authority Health, Zambia Bureau of Standards, Office of the President, • The district has an active DDCC under which all the above are represented and	
Proposals for expansion of the area	Possible triggers for population growth would include • Land availability for other activities other than agriculture. Land still available and still under customary ownership hence relatively cheap • Availability of international waters such as the Zambezi for some hospitality industry activities, and agricultural activities along perennial rivers such as Kafue and Lusitu rivers. • Opportunity for the hospitality industry to promote tourism • Presence of a national park	

Issues / Aspects	Discussion	Follow up action / Information
Vulnerabilities	Chirundu district as a whole has a number of child headed, female headed, widows, widowers and the aged...	
Concerns as regards water supply and sanitation	• Color of water is murky brown cause to worry. • Would it be possible to have an intake along the Kafue river??	

Meeting 2

Institution Visited	**Chirundu District Council**
Date of Meeting	18th February 2016
Name of Person Contacted:	Mr. Chipapa Kumpupa – Director of Works Mr. Richard Tembo – Health Inspector Mr. Jacob Tembo – Socio economic Officer - +260 979891324 Mr. Fred Munongo – District Planning Officer – fredmunongo@gmail.com

Issues / Aspects	Discussion	Follow up action / Information
General overview of Water Supply Services	Local authority function have been devolved to LWSC and the main challenges have been the following • Pipe network and pumping needs upgrading • Unused sewer system needs some attention • Considering the growth of the urban centre, there would be need to expand and extend the current water supply system to the new areas. Other activities that the local authority is engaged in are	

Issues / Aspects	Discussion	Follow up action / Information
	• Implementing the CTLS programme • Sourcing for funding to implement the RWSS national programme, which involves drilling boreholes.	
Water supply coverage area	Chirundu urban centre covers both state and customary land and the authorities are still negotiating for more land from the traditional leadership. • Urban centre has an approximate population of 15,052 • Cover portion of six wards.	
Proposals for expansion of the area	Possible triggers for population growth would include • Land availability for other activities other than agriculture. Land still available and still under customary ownership hence relatively cheap. • Availability of international waters such as the Zambezi for some hospitality industry activities, and agricultural activities along perennial rivers such as Kafue and Lusitu rivers. • Opportunity for the hospitality industry to promote tourism e.g. presence of a national park.	
Health and sanitation	• The town experiences a number of diarrhea cases amongst the under-fives especially in the rainy season. • There are no health sensitization programmes yet.	**To obtain more information from the Chirundu mission hospital and the District medical Office**
Gender and pro poor development	• LWSC receives a subsidy from government to facilitate provision of water to the poor. • Commercial Utilities do not have a deliberate policy to supply free water. • The local authority is yet to develop a gender policy. However, it is a requirement that a Water Point Committee consists of 30% female membership.	

Meeting 3

Institution Visited	**Area Women's Association – Chirundu Urban Centre**
Date of Meeting	19th February 2016
Name of Person Contacted:	

Issues / Aspects	Discussion	Follow up action / Information
General overview of Water Supply Services	• There is a serious water supply deficit. • In general water is available from 23.00hrs to 03.00hrs or 05.00hrs in the conventional housing areas, whilst in peri urban areas it is available from either 23.00hrs or 01.00hrs to 05.00hrs. • As a result women stay up or wait till 01.00 am to draw water. • Consequently most households draw water from the Zambezi River where there are high risks of being attacked by crocodiles. (Cases have been reported) • Severe problems are also present in the markets and peri urban areas.	
Water Quality	• It was reported that at times water is turbid, with visible organic matter and worms. • Some water points especially from private boreholes are saline causing stomach/ gastric problems.	
Sanitation	• There are prevailing unhygienic conditions at the main market where the toilets are closed and not operational. Most times the toilets do not have running water.	
Water and sanitation	Women were more highly concerned with the WSS situation at the market where they claimed is a source of food items	

services at the market	• The market is used as a haven for sleeping by travelers and farmers from different parts of the district. • Sanitation facilities are used by travelers, taxi drivers and other passer byes • At most times the toilets are closed and people use unfinished buildings or backyards of stores and bars. • Waste is disposed of indiscriminately.	
Effects of poor water supply and sanitation	• Disruptions disturb family life as the women are always exhausted and overburdened. • Compromises hygiene in the household • Compromises hygiene at the markets where foodstuffs are sold. • Women are not able to engage in gardening activities, due to the cost and lack of water	
Proposed solutions for water supply	• Need to pump more water from Zambezi River. • If boreholes are used, there is need to use technology for removing iron, however boreholes are not advisable due to the low yielding boreholes. • The current situation can be managed if there was a fixed schedule so that women can plan their daily activities. This would be unlike the current inconsistent schedule.	
Proposed solutions for sanitation for households	Households • Sewerage system would be the best • Septic tanks for those with household connections • And improved pit latrines for those without.	
Proposed solutions for sanitation for markets	• Markets should be connected to the sewerage system and if septic tanks are used should be emptied on time and kept clean. • Market toilets should be sub contracted to private operators e.g. the women's Association or the market cooperative.	

Annex F – Institutional Tables

Annex F1: Sector Performance (2015)

Annex F2: High Level Implementation Work plan

Annex F3: Statement of Comprehensive Income (2015)

Annex F4: LWSC Balance Sheet (2014)

Annex F5: Overview of Personnel Allocation


CRIDF