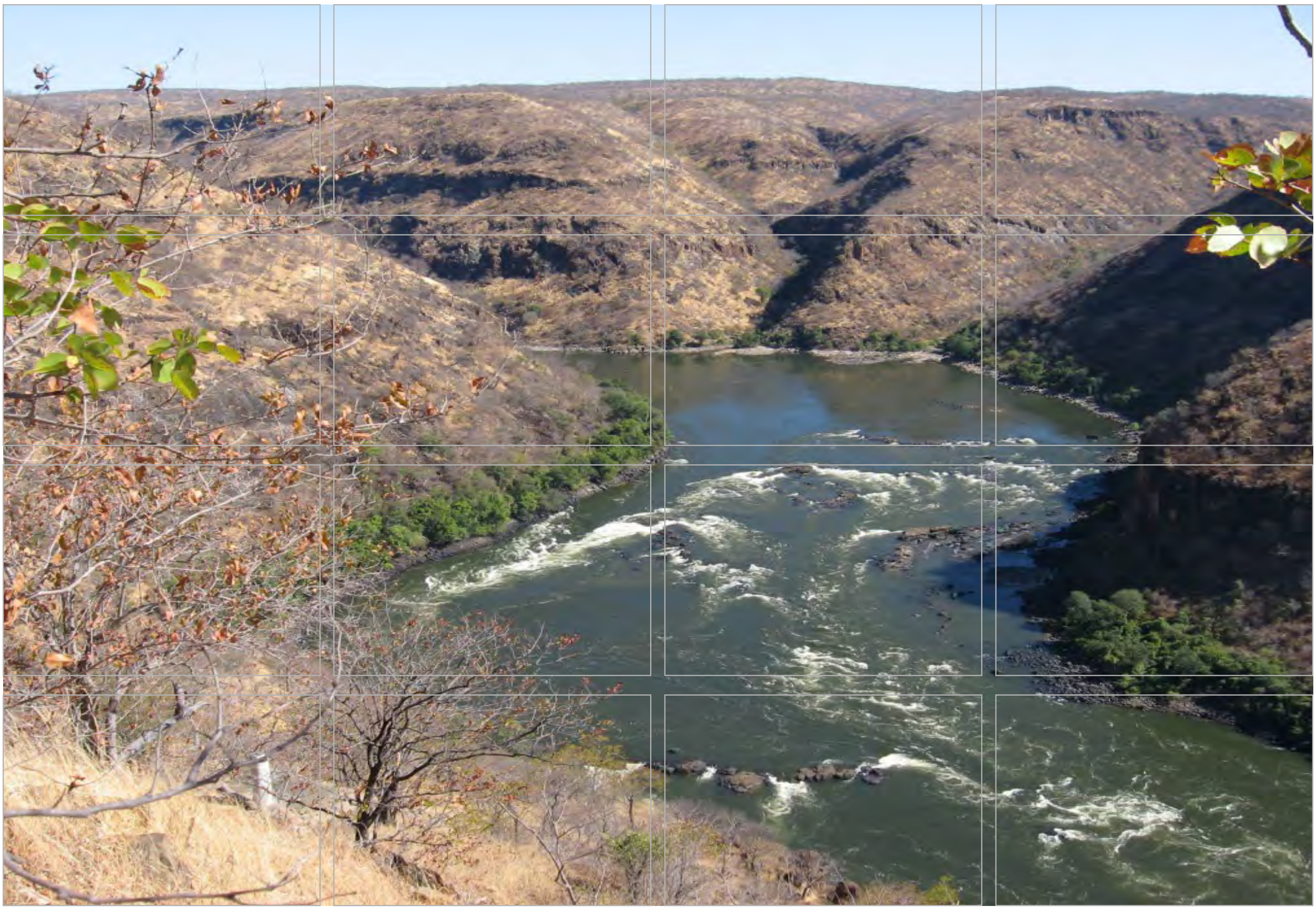

Proposed Batoka Gorge Hydro-Electric Scheme (Zambia and Zimbabwe) on the Zambezi River

Environmental and Social Impact Assessment (ESIA) for the Project Area of Inundation, Staff Villages and Quarries (V4.0)

Zambezi River Authority (ZRA)

September 2019

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Proposed Batoka Gorge Hydro-Electric Scheme (Zambia and Zimbabwe) on the Zambezi River

VOLUME I - Environmental and Social Impact Assessment (ESIA) for the Project Area of Inundation, Staff Villages and Quarries

Document Name: The Proposed Batoka Gorge Hydro-Electric Scheme (Zambia and Zimbabwe) on the Zambezi River – VOLUME I - Environmental and Social Impact Assessment (ESIA) for the Project Area of Inundation, Staff Villages and Quarries

Client: Zambezi River Authority (ZRA)	**Project No:** 0239269
Summary and Version History: This document is ERM's V4.0 ESIA for the Proposed Batoka Gorge Hydro-Electric Scheme (Zambia and Zimbabwe) on the Zambezi River associated with the Project Area of Inundation, Staff villages and Quarries	**Date**: 19 September 2019 **Approved by**: Mike Everett
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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXURE

ABOM	Agreement between Operating Members
ADI	Area of Direct Influence
AfDB	African Development Bank
AIDS	Acquired Immune Deficiency Syndrome
ALARP	As low as reasonably practical
amsl	above mean sea level
AoI	Area of Influence
AoII	Area of Immediate Influence
ARI	Acute Respiratory Infections
ART	Antiretroviral therapy
ASA	Alliance for Sustainable Agriculture
AZA	A'Zambezi River Lodge
AZMEC	Association of Zambia Mineral Exploration Companies
BCG	Bacillus Calmette–Guérin
BCR	Benefit-Cost Ratio
BEAM	Basic Education Assistance Module
BGHES	Batoka Gorge Hydro-Electric Scheme
BID	Background Information Document
BJVC	Batoka Joint Venture Consultants
BOD	Biochemical Oxygen Demand
C$	Cost in US Dollars
CADEC	Catholic Development Commission
CAMPFIRE	Communal Areas Management Programme for Indigenous Resources
CAPCO	Central African Power Corporation
CASECO	China Africa Sunlight Energy
CBO	Community Based Organizations
CEC	Copperbelt Energy Corporation
CESMP	Construction Environmental and Social Management Plan
CFAZ	Crocodile Farmers Association of Zimbabwe
CHW	Community Health Worker
CITES	Convention for International Trade in Endangered Species
COMESA	Common Market for Eastern and Southern Africa
CR	Critically Endangered
CRM	Cultural Resource Management
CRR	Comments and Response Report
CRU	Carnivore Research Unit
DANIDA	Danish International Development Agency
DATF	District AIDS Task Forces
dB	Decibel
DC	District Commissioner
DCFA	Discounted Cash Flow Analysis
DD	Data Deficient
DDCC	District Development Coordinating Committee
DDT	Dichlorodiphenyltrichloroethane

DFID	Department for International Development
DO	Dissolved Oxygen
DPT	Diphtheria, Pertussis and Tetanus
DRC	Democratic Republic of Congo
DSM	Demand Side Management
DSR	Draft Scoping Review
DSS	Decision Support System
EA	Environmental Assessment
EARS	East African Rift System
ECZ	Environmental Council of Zambia
EF	Environmental and Social Flow
EFA FTI	Education for All - Fast Track Initiative
EFA	Environmental Flow Assessment
EHS	Environment Health and Safety
EIA	Environmental Impact Assessment (generic term)
EIS	Environmental Impact Statements
EM	Environmental Management
EMA	Environmental Management Agency
EMAct	Environmental Management Act
EMB	Environmental Management Board
EMRAS	Emergency Medical Rescue Ambulance Service
EN	Endangered
EPFIs	Equator Principles Financial Institutions
EPPCA	Environmental Protection and Pollution Control Act
EPPRPs	Emergency Prevention, Preparedness and Response Plan
ERA	Energy Regulatory Authority
ERB	Energy Regulation Board
ERM	Environmental Resources Management Southern Africa (Pty) Ltd.
ERP	Emergency Response Plan
ESIA	Environmental and Social Impact Assessment (as applied in this document)
ESMP	Environmental and Social Management Plan
ESS	Environmental and Social Safeguards
FGD	Focus Group Discussion
FPIC	Free, Prior and Informed Consent
FR	Forest Reserve
FSL	Full Supply Level
GAI	Geomorphology Assessment Index
GDP	Gross Domestic Product
GEMSS	Generalized Environmental Modelling System for Surface-waters
GHG	Greenhouse Gas
GII	Gender Inequality Index
GIS	Global Information Systems
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH
GN	Government Notice
GPR	Ground Penetrating Radar

GVA	Gross Value Added
GWh	Gigawatt Hour
Ha	Hectare
HDI	Human Development Index
HES	Hydro-Electric Scheme
HH	Household Surveys
HIV / AIDS	Human Immunodeficiency Virus / Acquired Immune Deficiency Syndrome
HIV	Human Immunodeficiency Virus
HPP	Hydropower Project
HPS	Hwange Power Station
HDC	Hwange District Council
HSBC	Hwange Sebungwe Biodiversity Corridor
I&APs	Interested and Affected Parties
IBA	Important Bird Area
IBAT	Integrated Biodiversity Assessment Tool
ICOLD	International Commission on Large Dams
ICP	Informed Consultation and Participation
ICT	Information and Communication Technology
IFC	International Finance Corporation
IFI	International Finance Institutions
IGMOU	Inter-governmental Memorandum of understanding
IHA	International Hydropower Association
ILO	International Labour Organisations
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
IRBM	Integrated Results Based Management
IRR	Internal Rate of Return
IRS	Indoor Residual Spraying
ISC	International Seismological centre
ITCZ	Inter-tropical Convergence Zone
IUCN	International Union for the Conservation of Nature
IUMOU	Inter-unit Memorandum of Understanding
JICA	Japan International Cooperation Agency
JIMP	Joint Integrated Management Plan
JV	Joint Venture
KAZA TFCA	Kavango-Zambezi Transfrontier Conservation Area
KBA	Key Biodiversity Areas
KII	Key Informant Interview
Km	Kilometre
kV	Kilovolt
kWh	Kilowatt hour
L&FS	Life & Fire Safety
LC	Lower Risk / Least concern
LED	Light Emitting Diode
LHPC	Lunsemfwa Hydro Power Company
LPG	Liquid Petroleum Gas
LSA	Late Stone Age
m	metres

MAB	Man & the Biosphere
MAL	Ministry of Agriculture and Livestock
MEWD	Ministry of Energy and Water Development
MLGRUD	Ministry of Local Government, Rural and Urban Development
MoE	Ministry of Energy
MOHCW	Ministry of Health and Child Welfare
MOL	Minimum Operating Level
MP	Member of Parliament
MRR	Maximum Ramping Rate
MSA	Middle Stone Age
MW	Megawatts
MZWP	Matabeleland Zambezi Water Project
NASF	National AIDS Strategic Framework
NDVI	Normalised Difference Vegetation Index
NEC	National Environmental Council
NEP	National Energy Policy
NGOs	Non-Governmental Organisations
NHCC	National Heritage Conservation Commission
NMB	National Museum Board of Zambia
NMMZ	National Museums and Monuments of Zimbabwe
NPE	Zambian National Policy on Environment
NPV	Nett Present Value
NSC	North-South Carrier
NT	Near Threatened
OESMP	Operation Environmental and Social Management Plan
OG	Operating Guidelines
OHS	Occupational Health and Safety
p.a.	Per Annum
PAC	Problem Animal Control
PAPs	Project Affected Persons
PC	Provincial Council
PDC	Provincial Development Council
PDCC	Provincial Development Coordinating Committee
PES	Present Ecological Status
PIIM	Project Induced In-Mitigation
PM	Particulate Matter
PPE	Personal Protective Equipment
PPP	Public Participation Process
PS	Performance Standard
PV	Photovoltaic
RAP	Resettlement Action Plan
RCC	Roller Compacted Concrete
RDC	Rural District Council
RDDC	Rural District Development Committee
REA	Rural Electrification Authority
	Resources
RHC	Rural Health Centres
RPF	Resettlement Policy Framework

RTS	Reservoir Triggered Seismicity
SA	Strategic Assessment
SADC	Southern African Development Community
SAoI	Social Area of Influence
SAPP	Southern African Power Pool
SASS5	South African Scoring System version 5
SEP	Stakeholder Engagement Plan
SGs	Sustainability Guidelines
SHEQ	Safety, Health, Environment and Quality
SME	Small and Medium Enterprise
SNDP	Sixth National Development Plan
SNEL	Société nationale d'électricité (DRC)
SP	Studio Pietrangeli Consulting Engineers
STI	Sexually Transmitted Infection
SWASCO	Southern Water and Sewerage Company
TAZARA	Tanzam Railway
TB	Tuberculosis
TDG	Total Dissolved Gas
ToR	Terms of Reference
TSI	Trophic State Index
UDC	Urban District Council
UHC	Urban Health Centres or Clinics
UNCCD	United Nation Convention to Combat Desertification
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention Climate Change
UNICEF	United Nations International Children's Emergency Fund
UNISA	University of South Africa
USAID	United States Agency for International Development
USD	US Dollars
USGS	United States Geological Survey
VEGRAI	Vegetation Response Assessment Index
VFM	Victoria Falls Municipality
VFPS	Victoria Falls Power Station
VHW	Village Health Workers
VU	Vulnerable
WADCO	Ward Development Committee
WASAZA	Water and Sanitation Association Zambia
WCD	World Commission on Dams
WECSZ	Wildlife and Environmental Conservation Society of Zambia
WHO	World Health Organisation
WHS	World Heritage Site
WPE	Waterbird Population Estimates
WTTC	World Travel and Tourism Council
WWF	World Wildlife Fund
ZAMCOM	Zambezi Watercourse Commission

ZCCM-IH	ZCCM Investment Holdings Plc
ZDA	Zambia Development Agency
ZEMA	Zambia Environmental Management Agency
ZENT	ZESA Enterprises
ZERA	Zimbabwe Energy Regulatory Authority
ZERC	Zimbabwe Electricity Regulatory Commission
ZESA	Zimbabwe Electricity Supply Authority
ZESCO	ZESCO Limited
ZETDC	Zimbabwe Electricity Transmission and Distribution Company
Zim Asset	Zimbabwe Agenda for Sustainable Socio-Economic Transformation
ZimStats	Zimbabwe National Statistics Agency
ZimVAC	Zimbabwe Vulnerability Assessment Committee
ZINWA	Zimbabwe National Water Authority
ZISS	Zambian Scoring System
ZNASP	Zimbabwe National HIV and AIDS Strategic Plan
ZPC	Zimbabwe Power Company
ZRA	Zambezi River Authority
ZTA	Zimbabwe Tourist Authority

0.1 BACKGROUND AND INTRODUCTION

The development of a hydropower scheme on the Zambezi River downstream of Victoria Falls has been investigated to various degrees of detail since 1904, when geological investigations for potential sites commenced. Extensive work with regards to a potential hydropower scheme on the Zambezi River downstream of Victoria Falls began in 1972 and this study concluded that the Batoka Gorge was the most suitable site for a potential hydropower scheme, from two alternatives considered.

Since 1972, three more phases of site/geological investigations were undertaken. These investigations were conducted in 1981/82, 1983 and 1989 respectively in order to supplement information acquired during previous studies, and identified a site in the Batoka Gorge, which was 12 km upstream of that defined in 1972, as the most suitable. The results of these investigations revealed that the Batoka Gorge substrate conditions represented a feasible location for such a project, with surrounding rock masses that are generally considered to be strong, hard and of low permeability. It was this site that was the subject of a full feasibility study conducted by BJVC in 1993.

In 2014, the Zambezi River Authority (ZRA) initiated a further study on the proposed Batoka Gorge Hydro-Electric Scheme (BGHES) by appointing Studio Pietrangeli (SP) Consulting Engineers of Italy to update the engineering feasibility studies for the proposed BJVC (1993) scheme, and in parallel appointed Environmental Resources Management Southern Africa (Pty) Ltd. (ERM) of South Africa to undertake an Environmental and Social Impact Assessment (ESIA) of the proposed BGHES.

Prior to the end of 2015, ERM completed the Scoping Phase of the Project, which entailed extensive stakeholder engagement and the necessary environmental and social baseline studies.

This report presents the ESIA associated with the following Project components:

- Dam wall and impoundment, including the spillway facility;
- Surface power houses, one on each side of the river; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching areas).

Separate ESIA reports have been compiled for 1) Access Roads in Zambia and Zimbabwe; and 2) Transmission Lines in Zambia and Zimbabwe. For a holistic understanding of the Project environmental and social impacts and associated management recommendations, this ESIA should be considered in conjunction with the separate Project ESIA reports (and associated ESMPs). Moreover, Project Resettlement Policy Frameworks (RPFs) have been compiled (*Annex F*). These RPFs are aligned with the regulatory requirements of Zambia and Zimbabwe, and the requirements of International Finance Corporation (IFC) Performance Standard (PS) 5 and World Bank (WB) Environmental and Social Framework (ESF) 5. The preparation and implementation of a Project Resettlement Action Plans (RAPs) to address physical displacement will be undertaken in accordance with the requirements of the RPFs. The RAPs will also need to include Livelihood Restoration Plans (LRPs) to ensure that the livelihoods of all the directly Project affected persons (PAPs) are at the very least maintained if not improved.

Please Note:

LRPs for the BGHES Access Road in Zimbabwe and for the BGHES Staff Villages in both Zambia and Zimbabwe have been compiled. RAPs for these Project components are not required, as construction of these Project components will not affect any primary residential structures and therefore will not result in physical displacement.

Separate RAPs/LRPs will also be commissioned for the following Project components–

- Displacement (physical and economic) of upstream / downstream water users;
- Displacement (physical and economic) of Project affected peoples in footprints associated with BGHES transmissions lines; access road in Zambia; quarries; and other BGHES associated infrastructure.

To Note – RAPs/LRPs for upstream water users (specifically tourism operators), will only be undertaken at a later stage, as inundation of the Batoka Gorge (filling of the BGHES reservoir) is proposed in 2027 / 2028.

These separate RAPs/LRPs will be undertaken in accordance with the regulatory requirements of the Republics of Zambia and Zimbabwe, and the requirements of IFC PS5 and WB ESF5.

0.2 THE PROPOSED BATOKA GORGE HYDROPOWER PROJECT

The proposed BGHES will be located in the central portion of the Zambezi River Basin and will span across the international boundary between Zambia and Zimbabwe. It will further be situated upstream of the existing Kariba Dam hydroelectric scheme on the Zambezi River and approximately 47 km downstream of the Victoria Falls (refer to *Figure 0.1* and *Figure 0.2*).

In Zimbabwe, the proposed scheme falls within the province of Matabeleland North and in the Hwange District. It includes the wards of Matetsi, Chidobe, Katchecheti, Nemanhanga, Mbizha, Jambezi, Sidinda, Mashala and Simangani. The traditional authorities in the area of impact in Zimbabwe include chief Shana, Bishop Matata Sibanda (who is at the time of the studies Acting Chief Mvutu) and Chief Hwange.

In Zambia, the main areas of direct impact falls under the Southern Province and covers parts of the Kazungula District, most notably the wards of Mukuni and Katapazi, which fall under Chief Mukuni's jurisdiction. However, impacts will also be felt in Livingstone District, Zimba District and Choma District and downstream impacts are likely to be experienced in the District of Kalomo.

0.3 *THE NEED FOR THE PROJECT*

Investment in energy is a prerequisite to achieving social and economic development. If both the Republics of Zambia and Zimbabwe are to achieve those targets and goals detailed in their respective Vision 2030 and Vision 2040 Plans, and other complimentary plans, these countries will require private sector investment in energy technology that is efficient, sustainable and reliable. The generation of energy through hydropower is a proven technology that is sustainable and is actively being promoted at a national level in both Zambia and Zimbabwe. With a vast hydropower energy potential, hydropower is considered the most feasible and reasonable electrification option for both countries.

Therefore, the objective of the proposed BGHES is:

- To increase power generation capacity in both Zambia and Zimbabwe and subsequently mitigate the current power deficits currently experienced in both countries;
- To reduce the overall power tariffs in both Zambia and Zimbabwe
- Conjunctive operation of both the proposed BGHES and Kariba Complex;
- To reduce power outages; and
- Contribute to the sustainable and renewable energy Agenda in the two countries thereby reducing reliance on coal fired power stations.

The rationale for this Project, and a comparison of hydropower schemes to other power generation projects proposed or currently being planned in both Zambia and Zimbabwe, and within the Southern African Power Pool (SAPP) is further described in *Chapter 3*.

Figure 0.1 Proposed Dam Site Location (1)

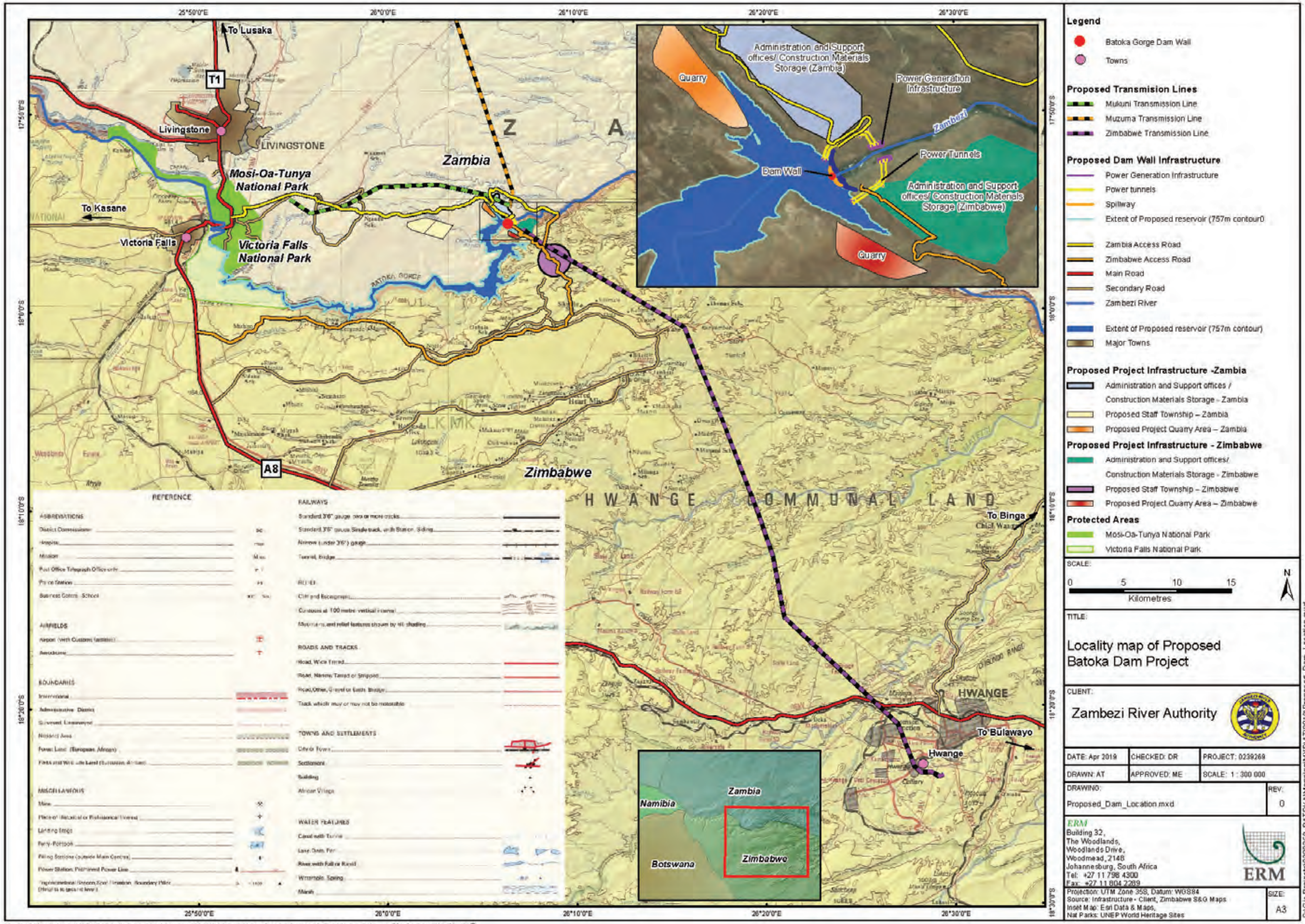
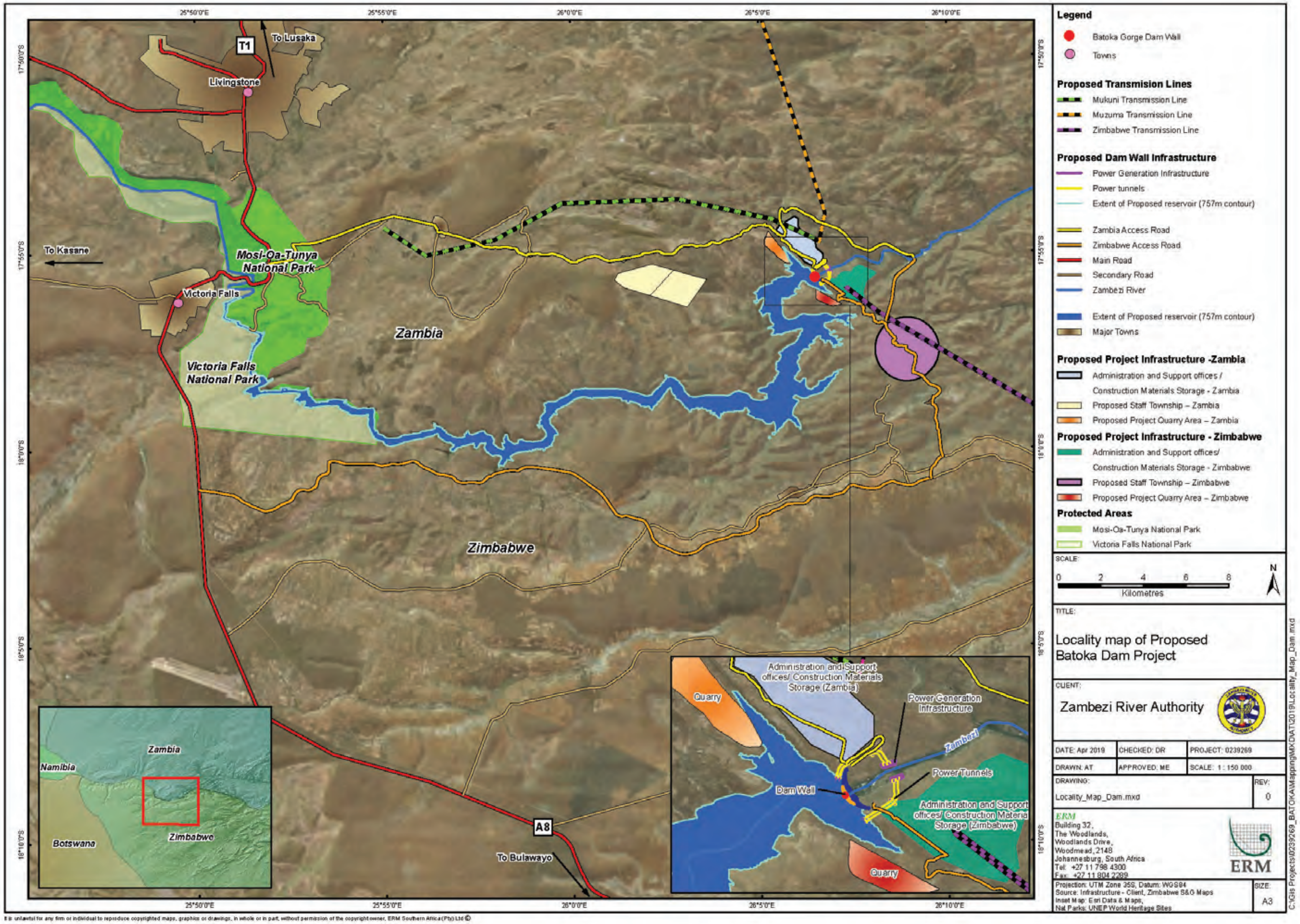


Figure 0.2 Proposed Dam Site Location (2)



0.4 *PROJECT DESCRIPTION*

The proposed BGHES includes the following key components:

- Dam wall and reservoir, including a spillway;
- Surface power houses, one on each side of the river;
- Transmission lines in Zambia and Zimbabwe;
- Access roads (and Batoka Bridge) in Zambia and Zimbabwe; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching areas).

These components are based broadly on the dam type that was proposed in the 1993 Batoka Gorge HES Feasibility Study (BJVC, 1993) and the updated design described in Studio Pietrangeli's (SP) October 2018 Phase II Option Assessment Report (Rev. F). A full description of the proposed Project is provided in *Chapter 2*.

For a more detailed description of the Transmission Lines and Access Roads proposed as part of the BGHES Project, refer to the standalone ESIAs for these Project components.

The principal components of the proposed BGHES are summarised in *Table 0.1* below.

Table 0.1 Main Components of the Proposed BGHES

Project Description	
Reservoir	
Catchment Area	508, 000 km²
Average Annual Runoff (m³/s)	1,070
Minimum Operating Level (MOL)	746 m asl
Full Supply Level (FSL)	757 m asl
Surface Area @ FSL	23 km²
Total Storage	1,392 Mm³
Dam	
Type	Arch-Gravity
Crest el.	762 m asl
Foundation min. el.	587 m
Max Height (u/s)	175 m
Crest length	720 m
Spillway	
Type	Gated
Spillway width	118 m
No. of Bays	7
Sill elevation (masl)	743.5 m
Energy dissipater	Plunge pool
Power House	
Type	Surface
Number	2
Turbine number and type	12/Francis, each of 200MW of installed capacity
Installed Power	2,400 MW

Project Description	
Annual Energy Production	10,215 GWh/y

Source: SP Option Assessment Report (Version F), July 2015.

To Note – although *Table 0.1* presents a FSL of 757 masl, during the course of the ESIA process it was decided through discussions with the ESIA team, Engineering Team (SP) and the ZRA that the operating level of the dam will be seasonally adjusted by reducing the FSL to 730 masl during the dry season (in rafting terms, from August to January) and increasing to 757 masl during the high-flow season under normal flow conditions, and to 762 masl under high flow conditions (defined as the flow above which the Victoria Falls Power Station would normally begin to flood). This was done to accommodate White Water Rafting during the dry season.

0.4.1 Project Townships

Project townships will be located on each side of the river. Project township locations in both Zambia and Zimbabwe are indicated in *Figure 0.2*.

During construction (up to nine years in duration), the Project townships will house approximately 8,000 staff in total (including security and support staff), but this will be only after the first two years, where initially 2,000 construction workers will be involved with the construction of access roads, infrastructure and the camps. In addition during the construction phase of the project the sites to be utilised for Administration and Support offices and Construction Materials Storage, are also indicated in *Figure 0.2*.

During operation, the construction staff will be replaced with the operational staff (i.e., maintenance, police, custom/immigration services,, plant operating staff, governmental institutional staff etc.). Approximately 1,500 operational staff will be required.

In addition to these services and amenities, project townships will also have facilities such as banks, shops, private offices etc.

0.4.2 Other Ancillary Infrastructure

Spoils areas, construction and batching camps will also be required in Zambia and Zimbabwe. These sites are yet to be defined and will be identified during the third phase of the feasibility study, although the ESIA has identified those sensitive zones where such activities will be discouraged.
The location of Project quarry areas in both Zambia and Zimbabwe are illustrated in *Figure 0.2*.

0.4.3 Proposed Project Timeframe

The construction phase is expected to last around nine years. It will be divided into two stages: the first stage will be when access roads and the first permanent camps will be built. It is expected that this phase will take one to two years. The second phase is when the dam and plants will be constructed; this will take six to seven years.

The start of the project is dependent on the applicable approvals being obtained and appropriate funding finalised.

Table 0.2 Anticipated Project Construction Schedule

Project phase	Duration
Construction: phase 1	1 – 2 years
Construction: phase 2	6 – 7 years
Operation phase	For life of dam

0.5 INSTITUTIONAL AND LEGISLATIVE FRAMEWORK, DEVELOPMENT POLICIES, AND INTERNATIONAL TREATIES AND GUIDELINES

Chapter 4 of the ESIA sets out the relevant legal and policy context applicable to the development of the BGHES in the Republics of Zambia and Zimbabwe, and specifically details:

- The relevant institutional framework in Zambia and Zimbabwe involved in the regulation of this Project;
- Relevant Zambian and Zimbabwean environmental and social laws and Regulations which are applicable to the Project;
- Development policies applicable to the Project for both Zambia and Zimbabwe;
- International treaties, conventions and protocols relevant to the Project and to which Zambia and/ or Zimbabwe is a signatory;
- Environmental and social guidelines and standards developed by the Southern African Power Pool (SAPP), and international organisations such as the International Finance Corporation (IFC) and the World Bank, with which the Project will need to align; and
- Other international guidelines and standards directly applicable to dam-building and hydropower projects, which are considered international good practice (such as the World Commission on Dams (WCD) Guidelines and Recommendations).

0.6 PROJECT ALTERNATIVES

Numerous Project alternatives have been considered for the proposed BGHES. These alternatives have considered alternative power generation options, design alternatives for the BGHES; and the environmental and social benefits/impacts associated with certain alternatives. More specifically, the ESIA includes an assessment on the following alternatives:

- Dam location;
- Installed power;
- Project operating rules (Environmental Flows);
- Dam height (or its Full Supply Level, both permanently and seasonally);
- Dam type;
- Spillway design;
- Use of underground versus surface power houses;
- No-go alternative (i.e. that the proposed BGHES is not constructed in its entirety);
- Routing of access roads and location of Project townships; and
- Transmission line routings.

These alternatives have been systematically evaluated considering environmental and social sensitivities, as well as engineering criteria, and the economic implications of each, this to optimise Project design. This is summarised in *Sections 0.6.1* to *0.6.2* below.

For a more detailed overview of Project alternatives considered for Transmission Lines and Access Roads, refer to the standalone ESIAs for these Project components.

0.6.1 *Summary of Alternatives Considered for the BGHES*

The alternatives considered for the proposed BGHES are provided in *Table 0.3* below. Shading in the table presents the most favoured alternative. It is this alternative that has been selected by SP (2018), and this selected alternative was described in *Chapter 2: Project Description*.

Table 0.3 Summary of Alternatives considered for the Proposed BGHES

Dam Location	**Upstream** • Benefits in terms of power production are greatly reduced (energy losses)	**Current Location** • Most favourable geology • Favourable geomorphology • Potential to exploit the entire hydropower potential of the cascade between Victoria Falls and Kariba dam	**Downstream** • Six most downstream projects would require saddle dams • Gorge widens, greatly increasing BGHES dam volumes • Concrete volumes 60% to 200% higher
Optimum Installed power	**1600MW** • Energy production reduced • High loss of 36% of the total flows of the river (spilled flows)	**2400MW** • Lowest Unit Generation Cost • Highest IRR • 23 % spilled flows during the wet season	**3000MW** • Increasing plant size increases cost of powerhouse, EM equipment, waterways and Transmission lines • For an installed plant size of 3,000MW, spills are reduced to 12%.
Refinement of the Project Operating Rules	AddPM01, AddPM02 and AddPM03 only meet the environmental criteria of no more than a 1.5 class drop in Overall Ecosystem Condition in the downstream river.	AddPM04 meets both environmental criteria set out for downstream river conditions (i.e. no more than a 1.5 class drop in overall ecosystem condition &that at least 90% of fish species should be impacted by <25%). This is the preferred scenario from an environmental perspective.	
Powerhouses	**Underground** • High uncertainties/geological risks during construction • Increased construction time	**Above ground** • Lower cost • Lower geological uncertainties • Lesser construction time • Allows for staggered financing • Allows for adjustments in the FSL and of the intake level, if necessary	
Spillway	**Flow over the top of the wall** • Water overtopping the dam wall may damage or even destroy the dam. Appropriate energy dissipaters and a plunge pool are therefore requirements. • Least expensive option requiring less excavation.	**Separate spillway** • Controlled release of flows from the dam downstream of the dam, decreasing the risk of damage to the dam wall during periods of high flows • Excavated rock from this spillway may be used as quarry materials in the construction of the dam wall, reducing the need for borrow pits and quarries outside of the inundation area. • Additional costs associated with excavation and support of the approach and downstream canals (estimated at US$ 107 million).	
FSL	>762 m • Backwaters (especially during high flows) would flood the outlets of the Victoria Falls Power Station • Backwaters would risk flooding all the way to the base of Victoria Falls, leading to visual impacts at the Falls and to the boiling pot, as well as to the viewsheds from the Victoria Falls Bridge and the Victoria Falls hotel.	757m • Allows for changes in the dam's operating rules during periods of high flow (to avoid waters back-flooding into the tailraces of the Victoria Falls Power Station) and during low flows (to allow for rafting in the low flow season to take place).	<762m • Lowering the FSL from 762 m to 740 would lead to a loss in benefit of approx. US$ million 600.
	Note: A full environmental and social analysis of the FSLs is provided in *Chapter 10*.		

0.6.2 Project Townships

Project Townships will be located on both the North bank of the dam (in Zambia) and on the South bank (in Zimbabwe). Six alternative areas were preliminarily identified, three locations in each of Zimbabwe and Zambia, as potential locations for the project townships.

The most suitable locations for the project townships in both Zambia and Zimbabwe are illustrated in *Figure 0.2* on *Page vi*.

This selection was made based on the following:

- Reduced physical (and economic) displacement.

- Reduced impact on other important resources such as water for agriculture, and Teak Forest reserves present in this area which the community rely on for sourcing wood for the making of curios (another important livelihood activity), as well as for firewood to meet energy needs and for wood for construction of homes and furniture. The forest areas are also used to source fruits for consumption and income generating purposes and thus access should be maintained.

- The results of the heritage survey revealed that the majority of cultural heritage sites that fall in the proposed project township area are small and already disturbed. As such, they have very limited heritage significance, and give further weight to the development of the camp in this area.

- Surrounding topography and opportunities for expansion of Project Townships, if deemed necessary.

0.7 PUBLIC PARTICIPATION PROCESS

The PPP for the ESIA has been designed to comply with the regulatory requirements set out in both the Republics of Zimbabwe and Zambia as well as international good practise and the policies of the IFC and World Bank Group. *Table 0.4* below provides details of the PPP activities undertaken during the Scoping Phase of the overall ESIA process to date. Moreover, due to the length of time that has lapsed between the public participation undertaken as part of the Scoping Phase (late 2014), and the recommencement of the ESIA process in late 2018, an interim round of public participation was also undertaken. The details for this round of engagement are also provided below.

0.7.1 Engagement during the Scoping Phase

Table 0.4 provides a summary of stakeholder engagement undertaken during scoping.

Table 0.4 Stakeholder Engagements Undertaken During the Scoping Phase of the Overall ESIA Process

Meeting	Venue	Date
Public Open Day, Harare	Harare Royal Golf Club	30th Sep 2014
Authorities Meeting, Bulawayo	Bulawayo Club	1st Oct 2014
Community meeting, Jambezi	Chief Shana's homestead	2nd Oct 2014
Hwange District Council Meeting	Hwange District Council Offices	3rd Oct 2014
Community meeting, Nemangana	Sacred Heart Mission	4th Oct 2014
Victoria Falls Open Day	Victoria Falls Municipal Offices	4th Oct 2014
Community meeting, Kattchecheti	Ndhlovu Business Centre	5th Oct 2014
Community meeting, Chidobe	Chisuma Primary School	6th Oct 2014
Community meeting, Chikandukubi	Mashake Secondary School	6th Oct 2014
Livingstone Open day	Livingstone Municipal Offices	6th Oct 2014
Community meeting, Matetsi	Matetsi Police Station	7th Oct 2014
Community meeting, Mbhizi	Milonga Clinic	7th Oct 2014
Lusaka Open Day	Long Acres Lodge	7th Oct 2014
Regulatory authority meeting, Lusaka	Long Acres Lodge	8th Oct 2014
Community meeting, Sidinda	Lumbora Primary School	8th Oct 2014
Community meeting, Mashala	Mashala Secondary School	8th Oct 2014
Livingstone Council Meeting	Provincial Conference Room, Livingstone	9th Oct 2014
Kazangula District Council Meeting	Kazungula Council Chambers	10th Oct 2014
Community meeting for Chief Musokotwane villages	Musokotwane Primary School	11th Oct 2014
Community meeting for Chief Mukuni villages	Njando Primary School	13th Oct 2014
Victoria Falls Information Sharing Meeting	Victoria Falls Municipal Offices	22nd Jan 2015
Livingstone Information Sharing Meeting	Livingstone Lodge	23rd Jan 2015

Issues raised during the scoping phase have been captured in *Chapter 7* and its associated *Annex*.

Final Scoping Report

The Scoping Report was made available to stakeholders for review and comment in December 2015. The comment period began from 1st December 2015 to the 22nd January 2016. The Scoping Report was accompanied by the following documents:

- Non-Technical Summary of the Scoping Report;

- Comments and Response Report; and
- Grievance Redress Mechanism (GRM).

The full Scoping Report was made available via the project website http://www.erm.com/batokahesesia; and/ or could be requested from Black Crystal and Kaizen Consulting offices (in Zimbabwe and Zambia, respectively); as well as public places within the project affected districts including:

Zimbabwe:	Zambia
• Hwange District Council Office • District Administrators Office in Hwange • Jambezi Clinic • Chisuma clinic • Matebeleland North Provincial Administrators Office • Victoria Falls Municipal Offices • Environment Africa Office Victoria Falls • Black Crystal's Office in Harare	• Livingstone City Council • Livingstone District Commissioner's Office • Kazungula District Council • Kazungula District Commissioner's Office • Lusaka Kaizen Consulting Office • District Commissioners offices in Zimba, Kalomo and Choma • District Council Offices in Zimba, Kalomo and Choma • National Assembly Offices Zimba, Kalomo and Choma • Chiefs Palaces (Sipatunyana, Simwatachela & Chikanta)

0.7.2 *Interim Engagement*

An interim round of public participation was undertaken in December 2018 with the following objectives:

- To notify stakeholders of the recommencement of the ESIA process and its associated timeline for delivery;
- To inform them of further opportunities for the engagement of Stakeholders;
- To update stakeholders on changes to the Project Team;
- To provide updated contact information for further communication;
- To invite new stakeholders to register as an I&APs for the Project; and
- To allow stakeholders an opportunity to raise questions or comment on the Project and ESIA process.

The activities undertaken in furtherance of the above stated objectives are described below.

Stakeholder Database Update

An exercise was undertaken to verify and update contact details for stakeholders on the existing stakeholder database, which was developed as part of the ESIA in 2015. The database has also been updated with the details of additional communities and leadership identified as part gathering of additional baseline information in the proposed Project area, particularly downstream of the proposed dam wall and in the areas proposed for the sourcing of quarry materials. The updated stakeholder database is provided in *Annex C2.*

Notification of Status of the ESIA Process

Stakeholders on the existing stakeholder database were notified of the status of the ESIA process via email or post on 6 December 2018. A copy of the letter is attached in *Annex C7*, together with proof of distribution.

In addition, a series of meetings were held with District Authorities and Traditional Leaders. These meetings afforded key stakeholders the opportunity to raise concerns and ask questions. *Table 0.5* presents a schedule of the meetings, and meeting minutes are provided in *Annex C7*.

Table 0.5 ***Meetings Undertaken during Interim Stakeholder Engagement***

Meeting	Date
Zambia	
Southern Province Secretary	3 December 2018
HRH Chief Mukuni	4 December 2018
Kazungula District Council	4 December 2018
Livingston City Council	5 December 2018
Zimba District Council	6 December 2018
Chief Simwatachela	10 December 2018
Chief Sipatunyama	11 December 2018
Zimbabwe	
DA Agritex	27 November 2018
Hwange District Administration	27 November 2018
Hwange District Council	28 November 2018
Ward Councillors from Chidobe Ward and Mbizha Ward	28 November 2018
Chief Shana	30 November 2018

0.7.3 *Next Steps*

Impact Assessment and Public Disclosure Phase

During this phase, the impact assessment phase of the Project, the primary aim of the PPP will be to engage stakeholders with regard to the results of the studies and the proposed management measures. A public comments period of 30 days for comment on the Draft ESIAs and ESMPs is currently proposed. Stakeholders will be notified via email, sms, mail, hand delivery and/or fax of the availability of the Draft ESIAs and ESMPs and engagements that are proposed during this phase.

Environmental Authorisation

The ESIAs and ESMPs will later be submitted to both the EMA and ZEMA for review and consideration. The environmental authorisation decisions taken by the EMA and the ZEMA will be advertised in the media and all registered stakeholders will be informed by email/fax/hand delivery/ mail/sms of the environmental authorisation decision.

0.8 BIOPHYSICAL AND SOCIAL ENVIRONMENT

The principal characteristics of the biophysical and social receiving environments are summarised below in *Table 0.7* and *Table 0.8*.

Table 0.6 Summary of the Biophysical Environment

Aspect	Summary description
Climate	• The Zambezi River Basin is subjected to one of the most variable climates of any major river basin in the world, experiencing extreme conditions across the catchment through time. • The climate is typically sub-tropical, with a dry season from June to August, and a wet season from December to February. • Average temperatures in the basin vary mainly with elevation, but also with latitude. • Mean daily temperatures during the warmest months can reach up to 31°C and down to 13 °C in the colder months. Average annual rainfall in the Basin is approximately 950 mm/year. • The predominant wind direction is from the east throughout the year, with varying wind speeds. The windier months are August through to October. • Zimbabwe and Zambia were responsible for 0.13% and 0.59% (respectively) of global greenhouse gas (GHG) emissions in 2012 and are considered to be low emitters. However, between 1990 and 2012, national emissions grew by 105% in Zimbabwe and 53% in Zambia, whilst global emissions increased by 41% over the same period [1].
Geology	• The Zambezi River flows through a deep gorge eroded in basalts. There are 13 basalt flows, which constitute the dam site, between 350 and 850 m above mean sea level. The basalts form a flat plateau with low flat-topped hills incised by the steep sided gorges of the Zambezi and its tributaries.
Soils	• Most of the soils in the Project area are regosols (i.e. have very low or non-existent reserves of weatherable minerals and a low silt/clay ratio).
Hydrology	• The major contribution to the flows at the BGHES site derive from the upstream sub-catchments including: Kabompo, Lungwe Bungu, and especially the Upper Zambezi sub-catchments (located in the Northern highlands), together with Luanginga sub-catchment. • The natural variability of Zambezi River flows is highly modified by large dams, particularly by Kariba and Cahora Bassa dams. • Flooding in the Basin occurs nearly every decade. Multi-year droughts are also observed in the Basin, with implications for river flows and hydropower production. • Climate change studies indicate that the Zambezi will experience drier and more prolonged drought periods, and more extreme floods.
Protected Areas	• The upper parts of the Batoka Gorge fall within a World Heritage Site and the Mosi-oa-Tunya and Victoria Falls National Parks. • The Batoka Gorge has also been categorised as an internationally Important Bird Area (IBA) due to its importance for breeding raptor species, which results in the inclusion of the Batoka Gorge within the global set of Key Biodiversity Areas recognised by the IUCN.

(1) Source: Source: https://edgar.jrc.ec.europa.eu/overview.php?v=GHGts1990-2012&sort=asc1

Aspect	Summary description
Ecological (Habitats and Flora)	• The vegetation within the project area is predominantly natural essentially woodland dominated by Mopane and Kirkia trees. Natural habitats have been described as basalt soil habitats with mixed deciduous woodland, riparian habitat (Batoka Gorge and side gorges), upper tributary woodlands and Kalahari sand habitat. Modified habitats consist of cultivation, urban and mining and industrial areas. • The threatened plant species diversity is important for the upper scree slopes of the Batoka Gorge, where a diversity of threatened plant species are known to occur and others are expected to occur. A list of threatened plant species is provided in Table 8.13 (Chapter 8).
Ecological (Fauna)	• A key component of the important raptor habitat is a small population of the very rare Taita Falcon within the Batoka Gorge. A recent reconnaissance survey (2019) confirmed the presence of this falcon but was unable to find evidence of breeding. Little is known about the ecology of this falcon but it is considered to be threatened through general disturbances, loss of breeding habitat and potentially the loss of prey (small swifts feeding on midges emerging from the rapids) if the BGHES is developed. Taita Falcons are included as a provisional critical habitat trigger pending the availability of data that demonstrates the presence of a breeding population. • A reconnaissance survey to assess the status of Taita Falcon was undertaken in the Batoka Gorge by the Wildlife Departments of Zambia and Zimbabwe in 2018. The upper 25 km stretch of the gorge was surveyed for the presence of Taita Falcon; however, a large part of the Batoka Gorge that will be impacted by the BGHES remain unassessed – this limitation was acknowledged in the survey. The impact of creating a reservoir on the Taita Falcon population is unknown, and key gaps in the ecological understanding continue to exist. Rock Pratincoles depend on the specific habitat of emergent rocks within fast flowing rivers. The global population of these migratory birds is limited and an important population occurs seasonally within the Batoka Gorge (confirmed during a 2019 reconnaissance survey), but is not restricted to the gorge.
Ecological (Biodiversity Offsetting)	• The Batoka Gorge qualifies as a Critical Habitat due to it being a highly unique ecosystem (criterion iv), which is supported by its Important Bird Area (IBA) and World Heritage status. Species triggers include Taita Falcon, which is directly associated with the Batoka Gorge and is a bird of particular interest. • Where critical habitats are impacted, the IFC Performance Standard 6 (PS6) require that Net Gains are demonstrated for the features that trigger those critical habitats. • The Batoka Gorge will experience extensive loss of habitat (located within the confines of the gorge) through inundation by the reservoir, and there is no effective mitigation to alleviate this impact. Offsetting the unique Batoka Gorge ecosystem (including all floral and faunal species therein) therefore presents the remaining option to achieve alignment to the IFC PS6. The feasibility of offsetting this ecosystem will need to be determined, but has not been included within the scope of this ESIA. •

Table 0.7 Social Environment

Aspect	Summary description
Population	• In the Project area in Zambia, the majority of households belong to the Tonga Leya tribe and speak Leya, a dialect of Tonga, as their primary language. However, there are also small numbers of Tongas, Lozis and Ngoni. • In the Zimbabwean Project area, Ndebele is the main ethnicity, followed by Nambiya and Tonga. Accordingly, these are the main languages spoken in the area.
Livelihoods	• Communities in the Social Area of Influence in both Zambia and Zimbabwe are principally subsistence farmers, selling what additional crop they produce to generate a small income. • Livestock rearing is common and there is also substantial engagement in the curio trade in order to generate additional income. • Other livelihood activities include trading, the collection and selling of firewood, grass and forest fruits, furniture making, brickmaking, hunting, fishing, or casual labour and tourism related activities.
Tourism	• The presence of the Victoria Falls and various national parks has contributed to Matabeleland North Province in Zimbabwe and Southern Province in Zambia being noted as major tourist destinations in their respective countries. • White water rafting on the Zambezi River also attracts people from around the world to the area. • Some members of the local communities are engaged in the tourism trade e.g. working as rafting guides or porters, maids at hotels or, selling of curios. • There are 10 rafting companies that operate on the Zambezi River and approximately 250 - 500 people are employed by the industry in some form, either as river guides, porters, drivers, assistants, as well as those engaged through other companies that are directly associated with rafting, such as media sales companies that film the daily rafting trips and take photographs. A large proportion of them are either part time or casual staff. Approximately 100% of the employees are from local communities in the area. • White water rafting, alongside kayaking, generates approximately US $ 3 340 000 per annum (ERM Economic Study for the BGHES, June 2019 – refer to Annex K). It is the most popular activity and largest contributor to tourism value downstream of the Falls. • White water rafting is seasonal and dependent on the level of water. During December to May water levels are high and only certain rapids can be rafted. From August to December water levels are low and all rapids are open.
Health	• Residents in the Project Area in some cases have to travel vast distances to access health facilities (up to 32km). • Very few facilities have their own ambulances and most patients travel on foot or use private transport in order to access them. • Malaria rates were reported to have decreased in recent years due to the effectiveness of preventative measures such as spraying and use of mosquito nets. However, Malaria is high in the valley communities in Zambia. • Households in both countries reported to suffer from food shortages, generally as a result of poor harvests resulting from drought conditions.

Aspect	Summary description
Education	• In the Project area, schools are sparsely distributed and children in some cases have to travel up to 10km to access primary schools and up to 20km to reach secondary schools. Most Children attending secondary schools have to board or rent accommodation in larger towns as there are inadequate numbers of secondary schools in the Project Area villages • Distance to schools and fees act as barriers to attendance in both countries. Approximately 73% of those aged 15 years and older can read and write in the Zambian Project area versus 76% in Zimbabwe.
Housing	• Housing is mainly constructed from mud walls and thatched or corrugated sheet roofs. However, a few houses are made from bricks and asbestos roofs, especially those located close to the chief's residences.
Services and infrastructure	• Public transport is virtually non-existent and the majority of people either walk, bicycle or rely on private taxis and lifts. • Drinking water tends to obtained from wells / boreholes with hand pumps. Its' quality was generally noted to be good however; its availability is variable during the dry season. Surface water is relied on for domestic and agricultural uses in Zimba, Choma and within those communities living in the Zambezi river valley on either side of the project. • Wood is the most popular source of energy for cooking, though in Zimbabwe, households also use paraffin. Charcoal is also a popular power source in the Project area. Dung, generators, torches, solar panels and candles are all used for lighting, heating and warming purposes as well. • Few households have a latrine, especially in Zambia and defecate in the bush.
Cultural Heritage	• A total of 170 sites have been identified on either side of the Zambezi River. • The majority of these sites are not of high heritage significance with the exception of 2 intangible sites of medium to high significance. • Areas of steep and broken relief and the dissecting basalt plateaus close to the proposed Batoka Gorge dam wall and Alternative Township B in both Zimbabwe and Zambia appear to have been void of significant archaeological sites. • The vast majority of sites recorded date from the Stone Age, in particular the Middle Stone Age (MSA) and Later Stone Age (LSA). Most of the Stone Age sites are located in the open basalt plains and low ridges. No diagnostic Early Stone Age (ESA) artefacts have been recorded during recent surveys. Farming Community sites are all clustered along paleo dunes where there is cultivatable soil.

0.9 *ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT*

This *Section* presents the predicted impacts to the physical, biological and social environments as a result of the proposed BGHES. More specifically, this *Section* presents those impacts for the following Project components:

- Dam wall and impoundment, including a spillway;
- Surface power houses, one on each side of the river; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching a

The findings are presented in *Table 0.8* according to the following categories, and as described in *Chapters 10* and *11*:

- Impact description.
- Impact assessment (with an assessment scale ranging from either minor, moderate or major positive or negative impacts).
- Mitigation measures to achieve avoidance or minimisation of negative impacts and enhancement of positive impacts.
- Residual impacts remaining after mitigation measures were implemented.

Table 0.8 Summary Environmental and Social Impacts

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
PHYSICAL ENVIRONMENT	**Impacts associated with Greenhouse Gas Emissions during Construction**: The most significant source of GHG emissions during construction is associated with land use change from the clearance of vegetation for the construction sites.	MAJOR NEGATIVE IMPACT	Mitigation proposed to reduce the most significant sources of GHG emissions includes utilising cleared vegetation (wood) for commercial timber and community fuelwood rather than clearance by fire during the construction period, and minimising the amount of biomass available to decay before the BGHES reservoir is inundated. A timber survey will be carried out to estimate the amount of commercially viable timber, which could be recovered from the areas that will be cleared of vegetation during construction. It would then be possible to estimate the amount of biomass that would not release GHGs and reduce the impact from land use change emissions. Whilst improvements/reductions in GHG emissions can be achieved through identified mitigation measures, the emission sources identified cannot be completely removed from BGHES construction and operation activities, and therefore residual emissions will remain.	MAJOR NEGATIVE IMPACT
	Impacts associated with Greenhouse Gas Emissions during Operation: The most significant source of GHG emissions during the operation phase is associated with the decay of remaining biomass submerged within the BGHES reservoir.	MAJOR NEGATIVE IMPACT		MAJOR NEGATIVE IMPACT
	Impacts on Flow Upstream during Operation: (water level and speed) conditions in the Zambezi River upstream of the water storage, including potential effects on the Victoria Falls power station and river users in the gorge.	MAJOR NEGATIVE IMPACT	Reduce the dry season (in rafting terms, from August to January) operational level to 730 masl, thereby freeing a reach of river for rafting during this period that extends all the way from the Falls downstream to around rapids 9 and 10, which is the current limit of half-day rafting trips on the river; and increase the FSL during the high-flow season to 757 masl under normal flow conditions in the river.	MINOR NEGATIVE IMPACT
	Impacts Related to Reservoir Water Quality during Operation (including filling of the reservoir): The construction of the dam is expected to affect the quality of water in the resulting reservoir, which could in turn have a detrimental impact on ecological habitats, fisheries and other water users in the area, and also further downstream.	MODERATE NEGATIVE IMPACT	Upstream pollution sources will need to be minimised and controlled specifically involving a sustained programme of investment to upgrade municipal and industrial wastewater treatment facilities and sewerage systems in the main urban centres of Victoria Falls and Livingstone, and preferably also in Kasane. Upgrading sewerage and wastewater treatment facilities, a more specific measure would be to initiate and promote a formal waste oil collection and recycling programme for the tourism and industrial sectors in both urban centres. Complete clearance of none floating and floating (e.g. water hyacinth) vegetation during the first few years of reservoir formation to reduce deoxygenation of water in the areas of flooding. Implement routine programme of water quality monitoring in the stored water, as currently performed by the ZRA for Lake Kariba, with both physical and biological indicators included.	MINOR NEGATIVE IMPACT

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
	Impacts Relating to the Changes to the Downstream River Conditions during Operation (including filling of the reservoir): There will be impacts relating to flow and water quality conditions in the river downstream of the BGHES during dam operation. This is based upon the high ecological value of the river sections through the Lower Gorge and the presence of other water users further downstream, combined with the potential magnitude of flow and water quality (sediment and temperature) related effects associated with dam operation, particularly under hydro-peaking operations.	**MAJOR NEGATIVE IMPACT**	It was agreed by the ZRA that the proposed BGHES is only operated as a hydro-peaking scheme during the wet season (Feb-Aug) in accordance with the operating rules established by scenario AddPM04 (i.e. - DRY Season (Sep-Jan): Baseline flows; no sediment flushing & WET Season (Feb-Aug): QMin with one 6-hour peak a day). Furthermore, the ZRA agreed to adopt an off peak flow condition during the wet season of QMin as per the flow statistics presented in Chapter 10. Minimum flow release conditions would still be required during the period of initial reservoir filling following construction. The ZRA have agreed that if flows are above the monthly 20th percentile values the surplus will be stored, and the remaining volume of water is released with no peaking or sediment flushing during the period of initial filling. It was further agreed to by the ZRA that there is gradual (smoothed) transition between wet and dry season minimum flow conditions, using the excess inflow volumes during off-peak hours in the wet season months (i.e. beyond what is needed to replenish the reservoir to FSL each day) to progressively increase minimum flow releases from the reservoir between February and April (i.e. until the peak floods occur and the spillway is fully operational), and thereafter reduce them between May and July. During hydro-peaking, the rate of change of flow releases (the so-called 'ramping rate') will be restricted such that there is a correspondingly gradual change in downstream water levels. The precise rate of change that is achievable for the BGHES will be determined during detailed design, and will be dependent on a number of factors including design considerations and equipment specifications. A maximum ramping rate (MRR) of around 250-300 m^3/hour would equate to a change in river level of approximately 1 m/hour (note - this is within the gorge itself; the rate of change in the wider river valley downstream of the Lower Gorge would be considerably less), which should be gradual enough for river users to respond to. The final MRR applied will be accompanied by the development and routine dissemination to all downstream river users of a 'Dam Flow Release Schedule' that will detail the timing and predicted magnitude of flow and water level effects at various strategic points downstream of the dam. An early warning system will also be considered, particularly for any non-routine flood releases The Operator should review and where necessary adapt dam operating procedures to mitigate any observed impacts on ecological habitat status from the water and fish monitoring results.	**MODERATE NEGATIVE IMPACT (RoR dry season)** **MAJOR NEGATIVE IMPACT (hydro-peaking in wet and dry seasons)**
	Impacts on BGHES Related to Changing Upstream Conditions during Operation: The combination of increased upstream abstractions and the potential reduction in yield due to future climate change could lead to a reduction of 5-6% in the average annual runoff at Victoria Falls in the next 20-30 years, although in the worst-case scenario it could be as high as 10% or more. Moreover, overlapped on this is the long-term recurring pattern of 15-20 year droughts that has been observed in the Upper Zambezi flow record over the last. This could in turn have implications for downstream river conditions in the event that the dam operating procedures are subsequently modified to offset any future reduction in inflows.	**MODERATE NEGATIVE IMPACT**	The potential reduction in river basin yield at Batoka in the next 20 to 30 years will be to factor into the design of the Project and thus ensure its future sustainability. This can be attained through the adjustment of water inflow used in the power generation model for the scheme to take account of a potential reduction of water over time, taking into account the slow effects of climate change, and the potential 'step' changes as the various phases of the Chobe-Zambezi Water Transfer Scheme are constructed. The hydrological calculations that are undertaken for dam spillway design will also be tested and verified against the potential effects of increased future rainfall intensities in the Upper Zambezi due to future climate change. Considerations will be made with regards to hydrological inflow series that is applied to the power generation model is also adjusted to match the long-term periodic drought cycle that is observed in the historical record at Victoria Falls.	**MINOR NEGATIVE IMPACT**

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
	<u>Construction Related Impacts on Soil and Water Resources during Construction</u>: Both surface water and groundwater resources will be at risk during construction activities from pollution by accidental spillage of fuels and lubricants, soil disturbance and sediment runoff, or from the inadequate or unsafe disposal of sanitary wastewater from the construction worker camps and facilities.	**MODERATE NEGATIVE IMPACT**	Training and equipping relevant staff in safe storage and handling practices, and rapid spill response and clean-up techniques. Minimal or total avoidance of soil disturbance close to watercourses (preferably establishing a 10 m buffer zone, or 50 m for main rivers, and leaving existing vegetation in place), and no stockpiling of waste or fill materials close to or within channels or community water supplies. Effective construction site drainage measures, utilising cut-off drains (to divert surface runoff from exposed soils or construction areas), oil interceptors and silt traps to manage and retain sediments on site. Leaving vegetation *in-situ* wherever possible and re-vegetation of bare soils before the next rainy season. The provision and maintenance of adequate on-site sanitation facilities. This will include temporary chemical toilets, which will be located in strategic locations near active work sites and sited away from any water bodies or wetlands. One toilet should be provided on site for every 15 contract personnel at each active working area. These toilets will have doors and locks and will be secured to prevent them blowing over. Temporary toilets will be emptied on a regular schedule. Emptied waste will be transported and disposed of at the BGHES sewage treatment plant.	**MINOR NEGATIVE IMPACT**
	<u>Impacts to Seismicity during Operation</u>: Impacts associated with earthquakes and tremors linked to dams.	**MINOR NEGATIVE IMPACT**	The engineers have used both the seismic source data presented in the impact assessment in *Chapter 10*, as well as the data on lineation patterns for the Project area defined using a DTM and satellite imagery, to devise appropriate design parameters for seismicity for the Batoka dam wall, which are also in line with those minimum design parameters stipulated by ICOLD (2010).	**NEGLIGIBLE IMPACT**
ECOLOGICAL ENVIRONMENT	**<u>Direct Loss of Habitat through Filling of the Reservoir and Development of Infrastructure during Construction and Operation (including filling of the reservoir)</u>:** The main activities resulting in the loss of habitat are construction of the dam wall (and associated infrastructure) approximately 50 km downstream of the Victoria Falls and the resulting flooding of the Batoka Gorge above that point. The key sensitive receptors are the Batoka Gorge critical habitat, and the World Heritage Site, which incorporates the uppermost 17 km stretch of the Batoka Gorge. The entire Batoka Gorge is recognised as a Key Biodiversity Area.	**MAJOR NEGATIVE IMPACT**	Preconstruction botanical surveys to be conducted before the gorge is inundated to understand and document the diversity of floral species present. Threatened and endemic plant species that are at risk of being inundated or lost due to construction activities will wherever possible and practical, be relocated to safe areas of similar habitat. Protection of parts of the Batoka Gorge habitat not impacted by inundation (such as the rim, cliffs and scree slopes that will be maintained as no go zones) will partially address the loss of critical habitat. Development of the BGHES may alter the demand for development sites overlooking the reservoir for residential, tourism and other purposes east of the national parks. Measures must be taken to protect the rim of the Batoka Gorge and the scree slopes below through development of a conservation plan and restrictions on development to retain the wilderness character of the area. Offsetting of impacts to the Batoka Gorge critical habitat and World Heritage Site will be necessary, and needs to be addressed through an Offset Plan. The feasibility of achieving such an offsetting plan to cancel the residual biodiversity impact needs to be determined, but falls outside of the current scope of this ESIA. Clearing of vegetation within the proposed flood area prior to inundation of the reservoir has been proposed as a benefit to affected communities as the timber within the riparian habitats may have an economic value. However, these habitats are currently inaccessible and creating access to these areas would be detrimental to sensitive biodiversity such as the Taita Falcon and other raptor nesting sites that may survive the inundation below. Pre-inundation clearing of vegetation within the gorge is therefore not supported. The outflow from the powerhouse will be located approximately 750 meters downstream of the dam wall. Continuity of the Zambezi River needs to be maintained and landscaping of the riverbed will be required to allow formation of a pool through backflow of water to the base of the dam wall. Design of the backflow pool must allow some circulation of water to prevent formation of stagnant conditions. The feasibility of available options for an offset, including consideration of a compensatory offset needs to be investigated. The IFC PS6 (paragraph 10) requires external specialist input into the offset design and implementation, but is beyond the scope of this ESIA.	**MAJOR NEGATIVE IMPACT**

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
	Impacts to the Avifaunal Communities during Operation (including filling of the reservoir): There is a large community of birds residing in the Batoka Gorge including the Taita Falcons, a small falcon is an extremely rare cliff-dwelling small raptor and the Batoka Gorge has for a long time been recognised as hosting the single largest population in existence. Apart from Taita Falcons described above, Rock Pratincoles, Verreaux's Eagle, Crowned Eagle, Peregrine Falcon, Lanner Falcon, Bat Hawks and Augur Buzzards.	**MAJOR NEGATIVE IMPACT**	A recent survey was undertaken for the upper 25 km stretch of the Batoka Gorge for Taita Falcons; however, a large part of the Batoka Gorge that will be impacted by hydropower development remains unassessed. Therefore, an action plan is urgently required that outlines an approach to thoroughly assess the occurrence of Taita Falcons, obtain an improved level of confidence on status of the population and potential threats, and to identify suitable mitigation that will be accepted by the international specialist community. The impact of creating a reservoir on the Taita Falcon population is unknown, and key gaps in the ecological understanding continue to exist. A reliable Impact Assessment cannot be finalised until these gaps have been addressed, which ZRA have committed to do. Collaborative workshopping is required between all Taita Falcon specialists to consolidate available information, establish an approach to addressing gaps and development of mitigation to address impacts. This approach must not be restricted to Taita Falcons but will include all affected raptors, Black Stork, Rock Pratincole and African Finfoot populations that depend on the same Batoka Gorge habitat and overlap in terms of the area of impact. A collaboration with specialist raptor ornithologists such as the ZFC, BirdWatch Zambia (partners of Birdlife International) and South African Taita Falcon specialists will be required to assess the feasibility of addressing gaps and above development of monitoring and management actions.	**MODERATE NEGATIVE IMPACT**
	Alteration of Fish Communities and their Utilisation during Operation (including filling of the reservoir): The construction of the dam will result in the change in the riverine aquatic habitat into an open water pelagic habitat due to the fluctuating water levels. Fundamental habitat alteration caused by the BGHES reservoir will require the establishment of entirely new fish populations	**MAJOR NEGATIVE IMPACT**	Two types of fisheries could be established after water impoundment, namely the capital intensive *Limnothrissa miodon* (Kapenta) - based pelagic fishery and an artisanal gill-net fishery. Successful establishment of this species is expected to lead to a healthy population of *Hydrocynus vittatus* Tiger Fish in the reservoir provided water quality is maintained. Monitoring and control of fisheries. Sport fishing for Tiger Fish may develop into a valuable industry that supports local economies and will receive consideration in the management of the fisheries. Monitoring of individual fish populations and possible introduction. Tiger Fish will need to be monitored for breeding success and population growth, and if necessary appropriate numbers of fingerlings may need to be introduced annually to achieve the fisheries potential of the reservoir. Young fingerlings will be introduced to the Batoka reservoir and the Zambezi River downstream of the wall to complement the fish diversity and contribute an important species to the fisheries there.	**MODERATE NEGATIVE IMPACT**
	Impacts to Crocodiles and Other Fauna during Construction and Operation: The primary Project activity that will affect conservation important species is the construction of the BGHES dam wall approximately 50 km downstream, of the Victoria Falls and the resulting inundation of the Batoka Gorge above that point.	**MINOR NEGATIVE IMPACT**	A qualified and competent SHEQ Officer will be appointed with sufficient authorisation to ensure protection of the environment is prioritised. He/she must ensure that mitigation listed with the ESMPs is implemented to minimise environmental impacts. A Biodiversity Protection Statement is required to conserve plants and animals, and is to be applicable for all staff and contractors involved in the project. ZRA must include such information as part of the site induction process so that all workers are aware of these prohibitions, as well as including in environmentally related information campaigns such as a quarterly newsletter. Awareness programmes will not be limited to staff and contractors, but should include an outreach programme to prominent individuals and community organisations such as schools, youth groups, women's groups. IFC standards require that developments in natural habitats demonstrate have a no net loss of biodiversity values as a result of their activities. This can be achieved through maintaining a structured inventory of species that are present. The species within this inventory will be classified into taxonomic groups and families, threatened status using the IUCN Red List and their perceived threat status within the Project area and surrounding areas. An animal rescue procedure will be developed and implemented for dealing with faunal species found to be at risk from or posing a threat to Project operations.	**MINOR NEGATIVE IMPACT**

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
	Habitat Degradation resulting from Altered Flow Regimes during Operation (including filling of the reservoir): The patterns of flow release from the BGHES will have an overriding influence of the Present Ecological State of the Zambezi River downstream of the dam wall.	**MAJOR NEGATIVE IMPACT**	Results from the environmental flow assessment demonstrate that peaking operations are expected to have a significant negative impact on the integrity of the downstream Zambezi River ecosystem, and given the slope of the river through the Batoka Gorge, it is highly unlikely that these flows will be attenuated to any meaningful extent before they reach Lake Kariba. . The proposed BGHES is only to be operated as a hydro-peaking scheme during the wet season (Feb-Aug) in accordance with the operating rules established by scenario AddPM04, which will meet both of the environmental criteria of no more than a 1.5 drop in overall ecosystem integrity and no more than a 25% reduction in abundance for 90% of the fish species represented in the DRIFT model. A comprehensive ecological monitoring programme will be required to assess the impacts of the hydropower scheme on the downstream stretches of the Zambezi River. This monitoring programme will need to include hydrological aspects as well as the state of ecological receptors. Develop and Implement a Sediment Management Plan consist of: • Monitoring sediment in the reservoir, including quantitative and qualitative analysis of sediment to verify properties and pollution levels; • Minimising sediment deposition in reservoirs where possible by sluicing or density current venting; • Removing accumulated deposits where possible by drawdown flushing (drawing the water level down during high-flow seasons), and excavation of sediments; and • Catchment management programmes to reduce sediment inflow to the reservoir where possible as part of a basin-wide plan.	**MODERATE NEGATIVE IMPACT**
	Eutrophication and Associated Floating Aquatic Weed Infestation during Operation (including filling of the reservoir): The BGHES may lead to an infestation outbreak of floating aquatic weeds, as the inundation of the Batoka Gorge is expected to lead to eutrophication of the waters as the initial standing biomass of vegetation decomposes. This impact will be cumulative with the upstream dysfunctional sewage systems of Livingstone and Victoria Falls towns.	**MODERATE NEGATIVE IMPACT**	Efficient Functioning of the Livingstone and Victoria Falls Sewage Works will be required to avoid introduction of additional nutrients and contaminants. The initial decomposition of flooded vegetation will contribute to eutrophication during the initial filling. Gradual filling, combined with extensive flushing of the reservoir will reduce the quantities of vegetation flooded at any one time and will slow down the release of nutrients into the water. Effective biological control mechanisms are available for many of the floating aquatic weeds. Specialist advice on the management of floating aquatic weeds will be sought to either remove floating aquatic weeds or appropriately manage this issue.	**MINOR NEGATIVE IMPACT**
SOCIO-ECONOMIC	**Economic Displacement - Disruption to Land Based Livelihoods during Construction and Operation:** The project's construction and operational activities will result in loss of access to land for households that are dependent on natural resources livelihood activities. The loss of land used for economic purposes will be lost to the staff townships, permanent townships and associated infrastructure, quarries for dam construction material, access roads and transmission lines.	**MODERATE NEGATIVE IMPACT**	Position infrastructure to avoid physical displacement and minimize economic displacement. Prepare a Livelihood Restoration Plan (LRP). The Project will consult with affected communities and in partnership with them, identify community development initiatives, based on their development priorities. The ZRA will implement and disseminate information regarding the grievance redress mechanism that has been developed for the Project. Re-establish and promote access to natural resource source areas where possible post-construction. Ensure communities participate in pre-construction harvesting of resources as part of clearing activities. Identify optimal methods of storing harvested materials. Work with Project affected communities and local authorities to assist in protecting land-based resources. This will include the provision of education for local agencies and communities related to threats to biodiversity from human activities and sustainable harvesting and grazing of natural resource.	**MINOR NEGATIVE IMPACT**
	Economic Displacement – Fishing Activities during Construction and Operation: During construction, access to fishing points will be limited in the areas in which the dam wall and powerhouses will be constructed, as well as the gorge in general. Security measures, such as the patrol of the area by security personnel, will enforce access restrictions.	**MODERATE NEGATIVE IMPACT**	Development of a livelihood restoration programme specifically focused on the impacts and needs of those who fish in the Project area. Consultation to affected stakeholders regarding potential impacts and the need for transitional livelihood support, establishment of fishing monitoring program and feasibility of establishing alternative fishing areas that will not be affected by the Project and/or alternative livelihood options. Re-establish and promote access to fishing areas where possible after construction.	**MINOR TO MODERATE NEGATIVE IMPACT (during construction)**

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
			Assess the need for compensation as part of livelihood restoration planning. Establishment of fisheries. In collaboration with the Departments / Units of Fisheries in Zambia and Zimbabwe, fisheries will be established in the reservoir created by the inundation. As part of the livelihood restoration programme, provide support to households and / or local enterprises in terms of how they can use the fisheries to support engagement with the tourism trade.	**POSITIVE IMPACT (during operation)**
	Economic Displacement of Downstream River Users during Construction and Operation: During construction and operation there may be a change to the flow regime – with a river diversion during construction and a dam release regime, which may not be run-of-river during the operational phase of the project. In addition to impacts on water flows, there could also be impacts on water quality, most likely heightened following the initial flooding of the dam and release of nutrients into the system. This could potentially impact those receptors whose only livelihood is reliant on water from the Zambezi River. Specifically those that do not have an alternative for domestic water are likely to be the most vulnerable to this impact.	**MODERATE NEGATIVE IMPACT**	Communication to affected stakeholders about the exact nature of impact once flow releases have been defined by the Engineers. A detailed survey will be carried out during project design of the pumping station and submersible pump intake levels for the abstractions that occur between the proposed BGHES and the headwaters of Lake Kariba. In the event that these levels fall below the predicted water level corresponding to the final chosen minimum flow condition, compensation (financial or in-kind) will be provided for abstractors to modify their pumping stations accordingly. Detailed surveys will also be undertaken of the agricultural activities downstream so that if there are impacts as a result of flooding, these can be appropriately compensated for. Environmental flows are to be maintained during all phases of the Project.	**MINOR NEGATIVE IMPACT**
	Positive Economic Benefits for the National Economy during Operation: It is expected that there would be an estimated unserved demand of 227 MW in Zambia when the proposed BGHES starts operating in 2022. In Zimbabwe, current predictions are for an unserved demand of 444 MW. The BGHES is anticipated to provide 2400 MW (1200 MW per country) which will meet this demand and provide additional power. Economic benefits therefore likely to be provided by the Scheme include: • Meeting current and future demand for electricity and therefore reducing the impacts on ongoing electricity blackouts; • Generating profits as a result of the sale of this electricity; • Enabling business development and household benefits that result directly from the provision of reliable power in both countries; • Increased employment opportunities as a result of spin-off economic benefits.	**POSITIVE IMPACT**	No mitigation as Positive Impact anticipated	**POSITIVE IMPACT**
	Economic Impact and Displacement of River Based Tourism Activities during Operation (including reservoir filling): The flooded area of the dam will impact on water rapids, white river rafting and jet extreme boating when flooding and for the life of the operation.	**MAJOR NEGATIVE IMPACT**	The impacts described in this section are a direct consequence of the reservoir impoundment and, because lowering the operating level to below 730m ASL would not be feasible for power generation, there is no option to mitigate the impact by altering the operating level of the dam. Compensate rafting companies for the expected loss in revenues Grant, rafting companies operating licences and tax incentives, for other tourism products and activities, which could take place on the reservoir. Compensation that would need to be paid to white-water activity companies that will either go out of business as a result of construction of the dam or that will have to retrench employees would need to be evaluated as part of the RAP process. Further consultation with these stakeholders to establish acceptable terms.	**MODERATE NEGATIVE IMPACT**
	Economic Impact and Displacement of Non-river Based Tourism Activities during Operation (including reservoir filling): Birding opportunities will reduce as a result of the inundation of the rapids and resultant loss of habitat for river borne insects impacting on reduced numbers of insectivorous birds and bats in the Gorge. The increased water levels up the Gorge will also remove prime nesting habitat along the vertical cliff faces. Hikers will no longer be able to hike along the bottom of the Gorge. Overnight hiking and camping trips will also no longer be able to operate as a result of increased water levels.	**MAJOR NEGATIVE IMPACT**	The impacts described in this section are a direct consequence of the reservoir impoundment and, because lowering the operating level to below 730m ASL would not be feasible for power generation, there is no option to adequately alleviate the loss of birding and hiking habitat. To compensate the affected businesses, establish the amount of turnover that would be lost as a result of inundation. Consider the non-use value associated with the Gorge and the potential permanent loss of an ecosystem and associated endemic flora and fauna through the RAP/LRP process. Further consultation with these stakeholders to establish acceptable terms.	**MAJOR NEGATIVE IMPACT**

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
	<u>**Impact on the Local Economy during Construction and Operation**</u>: Tourism in the Livingstone and Victoria Falls towns may be impacted on by the proposed Project, but the tourism economy is not solely reliant on tourism derived from the Gorge. The areas that will be impacted by the project will Victoria Falls National Park and Mosi-oa-Tunya National Park through flooding and the backwater effect from the reservoir causing a rise in the natural water levels.	**MODERATE TO MAJOR NEGATIVE IMPACT**	Developing and promoting a new type of tourism market. The change in the activities that are available below the Falls will change the type of tourist interested in coming to the area and may also have an impact on the overall numbers of visitors to the area. New tourist activities could be developed and promoted in the affected area. These new business ventures would be expected to offer new employment opportunities in the area. The new activities might be similar to the activities already on offer upstream of Victoria Falls and on Lake Kariba which is approximately 50 km away from the proposed BGHES site. Potential activities offered on the reservoir could include house boats, motor boat activities, dam cruises, canoeing, birding (waterfowl) and angling. Ensure that the activities developed on the reservoir do not flood the market and impact negatively on the activity businesses upstream of Victoria Falls or on Lake Kariba. Tourist market and visitor numbers to be assessed to determine accurately the carrying capacity of the reservoir area and the supply and demand of the market. Undertake a comprehensive tourist survey during the high season months to determine accurately what activities would be the most popular amongst tourists and which activities would not. In doing so, a more focused tourism product can be developed that will attract tourists to the area and will encourage the promotion of new activities. The construction of small to medium sized safari lodges and tented camps downstream of Victoria Falls in the vicinity of the proposed reservoir to encourage tourists to overnight in the area and to participate in new activities developed on the reservoir. Compensation that would need to be paid to businesses that will either go out of business as a result of construction of the dam or that will have to retrench employees would need to be evaluated as part of the RAP process. Further consultation with these stakeholders to establish acceptable terms.	**MODERATE NEGATIVE IMPACT**
	<u>**Impact on Accommodation Establishments in / on the Gorge during Construction and Operation:**</u> The views offered by the Taita Falcon and Gorges Lodges, as well as their proximity to the Gorge for hiking and birding are their main selling points. As a result of changes to the water levels, accommodation establishments will suffer from compromised views, altered landscapes and a lack of birding/hiking opportunities.	**MODERATE NEGATIVE IMPACT**	Market the lodges differently to attract visitors coming to the area to enjoy the activities available on the dam. Compensation for altering marketing material should be assessed as part of the RAP. Lodges could provide activities themselves, such as fishing trips and reservoir cruises on new revoir.	**MINOR TO MODERATE NEGATIVE IMPACT**
	<u>**Local Employment Opportunities during Construction and Operation**</u>: The Project will created an estimated 3, 000 direct job opportunities at the peak of construction and 300 direct opportunities during operation. Indirect employment will be created through the supply chain of the Project and elsewhere due to the increased spending by those employed.	**POSITVE IMPACT**	Develop and implement a Local Employment Program. Targets will be set to maximise the number of Zambian and Zimbabwean nationals, local, female, disabled, unskilled, skilled and highly skilled employees from the Project Area. The ZRA will provide all its Contractors with the requirements related to hiring for inclusion in tendering documents related to human resources database, aspirational hiring targets, auditing arrangements, and (where relevant) training requirements. Employment opportunities will be publically advertised in appropriate newspapers, public libraries, the District Offices and in all relevant languages. All employment requirements will be advertised in a timely manner. The Contractor will establish a recruitment office in Livingstone, Zambia and Victoria Falls, Zimbabwe. There will be no requirement for applicants to make payments for applying for, or securing, employment on the proposed Project. No employment will take place at the entrance to the site. Only formal channels for employment will be used. The ZRA will develop and implement a Training Policy and relevant programs prior to the commencement of construction.	**POSITVE IMPACT**

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
	Local Procurement of Goods and Services during Construction and Operation: Local, regional and national (small, medium, and large enterprises) will get the opportunity to become part of the Project's supply chain.	**POSITVE IMPACT**	A Procurement Plan will be developed and implemented prior to the start of the construction phase. Develop and maintain a database of all relevant local businesses that could be used as potential suppliers. Identify local procurement opportunities. Sound communication of the procurement programme. Promote capacity building to support in-country businesses to assist them with responding to tender opportunities and meeting administrative requirements of written communication, invoicing and reporting.	**POSITVE IMPACT**
	Opportunities for Community Development during Construction and Operation: Physical infrastructure will be developed as part of the Project that may benefit the local communities. This could include the access roads and social infrastructure in the permanent townships. ZRA has also committed to undertaking social development initiatives in the Project area to help support the economic and social development of directly affected and neighbouring communities. Contributions still to be made by contractors remains to be determined.	**POSITVE IMPACT**	Allow the wider public to access social infrastructure (such as health centres, educational and recreational facilities) located within the permanent townships. Livelihood restoration programmes to be developed as part of the RAP and will also require implementation. The Project will consult with affected communities and in partnership with them, identify community development initiatives, based on their development priorities. This will be undertaken in partnership with local NGOs. Options to link up to current initiatives of the Zambezi Valley Development Fund which currently has projects underway in the areas impacted on by the Lake Kariba Project will be explored further in terms of effectiveness of the current Fund and appropriateness for the proposed BGHES.	**POSITVE IMPACT**
	Community Anger over Unmet Expectations during Construction: Community anger and resentment over unmet expectations, be it over employment, social investment or, compensation for loss of assets or disruption to livelihoods, has the potential to strain relations and pose business and reputational risks to ZRA.	**MAJOR NEGATIVE IMPACT**	Implement the Grievance Redress Mechanism. Adopt mitigation for employment and procurement. Develop a stakeholder engagement programme and hold ongoing engagement with stakeholders. Establish a community development programme. This will be informed by local development priorities and acknowledgement of the most vulnerable groups. Effectively manage and implement the resettlement process under the Resettlement Action Plan.	**MINOR NEGATIVE IMPACT**

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
	<u>Impacts Related to In-migration during Construction:</u> The construction phase is typically when the risk of Project induced in-migration is at its highest, with a key driver being employment opportunities. Expectations regarding resettlement and compensation may also influence people to migrate to the area. Improved transport links associated with the development of the Project is likely to facilitate such movement.	**MAJOR NEGATIVE IMPACT**	It is important to note that in-migration is difficult to manage in any circumstance, regardless of location or driver. This is especially the case since some of the measures that need to be taken rely on the capacity and collaboration of third parties including the government, chiefdom authorities and other companies in the area. Amongst other some of the more important mitigation/management measures include: • Development and implementation of a Project Induced In-migration (PIIM) Management Plan. • ZRA will partner with the national, regional and local Government agencies to implement the plan. • Ensure livelihood restoration measures, as detailed in the RPF and subsequent LRP/RAPs are implemented. • Initiate discussions with the Ministry of Health in order to plan for anticipated increased demands on local health facilities from the Project (during construction) as newcomers to the area. • In collaboration with local government monitor in-migration rates. • Liaise with government regarding the location of the staff townships. • Assist with the identification and demarcation of transitional zones for settlement, business, and informal trading in anticipation of an influx of people and associated housing demands, with the aim of directing future settlement patterns. • Ensure community awareness and safety in terms of Project operational areas, hazardous areas, and future development areas. This will prevent inappropriate and unsafe settlement near to Project activities.	**MODERATE NEGATIVE IMPACT**

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
	Increased Incidence of Communicable Diseases during Construction: As a result of Project development, in particular during the construction phase when the workforce is likely to be greatest and when in-migration may peak, the rate of transmission of diseases may increase._	**MAJOR NEGATIVE IMPACT**	Health awareness training will be provided to all employees. Pre-Employment screening measures will be developed and implemented for workers, which will cover appropriate diseases. Individuals found to be suffering from communicable diseases will be provided with treatment prior to mobilisation to site. TB prevention measures will be implemented including free testing and free treatment for all personnel working on the Project. Develop Emergency Prevention, Preparedness and Response Plans. Monitor the emergence of major pandemics through WHO alerts. Ensure sufficient health services are available to meet the day-to-day needs of Project personnel without impacting on access to health care for communities. Develop agreements with health clinics or hospitals that the Project intends to use. Develop a recruitment strategy for employment of medical staff to avoid taking resources from the local area and prevent a negative impact on local health care. Operate workers' accommodation camps in accordance with international good practice. Develop and Implement a Workforce Code of Conduct. Commit community investment funds to public health initiatives being implemented by regional/local Government and /or relevant NGOs. A baseline for workers and residents of the affected communities will be prepared in line with the requirements of the International Council of Mining and Metals (ICMM)'s Good Practise Guideline on HIV/Aids, Tuberculosis and Malaria. The ZRA will develop a policy and management plan to reduce the transmission of STIs, including HIV/AIDS. Support local school education initiatives by government and NGOs regarding sexual education.	**MINOR NEGATIVE IMPACT**
	Increased Incidence of Malaria and Other Vector Borne Diseases during Construction and Operation: Malaria is currently the only vector borne disease of concern in the local communities there is a risk that others, such as yellow fever, dengue fever or lymphatic filariasis, may develop as a result of the creation of mosquito breeding grounds that could attract different species of mosquitoes in to the area	**MAJOR NEGATIVE IMPACT**	Development and implementation of an Integrated Malaria Control, Prevention and Treatment Programme. Maintain the health centres/hospitals that will be developed as part of the permanent townships. Allow wider public to access health centres located within the permanent townships.	**MINOR NEGATIVE IMPACT**
	Impacts to Community Security during Construction and Operation: Impacts to community security could occur as a result of clashes between security personnel and community members or due to increases in crime associated with the establishment of border posts.	**MODERATE NEGATIVE IMPACT**	Development of a Security Management Plan that will set out the process for recruitment and management of security personnel. Management of security providers in line with the Voluntary Principles on Security and Human Rights. Implement and disseminate information on the Grievance Redress Mechanism.	**MINOR NEGATIVE IMPACT**
	Worker Health and Safety Impacts during Construction: Construction is one of the most dangerous occupations in the world and the construction of Project infrastructure has the potential to put the Project workforce (including contractors and subcontractors) at risk of exposure to health and safety incidents due to the nature of the work. During construction workers will be susceptible to falling from heights, coming into contact with hazardous materials (e.g. through blasting), being struck by falling objects, experiencing excavation accidents, and being electrocuted, etc.	**MODERATE NEGATIVE IMPACT**	Develop and implement an Occupational Health and Safety Plan. Engage with workforce on health and safety incidents. Contractor auditing and supply chain management. Develop and implement a Blasting Management Plan. Develop and implement an Emergency Response Plan (ERP). Develop and implement a Worker Grievance Redress Mechanism.	**MINOR NEGATIVE IMPACT**

ENVIRONMENT	IMPACT	ASSESSMENT	MITIGATION OR RECOMMENDATIONS	RESIDUAL IMPACT
SOCIO-CULTURAL HERITAGE AND HERITAGE RESOURCES	**Impacts on Sites of Physical Cultural Heritage during Construction:** The construction of the dam wall and the associated power-generation infrastructure on each side of the Gorge will involve major groundworks, including extensive blasting and tunnelling. Additional quarries will also be required. No archaeological sites have been recorded in the immediate vicinity of the dam wall. This area is characterised by dissecting basalt plateaus of steep and broken relief, is not congenial to human settlement, and appear to have been void of significant archaeological sites. This area is still sparsely occupied. On this basis, no archaeological sites of sensitivity are expected in this area.	**MINOR TO MODERATE NEGATIVE IMPACT**	Additional pre-construction archaeological survey will be carried out, with the involvement of local archaeologists from the relevant host countries and palaeontologists, focussing on the areas that will be directly affected. Surveys will be systematic and intensive, with the objective of identifying all sites that will be affected. In the case of sites of high cultural significance, consideration will be given as to whether adjustment of the design can avoid unnecessary impacts before any other form of mitigation is considered. Should sites of medium or high archaeological sensitivity be identified by these pre-construction surveys, time and resources will be provided to permit more detailed recording/investigation ahead of the commencement of the construction process. This will need to include on the Zambian side: Site 151, 155, 167 and 168 Implement a Chance Finds Procedure with the following characteristics: • Unexpected discoveries made during construction to be reported; • Clear definition of roles and responsibilities; • Allowance for the temporary suspension of construction work should discoveries require further investigation; • Agreed repositories for finds in Zambia and Zimbabwe • All procedures to be agreed in advance with NMMZ/NHCC. Archaeological monitoring/watching briefs for both sides. Pre-construction survey of the access routes in Zimbabwe as this was not conducted yet. Settlement A in Zimbabwe must be re-assessed and suitable mitigation measures proposed on the sites within the footprint. Although these sites are of no to low significance, the magnitude of the impact necessitates additional mitigation measures on certain sites including surface sampling and analysis.	**MINOR NEGATIVE IMPACT**
	Impacts on Living Cultural Heritage during Construction: All aspects of the scheme construction - dam infrastructure, inundation, staff townships, quarries access roads, transmission lines – have the potential to have impacts on sites of living heritage significance. This would cover both direct disturbance of such sites, and also the creation of impediments to access to such sites.	**MAJOR NEGATIVE IMPACT**	Chemapato Hill: this site, owing to its importance and the fragile nature of the remains on it, requires special and specific management. This will be based on further consultation with local communities, with a focus on Toka-Leya groups, who are believed to have been historically the most important group associated with the Hill's ritual use. Additional pre-construction surveys will be carried out among the affected local communities to identify which sites of intangible significance, if any, could be disturbed by the proposals. The access road on the Zambian side could impact on the following sites: 136, 141 and 142. Wherever possible, construction designs will be adapted in order to avoid unnecessary impacts on sites on intangible significance. On the Zambian side this includes site 169 and 170 as per the request of Chief Mukuni. Where impacts on sites on intangible value cannot be avoided, memoranda of understanding will be agreed with affected local communities setting out procedures for the relocation of graves and, where appropriate, compensation for the loss of sites on intangible/ritual significance.	**MINOR NEGATIVE IMPACT**

0.10 CONCLUSIONS

Both Zambia and Zimbabwe currently have an electricity deficit where demand exceeds the available supply.

In both Zambia and Zimbabwe, a number of new generation options are either being planned or commissioned. The proposed BGHES would provide electricity at a cost that would be considerably lower than most of the reasonable alternatives.

The economic assessment undertaken as part of this ESIA shows that the proposed BGHES is a financially feasible scheme (at a FSL of 757 m amsl) with an Internal Rate of Return (IRR) of 28%, a Benefit Cost Ratio (BCR) of 4.74 and a Nett Present Value (NPV) of US$ 10,643 million (Stratecon 2019). In terms of the macro-economic benefits to both Zambia and Zimbabwe, in aggregate, the proposed BGHES would have added a cumulative US$ 771 million to the GDPs of the two countries by the end of construction, and by 2040, this cumulative contribution is estimated at US$20,237 million (Stratecon 2019). Moreover, the Project has the potential to provide social benefits at national, regional and local levels through employment opportunities and procurement of local goods and services.

The proposed BGHES does also come at a potential cost, with impacts to both the regional and local economic, social and biophysical environments, as elaborated in this report. These need to be weighed up together with the positive contributions the BGHES will provide to both countries.

The importance of the BGHES to the economies and growth of both Zambia and Zimbabwe is recognised; however, the significant challenges with balancing the needs of environmental protection with the economic and developmental needs of both countries are also recognised.

This Project is not immune to these challenges. This ESIA (together with the ESIAs for other BGHES Project components) has therefore attempted to describe both the benefits of the proposed Project as well as the environmental and social sensitivities associated with it. Where impacts are identified, detailed mitigation measures to reduce the significance of these impacts are described; also, where impacts may not be mitigated, this too has been described. In the case of positive impacts, measures to enhance such positive impacts are provided.

ERM recommends that the decision makers consider both the benefits and the sensitivities associated with the BGHES, so that an informed decision is made in this regard.

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Authorised by the Chief Executive of the Zambezi River Authority, as the proponent of the Batoka Gorge Hydro-Electric Scheme:

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Engineer Munyaradzi. C. Munodawafa.
Chief Executive
Zambezi River Authority
21th February 2020

1 INTRODUCTION

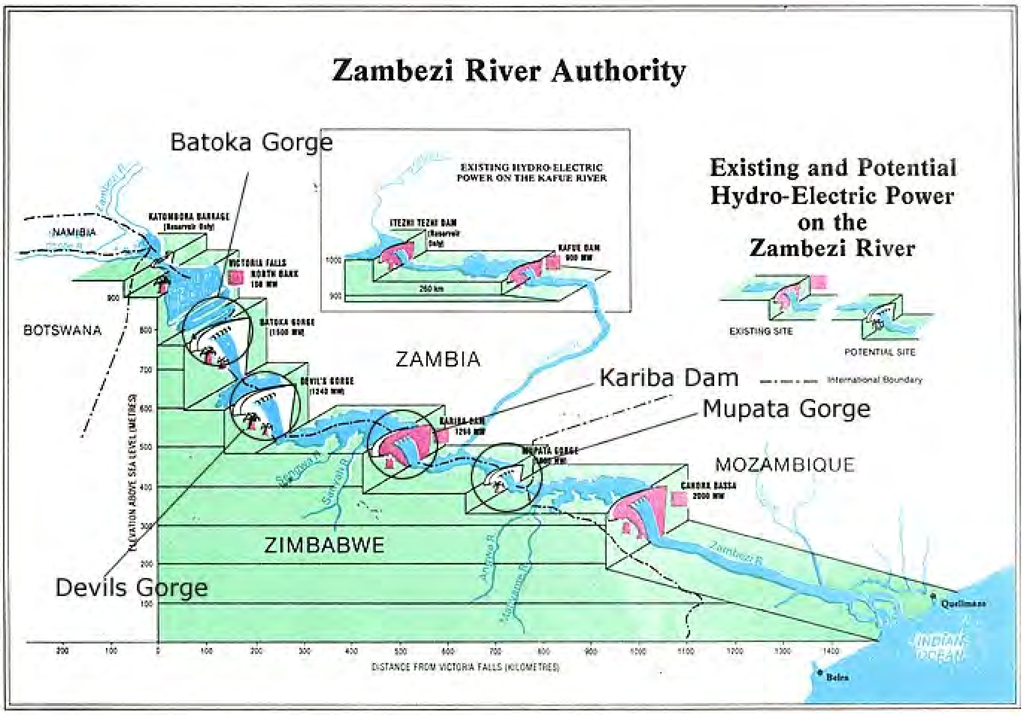
1.1 A BRIEF HISTORY AND BACKGROUND TO THE PROPOSED HYDROPOWER SCHEMES ON THE LOWER ZAMBEZI RIVER

The development of a hydropower scheme on the Zambezi River downstream of Victoria Falls has been investigated to various degrees of detail since 1904, when geological investigations for potential sites commenced. EExtensive work with regards to a potential hydropower scheme on the Zambezi River downstream of Victoria Falls began in 1972, however, when suitable sites for the development of such a scheme were investigated, and where, as part of this study, the Batoka Gorge, Devil's Gorge and Mupata Gorge sites were specifically identified for further study (*Figure 1.1*).

This 1972 study identified the Batoka Gorge as the most suitable site for a potential hydropower scheme, although engineering and geological investigations undertaken at the time identified a site some 12 kilometres (km) downstream from the site now identified as the most suitable location for the proposed Batoka Gorge Hydropower Development.

Since 1972, three more phases of site/geological investigations were undertaken at the preferred Batoka Gorge site (12 km upstream of that defined in 1972). These investigations were conducted in 1981/82, 1983 and 1989 respectively, in order to supplement information acquired during previous studies. Amongst other findings, the results of these investigations revealed that the Batoka Gorge substrate conditions represented a feasible location for such a project, with surrounding rock masses that are generally considered strong, hard and of low permeability.

Figure 1.1 Identified Sites on the Zambezi for Proposed Hydropower Developments



Source: Zambezi River Authority

Following these studies, in 1992 the Zambezi River Authority (ZRA) commissioned the Batoka Gorge Joint Venture Consultants (BJVC) to carry out a feasibility study for the proposed Batoka Gorge Hydro-Electric Scheme (hereafter referred to as the BGHES). This study examined two alternative sites, in addition to the 1981/82 site, but found neither to be better than the site identified in the 1981 report (BJVC, 1993). As such, the above-mentioned feasibility study concentrated on this site, with 18 different configurations for development being considered, costed and compared (BJVC, 1993). The findings identified that a Roller Compacted Concrete (RCC) gravity arch dam with two underground power stations (one on the Zambian bank of the river and another on the Zimbabwean bank), each with four turbines fed by two penstocks, with a combined total capacity of 1,600 MW, was the optimal project sizing for the site. An Environmental and Social Impact Assessment (ESIA) for this proposed scheme was also undertaken as part of this 1993 feasibility study, and to address gaps identified in this 1993 ESIA, further environmental and social studies were undertaken in 1998.

In 2014, the ZRA initiated a further study on the proposed BGHES by appointing Studio Pietrangeli (SP) Consulting Engineers of Italy to update the engineering feasibility studies for the proposed BJVC (1993) scheme, and in parallel appointed Environmental Resources Management Southern Africa (Pty) Ltd. (ERM) of South Africa to update and carry out an Environmental and Social Impact Assessment (ESIA) of the proposed BGHES, in parallel. This *report* represents the ESIA report for the proposed BGHES.

Prior to the end of 2015, ERM completed the Scoping Phase of the Project, which entailed extensive stakeholder engagement and the necessary environmental and social baseline studies. In late 2015, the ESIA process was placed on hold for numerous technical and commercial reasons; however, ongoing discussions have been held between ERM, the ZRA and the World Bank (the funder of the feasibility studies), and the ESIA process for the Project has since recommenced.

This *report* represents the ESIA report for the proposed BGHES. More specifically, this report presents the ESIA associated with the following Project components:

- Dam wall and impoundment, including the spillway facility;
- Surface power houses, one on each side of the river; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching areas).

Following the submission and approval of the Scoping report (in December 2015), the Zambian Environmental Agency (ZEMA) requested that three separate ESIA reports be submitted for each of the components of the BGHES. Accordingly, separate ESIA reports have been compiled for 1) Access Roads in Zambia and Zimbabwe; and 2) Transmission Lines in Zambia and Zimbabwe. For a holistic understanding of the Project environmental and social impacts and associated management recommendations, this ESIA should be considered in conjunction with the separate Project ESIA reports (and associated ESMPs).

1.2 THE PROPOSED BATOKA GORGE HYDRO-ELECTRIC SCHEME

The proposed BGHES is to be located at 17° 55' 38.55" S and 26° 6' 28.38" E [(1)], in the central portion of the Zambezi River Basin and will span across the international boundary between Zambia and Zimbabwe. It will be situated upstream of the existing Kariba Dam hydroelectric scheme on the Zambezi River and approximately 47 km downstream of the Victoria Falls (refer to *Figure 1.2* and *Figure 1.3*).

This proposed bilateral hydropower project between Zambia and Zimbabwe includes the construction of a proposed 180 metres (m) high gravity arch dam that would provide a total capacity of 2,400 megawatts (MW) (to be shared equally between Zambia and Zimbabwe), and annual energy production of 10,215 Gigawatt hours per year (GWh/y).

In Zambia, the proposed Project falls within the Southern Province and in the districts of Kazungula, Zimba, Kalomo and Choma. Kazungula District, and in particular the ward of Mukuni, which falls in the Katombola Constituency and is under the jurisdiction of Chief Mukuni, will be most directly affected due to the placement of the dam infrastructure, access roads and township. The

(1) More accurate coordinates (in ITRF2008 Geographic) are provided by SP (2015) for the proposed site on both the Zambian and Zimbabwean banks of the river.
UTM Coordinates are 8017623.076 (Y) and 405516.5006 (X)

proposed transmission line alignment impacts on Kazungula District, as well as Zimba District, (namely Zimba ward), which is under the jurisdiction of Chief Sipatunyana, Kalomo District (especially Chawila ward), also under Chief Sipatunya and Choma District (in the ward of Singani). In Choma, it is Chief Singani holds influence in the area of interest. The SAoI also covers Livingstone District, as impacts are also likely to be experienced here.

In Zimbabwe, the proposed scheme falls within the province of Matabeleland North and in the Hwange District. It includes the wards of Matetsi, Chidobe, Katchecheti, Nemanhanga, Mbizha, Jambezi, Sidinda, Mashala and Chinkandukubi. The affected chiefdoms are Hwange, Mvutu and Shana.
The proposed dam site is provided in *Figure 1.2*, (which is based on the map of the Surveyor-General, Zimbabwe Rhodesia, Batoka Gorge 1726 C3, Edition 2, Scale 1:50 000) and *Figure 1.3*.

Figure 1.2 Proposed Dam Site Location (1)

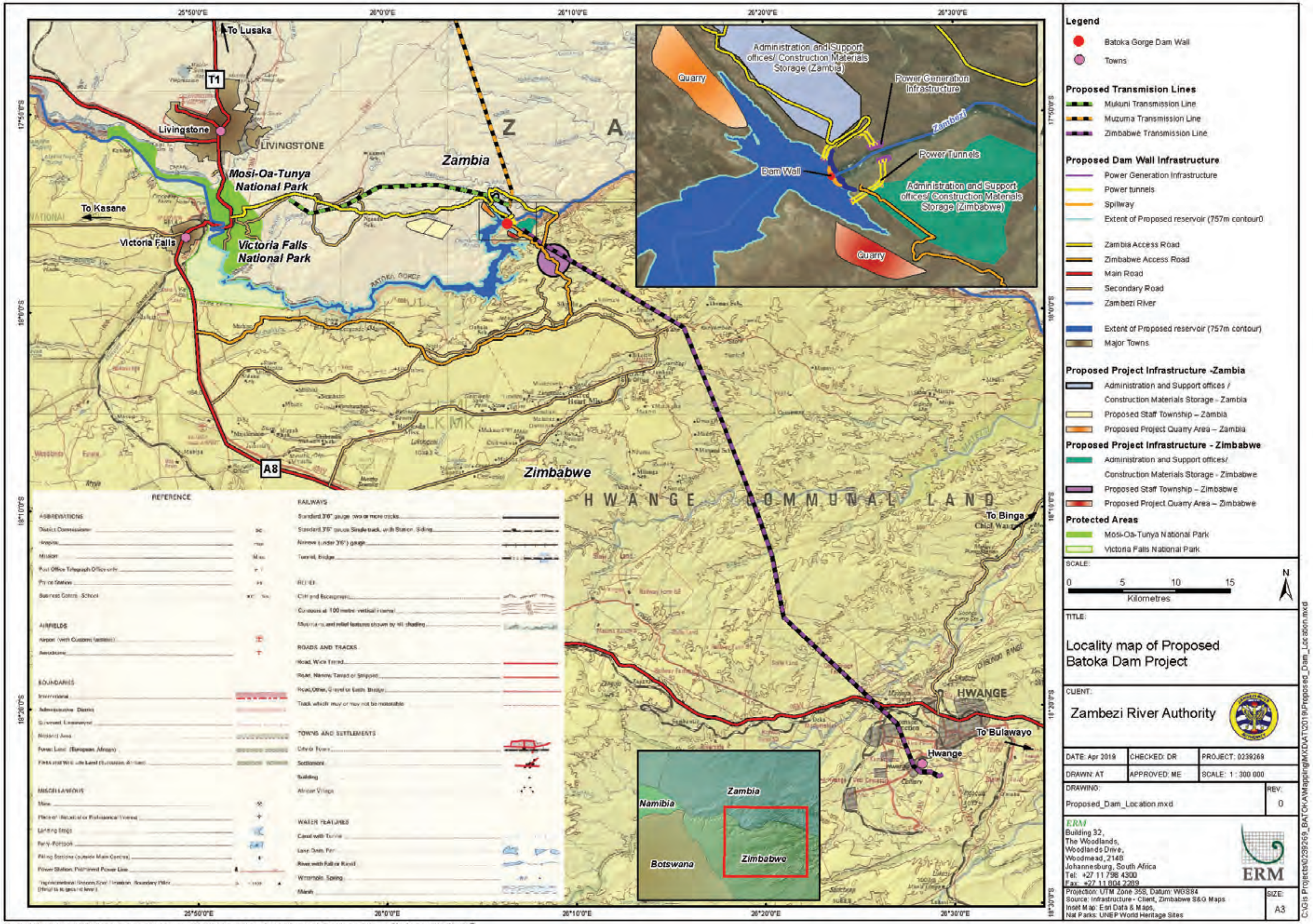


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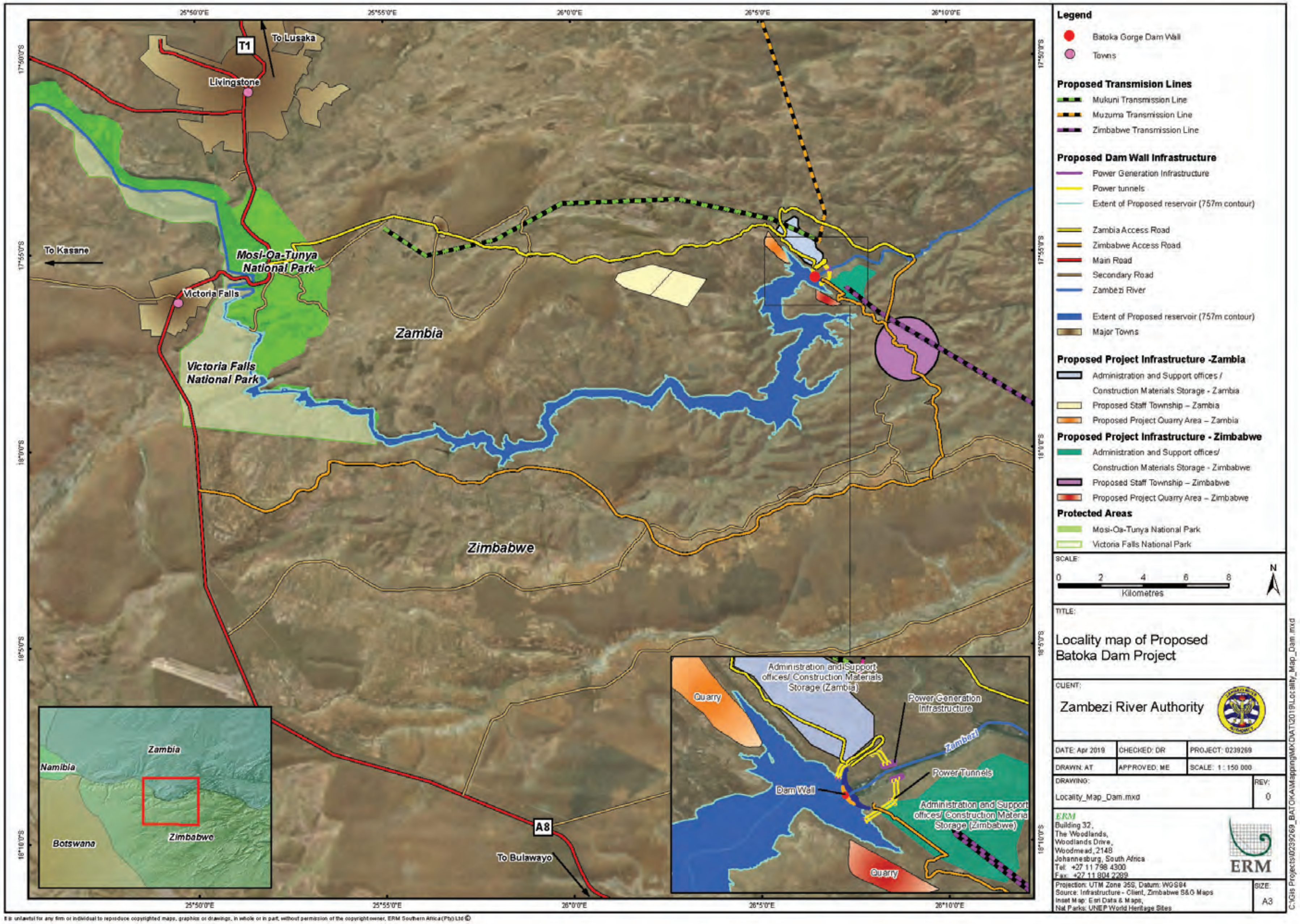
Figure 1.3 Proposed Dam Site Location (2)



1.3 *KEY COMPONENTS OF THE PROPOSED BATOKA GORGE HYDRO-ELECTRIC SCHEME*

The proposed BGHES includes the following key components:

- Dam wall and reservoir, including spillway infrastructure;
- Surface power houses, one on each side of the river;
- Transmission lines in Zambia and Zimbabwe;
- Access roads in Zambia and Zimbabwe; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area, construction camps and batching areas).

These components are based on the dam type that was proposed in the 1993 BGHES Feasibility Study (BJCV, 1993) and the updated design described in Studio Pietrangeli's (SP) October 2018 Phase II Option Assessment Report (Rev. F), and subsequent Phase III Feasibility Report (2019). A full description of the proposed project is provided in *Chapter 2*.

Please Note:

As mentioned in *Section 1.1*, following the request of the ZEMA to have separate ESIAs for each of the components of the BGHES, this ESIA is specific to the following Project components:

- Dam wall and impoundment, including a spillway;
- Surface power houses, one on each side of the river; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching areas).

The total investment cost of the proposed BGHES is approximately US$ 2.5 - 4 billion. At current estimations, it is believed that the expected commissioning of the proposed BGHES will be in 2027.

1.4 *THE NEED FOR THE PROJECT*

Investment in energy is a prerequisite to achieving social and economic development. The use of solar power is favourable in providing rural and urban areas with access to power; however, if the Republics of Zambia and Zimbabwe are to achieve those targets and goals detailed in their respective Vision 2030 and Vision 2040 Plans, and other complimentary plans, these countries will require private sector investment in energy technology that is efficient, sustainable and reliable. The generation of energy through hydropower is a proven technology that is sustainable and is actively being promoted at a national level in both Zambia and Zimbabwe. With a vast hydropower energy potential, hydropower is considered the most feasible and reasonable electrification option for both countries.

The objective of the proposed BGHES therefore is to increase power generation capacity in both Zambia and Zimbabwe to reduce the current power deficits currently experienced in both countries, to reduce power outages and to reduce reliance on coal fired power stations. Once completed, the proposed BGHES will contribute significantly to the electricity supply of both countries, and also serve to distribute power within the Southern African Power Pool (SAPP).

The rationale for this project, and a comparison of hydropower schemes to other power generation projects proposed or currently being planned in both Zambia and Zimbabwe, is further described in *Chapter 3*.

1.5 PROJECT PROPONENT

The Zambezi River Authority (ZRA), a corporation jointly and equally owned by the governments of Zambia and Zimbabwe, is considering developing the proposed BGHES, and is the project proponent for the proposed BGHES.

ZRA was formed by the Zambezi River Authority Act of 1987 (Act No. 17 and 19 Zambia and Zimbabwe respectively) and is governed by a Council of Ministers consisting of four members: two are Ministers in the Government of the Republic of Zambia; and two are Ministers in the Government of Zimbabwe. The Ministers are those holding portfolios of Energy and Finance in the respective countries.

The functions of ZRA are set out in the schedule to the Act, and are as follows (1):

- Operate, monitor and maintain the Kariba Complex ("Kariba Complex means: the Kariba Dam and reservoir, all telemetering stations relating to the Kariba Dam, any other installations owned by the Authority");
- In consultation with the National Electricity Undertakings, investigate the desirability of new dams on the Zambezi River and make recommendations thereon to the Council;
- Subject to the approval of the Council, construct, operate, monitor and maintain any other dams on the Zambezi River;
- Collect, accumulate and process hydrological and environmental data of the Zambezi River for the better performance of its functions and for any other purpose beneficial to the Contracting States;
- In consultation with the National Electricity Undertakings, regulate the water level in the Kariba reservoir and in any other reservoir owned by the Authority;
- Make such recommendations to the Council as to ensure the effective and efficient use of the waters and other resources of the Zambezi;
- Liaise with the National Electricity Undertakings in the performance of its functions that may affect the generation and transmission of electricity to the Contracting States;
- Subject to provisions of Article 13 of the Act, recruit, employ and provide for the training of such staff as may be necessary for the performance of its functions under the Agreement;
- Submit development plans and programmes to the Council for approval;

(1) ZRA, 2014, Functions, http://www.zaraho.org.zm/functions.html

- Give effect to such directions, as may from to time, be given by the Council; and
- Carry out such other functions as are provided for the Agreement or are incidental or conducive to the better performance of its functions.

The Project Proponent's physical address and contact details are provided below:

Project Proponent	Physical address	Postal address
Chief Executive Officer Zambezi River Authority	Kariba House 32 Cha Cha Cha Road Lusaka, Zambia	P.O. Box 30233 Lusaka, Zambia

1.6 *THE ESIA PROCESS*

The ESIA process is being conducted in accordance with the Zambian Environmental Management Act (Act No. 12 of 2011), pursuant to Statutory Instrument No. 28 of 1997 - the Environmental Impact Assessment (EIA) Regulations. In Zimbabwe, the process is being conducted in line with the following legislation: the Environmental Management Act (the Act) (Chapter 20:27), No. 13 of 2002; Statutory Instrument 7 of 2007: Environmental Management (Environmental Impact Assessments and Ecosystems Protection) Regulations; the Environmental Impact Assessment Policy of 1997; as well as the Environmental Impact Assessment Guidelines of 1997.

In 2014, ERM undertook a harmonised ESIA process [(1)] for the proposed Kariba Dam Rehabilitation Works, which satisfied both the Zambian and Zimbabwean ESIA requirements mentioned above. As with the proposed BGHES, the proposed Kariba Dam Rehabilitation Works project is located on the Zambezi River on the border of Zambia and Zimbabwe and is managed by the ZRA. The Zambian and Zimbabwean Environmental Management Authorities have required that a similar harmonised process be undertaken for the proposed BGHES. Accordingly, joint ESIA reports will be submitted to both Environmental Authorities for review.

In addition to Zambian and Zimbabwean legal requirements, the ESIA will conform to international standards and good practices, in particular the requirements of the World Bank Environmental and Social Safeguard Policies and the International Finance Corporation (IFC) performance standards. The ESIA will also align to other international guidelines and standards directly applicable to hydropower projects, such as the World Commission on Dams (WCD) and the International Hydropower Association (IHA).

The institutional and legislative framework, development policies, and international treaties and guidelines against which this Project needs to conform, are further described in *Chapter 4*.

(1) A harmonised ESIA process essentially means that the ZEMA and the EMA will receive identical ESIAs and ESMPs for review and consideration

1.7 *PURPOSE OF THE ESIA*

The purpose of the ESIA is to provide information to regulators and other stakeholders to aid the decision making process. The main objectives of the ESIA are as follows.

- To analyse the potential interactions of Project activities with the natural and social (including socio-economic and health) environment.

- To provide a description of the Project activities and the existing physical, biological and human environment that these activities may interact with.

- To assess the potential environmental and socio-economic impacts resulting from the Project activities and develop viable mitigation measures and management actions that are designed to avoid, reduce, control, remedy or compensate for any significant adverse environmental and socio-economic impacts and, where practicable, to enhance potential positive impacts and opportunities that may arise due to the Project.

- To provide Environmental and Social Management Plans (ESMPs) by which the mitigation measures will be implemented and residual impacts managed by ZRA during Project implementation. This includes monitoring plans for various environmental and socio-economic impacts and a mechanism for audit, review and corrective action.

- To develop a consentable project, and to help develop the project in a responsible manner by providing meaningful measures for the project that will be taken to avoid, minimise, reduce or compensate for any potential adverse environmental and social effects.

1.8 *THE ESIA STUDY TEAM*

Environmental Resources Management Southern Africa (Pty) Ltd. is responsible for facilitating the environmental licensing process, in accordance with both Zambian and Zimbabwean national and international requirements. ERM sub-contracted Black Crystal Consulting Private Limited (EMA Reg. No. 000225/2014) to assist with aspects of the ESIA study in Zimbabwe, and Felix Chisha K, to assist with aspects of the ESIA study in Zambia.

The ESIA team comprises environmental and socio-economic specialists. The project team associated with the proposed BGHES ESIA is as follows:

Table 1.1 Names and Qualifications of the Senior ESIA Consultants

Organisation	Name	Qualification	Role on the ESIA Team
Environmental Resources Management	Mr M Everett	BSc and MSc (Hydrology)	Project Director
	Mr D Rodewald	BSc and MSc (Agricultural Economics)	Project Manager

Organisation	Name	Qualification	Role on the ESIA Team
	Mr T Smith Mr. B Dunlop	BSc and MSc (Engineering Hydrology) MEng Civil Engineering	Water Resources Lead
	Mr A Cauldwell	MSc and BSc (Hons.), Wildlife Management, PrSciNat Ecology	Biological Lead
	Ms L Bungartz Ms K Horton Mr C Johnstone	BSocSci (Hons) (Environmental Management) BSc. (Environmental Sciences) M.A.	Social, Stakeholder Engagement and Resettlement Lead
	Mr D Shandler	MA, BA Hons, BA	Public Consultation Facilitator
Southern Waters	Dr C Brown	PhD., M.Sc., B.Sc. (Zoology and Biochemistry) B.Sc. Hons. (Zoology)	Environmental Flow Team Lead
Stratecon Applied Economic Research	Barry Standish Antony Boting	B.Com, M.A. (Economics) M.Sc (Civil Eng), M.B.A.	Economic Impact Team Lead Economic Analyst
Anchor Environmental Consultants Pty Ltd	Jane Turpie	PhD (Ornithology) BSc Honours (Zoology)	Tourism specialist
Black Crystal Consulting	Peta Jane Spong	BSc Hons (Environmental Water Management) BSc (Zoology and Geography)	Zimbabwe Team Coordinator
	Ms S.L. Childes	BSc Hons (Botany and Zoology) MSc (Ecology)	Ecology specialist
	Tasara F. Marondedze	BSc Hon Sociology	Zimbabwean Social, Stakeholder Engagement and Resettlement Specialist
	Mr R Burrett	BSc Hons (Archaeology and Geography) MSc (Archaeology)	Zimbabwean Archaeology specialist
Independent	Felix Chisha K	Diploma in Information Technology	Zambian Social, Stakeholder Engagement and Resettlement Support
Independent	Richard Mbewe	BA Archaeology	Zambian Archaeology specialist

1.9 STRUCTURE OF THIS REPORT

Table 1.2 presents the structure of this ESIA. The Construction Environmental and Social Management Plan (ESMP) and Operational ESMP for the proposed BGHES is contingent on the outcomes of the ESIA study, and are presented as a separate standalone document.

Table 1.2 ESIA Report Structure

Chapter	Title	Contents
	Executive Summary	Summary of the ESIA report.
1	Introduction	Introduction to the project; ESIA team and report structure (this *Chapter*).
2	Project Description	Technical description of the Project.
3	Project Rationale	A summary of the need and desirability of the Project.
4	Institutional and legislative framework, Development Policies, and International Treaties and Guidelines	An overview of relevant national and international legislation, policies and industry standards and guidelines.
5	ESIA Approach and Methodology	The scope of the ESIA, the ESIA process and assessment methods employed.
6	Project Alternatives	Consideration of different Project alternatives.
7	Public Participation Process	Best practice and requirements, consultation process followed during Scoping and ESIA, stakeholders identified and summary of issues that were raised.
8	Biophysical Environment Baseline	Description of the existing relevant physical, ecological, and environmental conditions.
9	Socio-economic Environment Baseline	Description of the existing relevant social, economic and health conditions
10	Biophysical Environment Impact Assessment	Evaluation of potential and residual biophysical environment impacts. Proposed mitigation measures for identified potential impacts.
11	Socio-Economic, Health and Cultural Heritage Impact Assessment	Evaluation of potential and residual socio-economic environment impacts. Proposed mitigation measures for identified potential impacts.
12	Cumulative Impact Assessment	Evaluation of potential cumulative impacts associated with the BGHES
13	Conclusions and Recommendations	Presents the conclusions to the ESIA, together with relevant recommendations.
14	References	A list of references and websites cited in the text.
Annex A	Project Terms of Reference	Zambian (ZEMA) approval of the Project Terms of Reference.
Annex B	Stakeholder Engagement Plan	Outlines the stakeholder engagement plan.
Annex C	Public Participation Documentation	Including Background Information Document; Comment and Response Report; Attendance Registers; Stakeholder Database; Notification Material; Meeting Minutes and Notes from Key Stakeholder Discussions. Also includes public participation documentation for interim notification of stakeholders.
Annex D	Heritage Impact Assessment Methodology	Description of the heritage assessment methods employed.
Annex E	Grievance Redress Mechanism	Approach to managing grievances.
Annex F	Biophysical Baseline Data	Water Quality Data, Water Abstraction Data and Biodiversity Species Lists.
Annex G	Baseline Data Collection Methodologies	Baseline Data Collection Methodologies for Biodiversity, Social and Cultural Heritage.
Annex H	Climate Change Risk Review	Climate Change Risk Review Specialist Study.

Chapter	Title	Contents
Annex I	Reservoir Water Quality Modelling Study	Reservoir Water Quality Modelling Specialist Study.
Annex J	Environmental Flow Assessment Specialist Study	Environmental Flow Assessment Specialist Study.
Annex K	Economic Assessment Specialist Studies	Economic Assessment Specialist Studies.
Annex L	Cultural Heritage Report, Zimbabwe	Cultural Heritage Report and associated addendum for the Project quarry area, Zimbabwe.
Annex M	Cultural Heritage Report, Zambia	Cultural Heritage Report and associated addendum for the Project quarry area, Zambia.
Annex N	Review of ESIA against WCD and IHA Guidelines & background on the World Commission on Dams (WCD) and International Hydropower Association (IHA)	Provides a review of the ESIA against the WCD and IHA Guidelines. Further detail on the WCD's Strategic Priorities and Policy Principles and the IHA's Sustainability Guidelines & Hydropower Sustainability Assessment Protocol also provided.
Annex O	Dam Safety Plan for the BGHES	Dam Safety Plan including Emergency Preparedness Plan (Framework Plan) for the BGHES.
Annex P	Resettlement Policy Frameworks	Resettlement Policy Frameworks (one for Zimbabwe and one for Zambia), which sets out the guiding principles and procedures that will be followed in managing the impacts of acquiring land for the BGHES Project.
Annex Q	Letter from Zimbabwean Ministry of Defence	A letter issued by the Zimbabwean Ministry of Defence regarding the presence of mines in the Project Area.
Annex R	Greenhouse Gas Assessment	This greenhouse gas (GHG) assessment estimates the emissions contributing to climate change from the proposed Batoka Gorge Hydro-Electric Scheme (hereafter known as the proposed Project or BGHES) during its construction and operation.
Annex S	Livelihood Restoration Plans	These LRPs present impacts and recommended restoration measures to livelihoods as a result of the construction and operation of staff townships on either side of the Project.

2 DESCRIPTION OF THE PROJECT INDICATING THE VARIOUS PROJECT COMPONENTS

2.1 INTRODUCTION

The information in this *Chapter* was sourced from the BGHES Phase II – Layout - Options Assessment Report of October, 2018 (Rev F) prepared by Studio Pietrangeli Consulting Engineers (SP), and subsequent Phase III Feasibility Report (May 2019).

SP has been contracted by ZRA to update the previous feasibility studies (1993 and 1998) for the proposed BGHES.

2.2 PROJECT COMPONENTS

The following constitute the key components of the proposed BGHES:

- Dam wall and reservoir, including spillway infrastructure;
- Surface power houses, one on each side of the river;
- Transmission lines in Zambia and Zimbabwe;
- Access roads (and Batoka Bridge) in Zambia and Zimbabwe; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching areas).

Please Note:

This Chapter provides a description of the following Project components that are specific to this ESIA:

- Dam wall and reservoir, including spillway infrastructure;
- Surface power houses, one on each side of the river; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching areas).

For a more detailed description of the Transmission Lines and Access Roads proposed as part of the BGHES Project, refer to the standalone ESIAs for these Project components.

The following sections reference the dam design that was proposed in the 1993 Batoka Gorge Hydro-Electric Scheme Feasibility Study (BJCV, 1993), but which has now been updated, as outlined in Studio Pietrangeli's (SP) Phase II Option Assessment Report (Rev F), October 2018, and subsequent Phase III Feasibility Report (May 2019).

However, it is important to note that Project planning, decision making and refinement of Project design will continue throughout the detailed design phase of the BGHES, as a result of continued engineering studies, as well as the findings of the BGHES ESIAs, and possibly through further environmental and social studies.

2.2.1 *Selected Layout Overview*

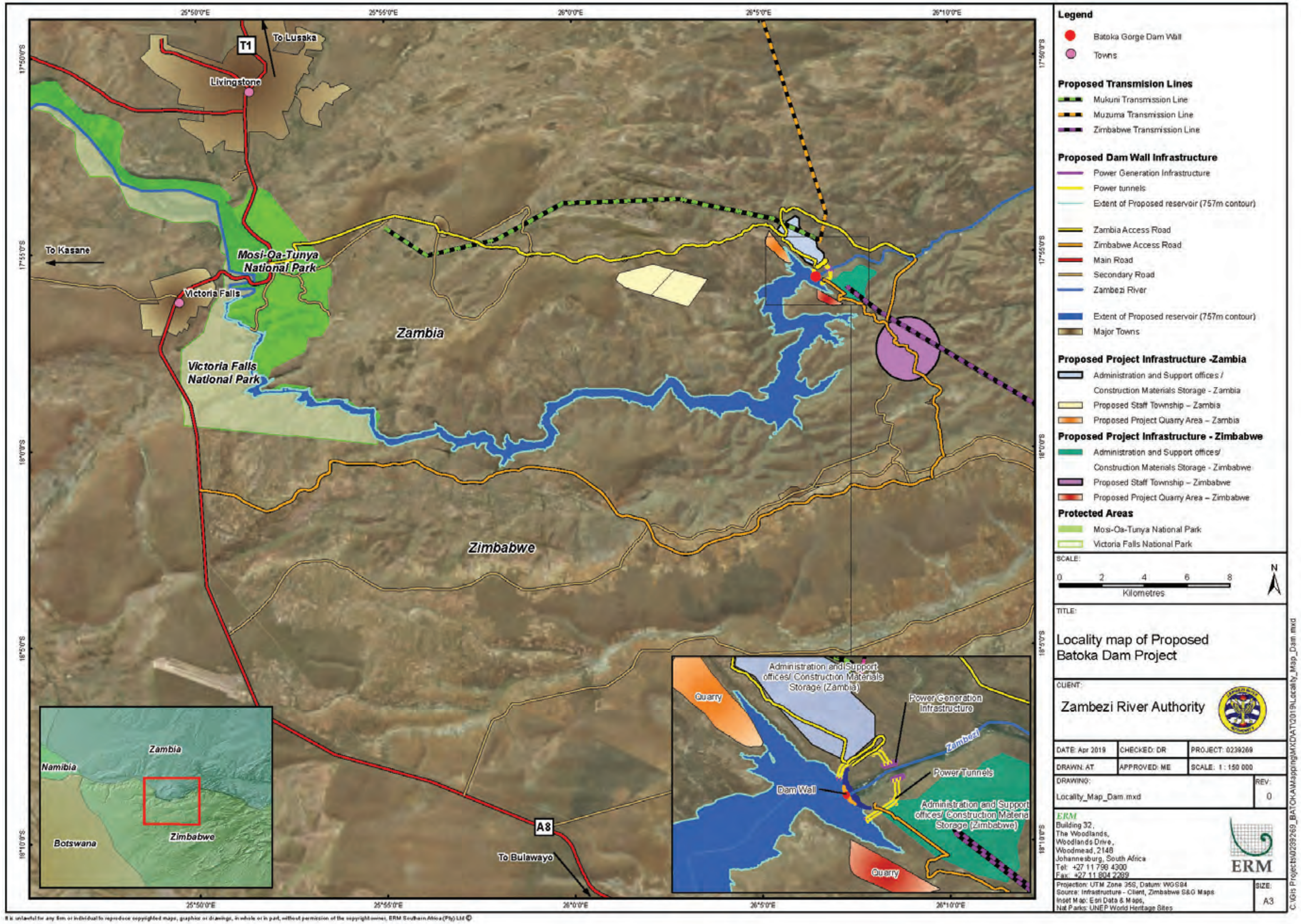
SP (2018) investigated four alternative schemes for the construction of the proposed BGHES, one of which included the layout of the proposed scheme as described in the BVJC (1993) feasibility study. SP (2018) selected Alternative No. 3, which is fully described in this *Chapter*. The alternative layouts, and the reason as to why they were not selected for the proposed BGHES, are described under an analysis of alternatives, provided in *Chapter 6*.

The characteristics of the main works as described for this selected alternative for the proposed BGHES, include the following:

- A Roller Compacted Concrete (RCC) arch-gravity dam wall, with a spillway;
- Pressure waterways, located in the abutments;
- Two surface power houses, one on each side of the river, located on the abutments; and
- The impoundment (or dam).

The proposed layout of the proposed BGHES is provided in *Figure 2.1*.

Figure 2.1 Proposed Layout of the Proposed BGHES



RCC Arch-gravity Dam Wall

The proposed RCC arch-gravity dam wall will be 175 m in height, with a crest length of approximately 720 m. The crest has on its central part a spillway crest divided into seven channels. The outlet works are included into the dam body with the intake on the upstream face. Examples of recently constructed RCC arch-gravity dams recently built are provided in *Figure 2.2*.

Figure 2.2 ***Examples of Recently Built RCC Arch-gravity Dams***

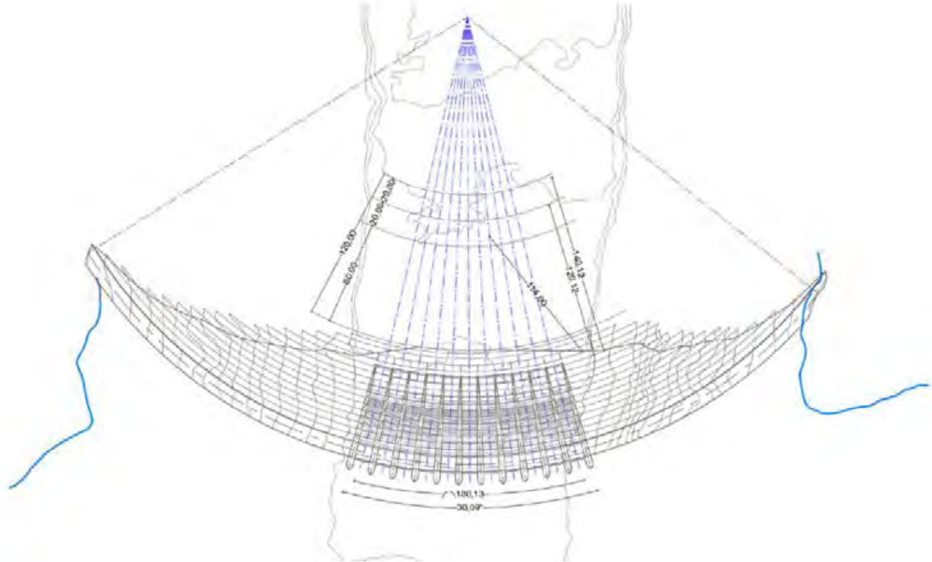
Changuinola Dam H=105m, L=600m

Portoguese Dam H=67, L=370

Source: SP Phase III Feasibility Report (2019)

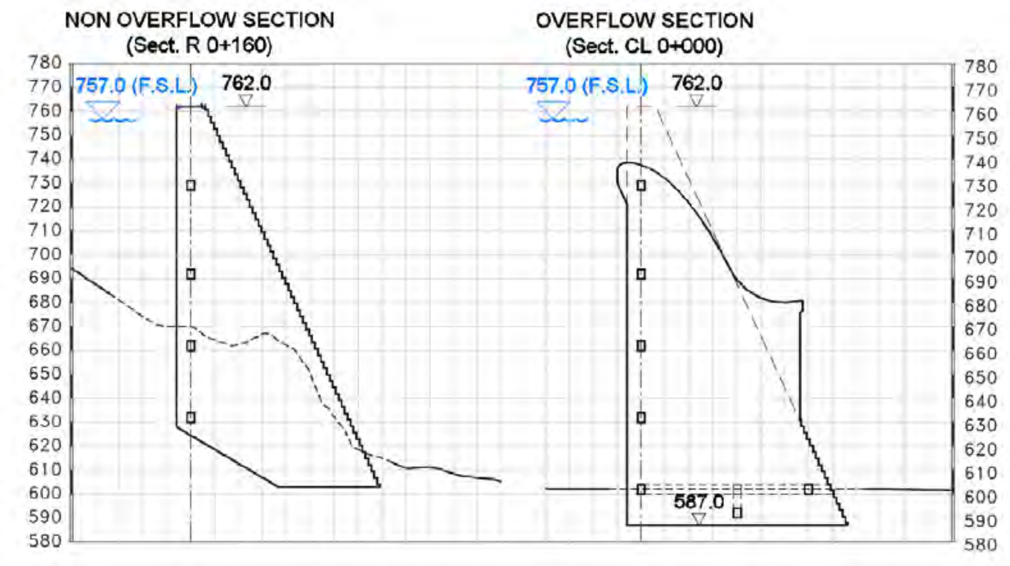
Moreover, a plan view of the proposed BGHES dam is provided in *Figure 2.3*, with a typical cross-section provided in *Figure 2.4* and 3D views illustrated in *Figure 2.5*.

Figure 2.3 BGHES Arch Gravity Dam – Plan View



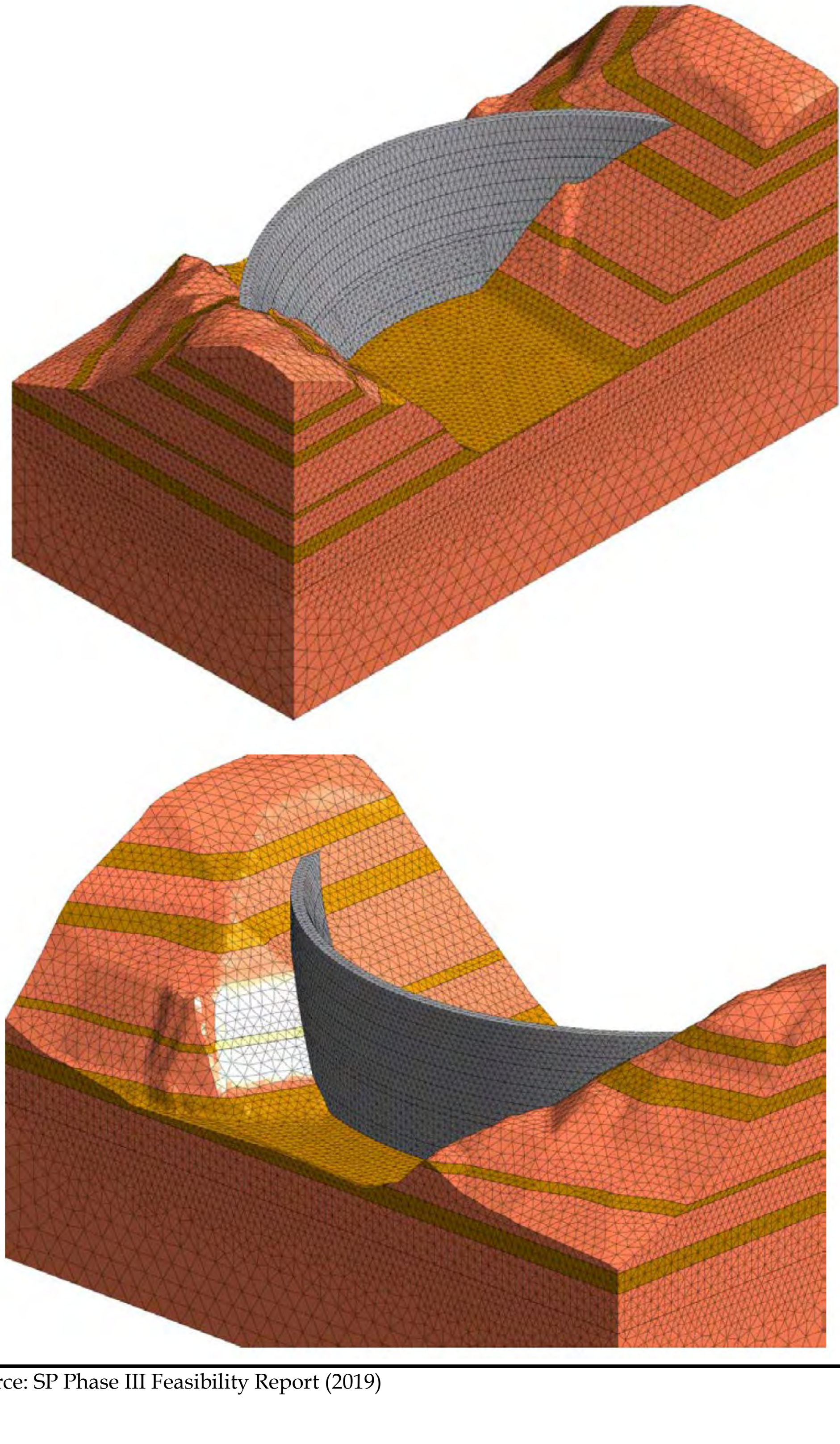
Source: SP Phase III Feasibility Report (2019)

Figure 2.4 BGHES Arch Gravity Dam - Typical Sections



Source: SP Phase III Feasibility Report (2019)

Figure 2.5 BGHES Arch Gravity Dam – 3D Views



Source: SP Phase III Feasibility Report (2019)

Pressure Waterways

Two lines of power pressure waterways are envisaged for each bank, including surge shafts.

Each power waterway includes:

- Intake, excavated in the banks with trashracks;
- Power tunnels, with a circular section;
- A wet shaft with control gates;
- A surge shaft for hydraulic transient control; and
- Penstocks in steel lining, with manifolds feeding the turbines in the powerhouses.

Surface Power Houses

This layout includes two surface power houses, each of approximately 175 m in length, one on each bank, downstream of the plunge pool. The two power houses are identical and each of them includes:

- Six Francis Turbines, each one of about 200 MW of installed capacity;
- Six generators having rated voltage 15 kV;
- Main and auxiliary cranes, draft tube gates, auxiliary equipment;
- One erection bay; and
- Step-up transformers feeding the out-coming overhead lines directed to the Switchyards.

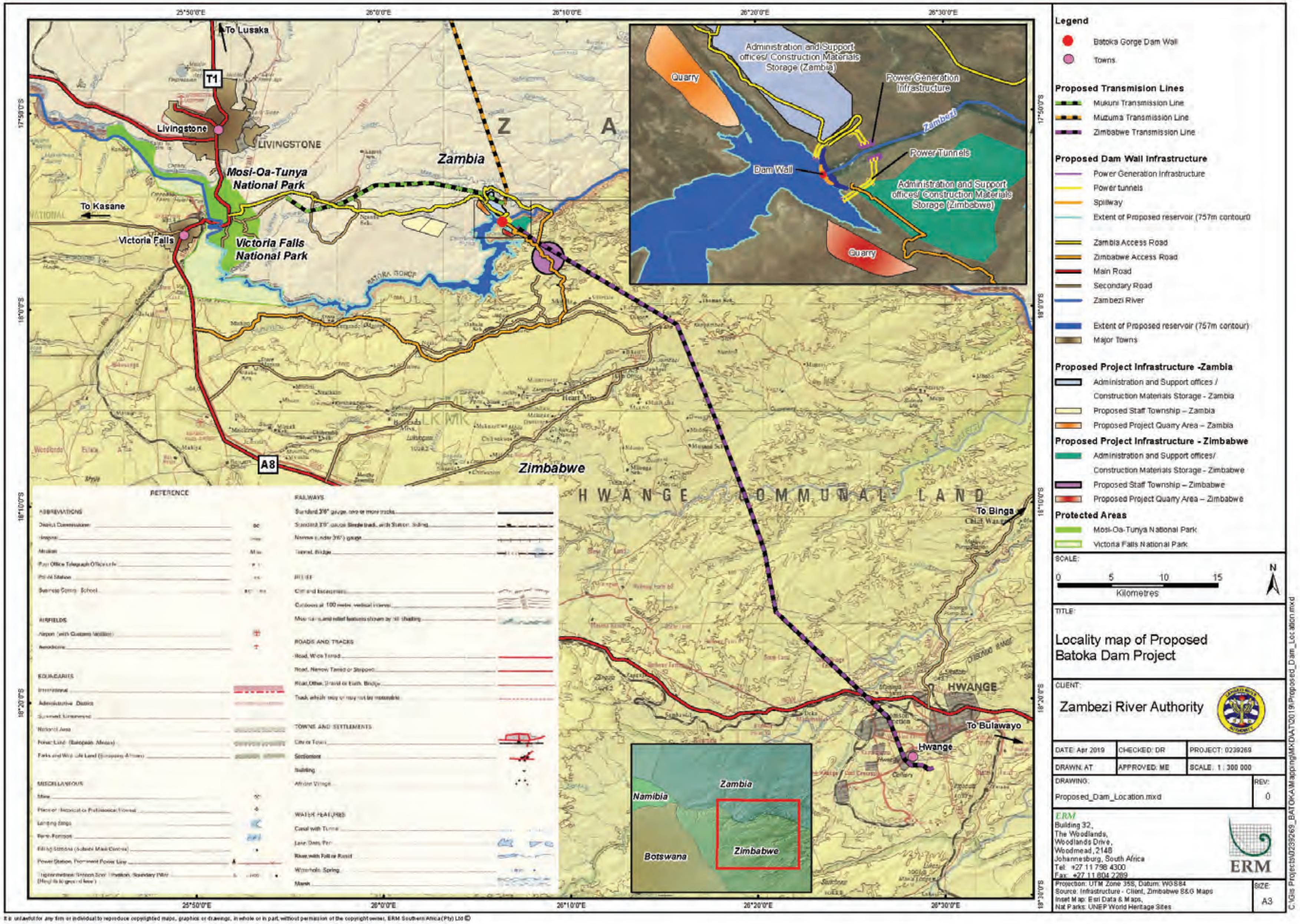
The two switchyards are located on each bank of the river, just downstream of the dam abutments above elevation 800 m, where the ground is flatter and they can be more easily accommodated.

Spillway

The spillway will not be separate to the dam wall, but would be released to a plunge pool (after energy dissipation) via seven gated bays, each with a sill elevation of 743.5 masl.

An alternative spillway design is presented in *Chapter 6*. The environmental flow assessment specialist study (*Annex J*) makes reference to a separate spillway at a saddle on the right abutment, about 2 km from the dam site. However, not separating the spillway from the dam wall does not affect the outcomes of the environmental flow assessment specialist study.

Figure 2.6 Location of the Dam Impoundment (at a FSL of 757 m amsl)



Impoundment

The full supply level (FSL) of the reservoir is set at 757 m above mean sea level (amsl). After impoundment to the Full Supply Level (FSL), the reservoir surface area will cover approximately 23.0 km² (*Figure 2.6*).

Due to the small storage capacity of the planned reservoir (~1,392 Mm^3 at FSL), relative to inflows, the proposed BGHES will only allow a daily, or weekly (under specific conditions) regulation of the inflows. As such, the proposed BGHES shall be operated as a baseload plant on a runoff river regime with limited capacity for peaking for environment compliance.

The FSL of 757 m has been selected so as to ensure the backwaters from the resulting impoundment do not reach the base of the Victoria Falls or flood the outlets of the existing Victoria Falls Power Station, located in the region of Silent Pool, during periods of high flows. An analysis of the optimum dam heights is provided in *Chapter 6*.

To Note – during the course of the ESIA process it was decided through discussions with the ESIA team, Engineering Team (SP) and the ZRA that the operating level of the dam will be seasonally adjusted as follows:

- Reduce the dry season (in rafting terms, from August to January) operational level to 730 masl, thereby freeing a reach of river for rafting during this period that extends all the way from the Falls downstream to around rapids 9 and 10, which is the current limit of half-day rafting trips on the river; and

- Increase the operating level during the high-flow season to 757 masl under normal flow conditions in the river, and to 762 masl under high flow conditions, defined as the flow above which the Victoria Falls Power Station would normally begin to flood.

These seasonal operating rules are presented as a ZRA commitment in the impact assessment relating to upstream river conditions (*Section 10.2.3* in *Chapter 10*).

Installed Capacity

In the 1993 Feasibility Study it was planned that two power houses, each with an installed capacity of 800 MW, would be constructed on each river bank, with a total capacity of the scheme being approximately 1,600 MW.

SP (2018) however, updated this study and undertook an analysis of the optimum installed power, taking into consideration a capacity that:

- minimises the unit generation cost;
- maximizes the Internal Rate of Return (IRR); and
- was acceptable from an environmental flow point of view.

Based on the results of the SP (2018) review, further described in *Chapter 6*, the optimum installed capacity that maximises the IRR and minimises the unit generation costs is 2,400 MW. The main characteristics of the proposed BGHES, as per the 2018 Option Assessment Report (SP, 2018) are summarised in *Table 2.1* below.

Table 2.1 Main Components of the Proposed BGHES

Project Description	
Reservoir	
Catchment Area	508, 000 km²
Average Annual Runoff (m³/s)	1,070
Minimum Operating Level (MOL)	746 m asl
Full Supply Level (FSL)	757 m asl
Surface Area @ FSL	23 km²
Total Storage	1,392 Mm³
Dam	
Type	Arch-Gravity
Crest el.	762 m asl
Foundation min. el.	587 m
Max Height (u/s)	175 m
Crest length	720 m
Spillway	
Type	Gated
Spillway width	118 m
No. of Bays	7
Sill elevation (masl)	743.5 m
Energy dissipater	Plunge pool
Power House	
Type	Surface
Number	2
Turbine number and type	12/Francis, each of 200MW of installed capacity
Installed Power	2,400 MW
Annual Energy Production	10,215 GWh/y

Source: SP Option Assessment Report (Rev F), October 2018.

2.2.2 *Project Townships*

Project townships will be located on each side of the river. Six alternatives for the locations of these project townships were originally proposed (ie three locations on each side of the river); the chosen project township locations were selected on the basis of reducing the likelihood or extent of resettlement required and avoiding environmentally sensitive areas identified as part of the ESIA baseline data collection process, as discussed in more detail in *Chapter 6*.

Project township locations in both Zambia and Zimbabwe are identified as 'Proposed Project Township (Zambia)' and 'Proposed Project Township (Zimbabwe)' in *Figure 2.1*. The location of administration buildings and construction materials storage yards in both Zambia and Zimbabwe are also indicated in *Figure 2.1*.

During construction (up to seven years in duration), the project townships will house approximately 8,000 staff ***in total*** (including security and support staff), but this will be only after the first two years, where initially 2,000 construction workers will be involved with the construction of access roads, infrastructure and the camps.

During operation, the construction staff will be replaced with the operational staff (i.e. maintenance, police, custom/immigration services, governmental institutional staff etc.). Approximately 1,500 operational staff will be required (see *Table 2.2* below).

Table 2.2 ***Estimated Number of Staff during Operation***

Organization	Number of Staff
ZESA	320
ZESCO	350
ZRA	50
Police	20 (2x10)
Customs	20 (2x10)
Immigration	20 (2x10)
Health	30 (2x15)
Education	30 (2x15)
Commercial / Industrial	300 (2x150)
Utilities - Water	20 (2x10)
Utilities - Sewage	20 (2x10)
Utilities - Refuse	20 (2x10)
Post Office	6 (2x3)
Local Government	60 (2x30)
Miscellaneous	100 (2x50)
Sub-Total	1,366
10% Contingency	134
Total	**1500**

Source: SP Option Assessment Report (Rev F), October 2018.

It is envisaged that each project township will also have the following services and amenities:

- 2 Health centres/hospitals
- 2 Primary schools
- Secondary Schools
- 2 Sporting centres
- 1 Custom service and immigration centre
- 1 Police station
- 1 Post office
- 2 Supermarkets
- Municipality Office
- ZRA Offices
- Warehouses for the plant's maintenance
- Water treatment plant
- Sewage treatment plant; dump site
- Hospitals with incinerators
- Boreholes

In addition to these services and amenities, project townships will also have facilities such as banks, shops, private offices etc.

2.2.3 *Water Provision*

Water will be required for the construction of the BGHES for the following:

- Earthwork compaction;
- Dust control;
- Aggregate wash;
- Concrete manufacture;
- Employee sanitary consumption; and
- Stand-by water in preparation for potential fire emergencies.

Assuming an average demand for drinking water per person of about 100 litres/day and considering the estimation of about 4,500 persons in the Project Townships at any one time, an average of 450 m^3 / day of potable water supply will be required. In addition to potable water requirements, approximately 200 m^3 of non-potable water will be required.

Water for potable and non-potable demands will be abstracted from the Zambezi River. Water for domestic use will be pumped to a treatment plant; whilst the non-potable water will be conveyed into the purifying basin prior to use.

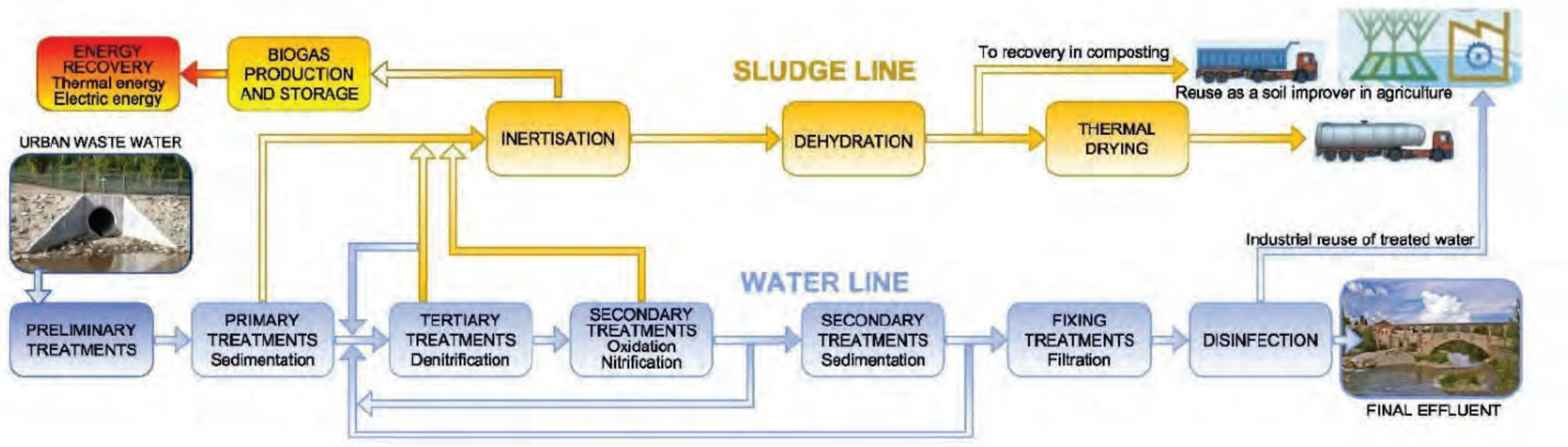
2.2.4 *Sewage*

Considering the estimation of about 4,500 persons in the Project Townships at any one time, a sewage treatment plant with a capacity of approximately 350 m^3/day will be constructed.

The treatment plant will be an anaerobic type, with a purification process design per *Figure 2.7*.

The discharge of final treated effluent (wastewater) will satisfy the water quality criteria / standards for effluent discharge into environment as set out in the BGHES ESMPs. Treated water will be reused on the Project on haul roads for dust control. Non-liquid waste (treated sludge) generated during treatment will be disposed of at approved disposal locations or recovered for use in compositing or soil improver in agriculture.

Figure 2.7 Sewage Purification Process



Temporary chemical toilets will be located in strategic locations near active work sites and sited away from any water bodies or wetlands. One toilet should be provided on site for every 15 contract personnel at each active working area. These toilets will have doors and locks and will be secured to prevent them blowing over. Temporary toilets will be emptied on a regular schedule. Emptied waste will be transported and disposed of at the BGHES sewage treatment plant.

2.2.5 Waste

The BGHES will generate commercial waste of which a portion will be diverted for reuse or recycling. The types of commercial waste generated are broad and include general (textiles, mixed organics/ food, and mixed plastics), metals, plastics, wood, paper, water, other, and hazardous materials. Examples of other materials consist of conduit, glass, insulation, tyres, and welding materials. Hazardous materials include mixed contaminated waste and mixed hazardous wastes as well as batteries, contaminated rags, contaminated soils, oil drums, oil filters, oily rags, paint/ epoxy coating cans, printer cartridges, printer toner & drums, solvents, used/ waste oil, anti-freeze fluid, and bio-medical waste.

Waste streams will be segregated at source in order to optimize diversion. For example paper, plastics, glass, and metals will be segregated specifically for reuse or recycling. Lubricant waste oil will be collected by firms that will repurpose to harvest the value of the product's. Food waste products will be composted and/ or sourced for reuse in the agricultural sector. Segregation will start at the initial generation point (i.e. paper is collected in a paper only bin) and continue through pick-up for diversion or disposal. Waste recycling, reuse or disposal will be conducted as per the ESMPs, and in conformance with the Zambia and Zimbabwe waste management regulations. Only approved waste contractors will be used on the Project.

Any non-hazardous wastes that cannot be reused, recycled will be directed to designated and licensed BGHES waste disposal areas. SP has provided no specific locations for the siting of waste disposal areas; however, the following factors will be applied for siting of these areas:

- Disposal areas will be located in such way that they will not require relocation prior to final rehabilitation;
- A 50 meter buffer around the rim of the Batoka Gorge (including the rim of side tributaries entering the Gorge) will be avoided; and
- Drainage lines will also be avoided.

In addition to the above recommendations, disposal areas will avoid critical and natural habitat areas, as these have a very high and high sensitivity. Disposal areas will as far as possible be located in areas with a lower sensitivity – i.e. – low sensitivity natural habitat and modified habitat.

Moreover, disposal areas will be clearly and permanently demarcated and located in defined no go areas.

Where possible the visual impact of disposal areas will also be considered.

2.2.6 *Other Ancillary Infrastructure*

Spoils areas, construction and batching camps will also be required in Zambia and Zimbabwe. These sites are yet to be defined and will be identified during the third phase of the feasibility study, although the ESIA has identified those sensitive zones where such activities will be discouraged.
The location of Project quarry areas in both Zambia and Zimbabwe are illustrated in *Figure 2.1*.

3 PROJECT RATIONALE

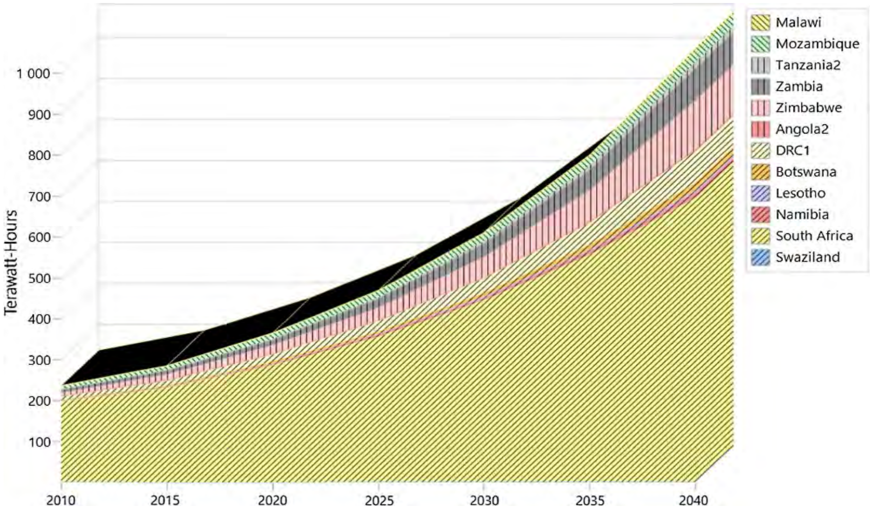
3.1 THE ENERGY GAP IN THE SOUTHERN AFRICAN DEVELOPMENT COMMUNITY REGION

Southern Africa's electricity security situation, although diverse, looks generally bleak (Gaylor Montmasson-Clair and Bhavna Deonarain, 2017). The region has been suffering from electricity shortages, with severe implications for economic growth and social development. Over the past decade or so, Botswana, Namibia, South Africa, Tanzania, Zambia and Zimbabwe have had to resort to load shedding as a stop-gap measure to conserve energy. As of November 2015, available generation within the region was only 46,910MW while the peak demand, including reserves, stood at 55,157MW, giving a deficit of 8,427MW (SADC Energy Monitor, 2016).

For the Southern African, power consumption, between the years 2010 to 2040, is expected to increase from ~200 TW hours to over 1,000 TW hours (*Figure 3.1*). Demand for electricity in the Southern Africa Development Community (SADC) is growing, and is predicted to follow economic growth trends of between 3 and 6% (Stockholm Environment Institute, 2018). JICA (2010) report that the peak power demand in the Southern African Power Pool (SAPP) (1) countries will increase by a total of ~121,400 MW over the period 2012 to 2045; corresponding to an average annual rate of increase of 3 %. The increase in demand may even accelerate, as most SADC countries have set themselves ambitious targets for economic growth – in most cases exceeding 5 % per year. In parallel there is a considerable suppressed demand for electricity access in the SADC with, in general, only 32% of the region's population having access to electricity (SADC 2012, REN21 2015). To increase access to electricity and meet the predicted growth trends in the demand, there is urgent need to increase electricity generation including tapping into the region's vast renewable energy potential to diversify the power mix.

(1) SAPP countries are comprised of Angola, Botswana, DRC, Lesotho, Malawi, Mozambique, Namibia, South Africa, Swaziland, Tanzania, Zambia and Zimbabwe.

Figure 3.1 *Southern Africa Power Forecasts*



Source: Nadia S. Ouedraogo (2017)

3.2 *ENERGY CONSUMPTION AND PRODUCTION IN ZAMBIA*

3.2.1 *Energy Consumption (Zambia)*

According to the Zambia Development Agency (ZDA; 2014) the country's economy has been growing at an average of 5 % per annum over the past 10 years and as a result, the demand for energy has also been rising. This is due to economic activities in the country particularly in the mining, manufacturing and agriculture sectors.

The Japan International Cooperation Agency (JICA) (2010), in their power system development master plan for Zambia, introduced three power forecast scenarios, based on differences in respect of macro-economic conditions, population growth, and customer increase rate, namely base, high, and low cases (*Figure* 3.2).

In this study (JICA; 2010), gross domestic product (GDP) growth is assumed to be 6 % (per annum) p.a. (equivalent to the actual growth rate from the mid-2000s) in the base-case scenario, 7 % p.a. (the target figure in the government's economic development plan) for the high-case scenario, and 5 % p.a. rate in the low-case scenario (as reported above by the ZDA (2014)). Population growth is forecast at 2.3 % p.a. following the historical trend. The electrification rate is forecast to increase at the rate of 4 % p.a., equivalent to the increase in the number of customers in the residential and commercial sector for the past five years, in the base-case scenario, 6 % p.a. in the high-case scenario, and 3.5 % p.a. in the low-case scenario.

Zambia's Strategic Plan (2018 - 2021) report states that the GDP growth rate in 2017 was 5.8%, so the data reported in *Figure 3.2* is likely to trend more towards the base case scenario. The strategic plan further indicates that the domestic economy in 2017 continued to exhibit a stable and favourable trend in key macroeconomic indicators relative to 2016.

As of December 2016, total energy demand exceeded internal generation capacity despite the commissioning of new generation power plants (Maamba Coal power plant, 300 MW and the Itezhi-Tezhi 120 MW hydropower), increased power imports and an increase in hydropower generation as a result of better rains experienced in 2016/2017 rainy season (1). This was as a result of the expansions in the mining and manufacturing sectors as well as overall expansions in the economy and population. The mining customers remained the largest single consumers of power taking up about 52% of demand while the balance was shared between retail and export consumers. The annual growth in electricity demand has been estimated at approximately 3%, requiring between 150 MW and 200 MW of new capacity per year (2).

The current power deficit has resulted in prolonged load shedding and power cuts, which have occasionally affected trade and production.

3.2.2 Energy Production (Zambia)

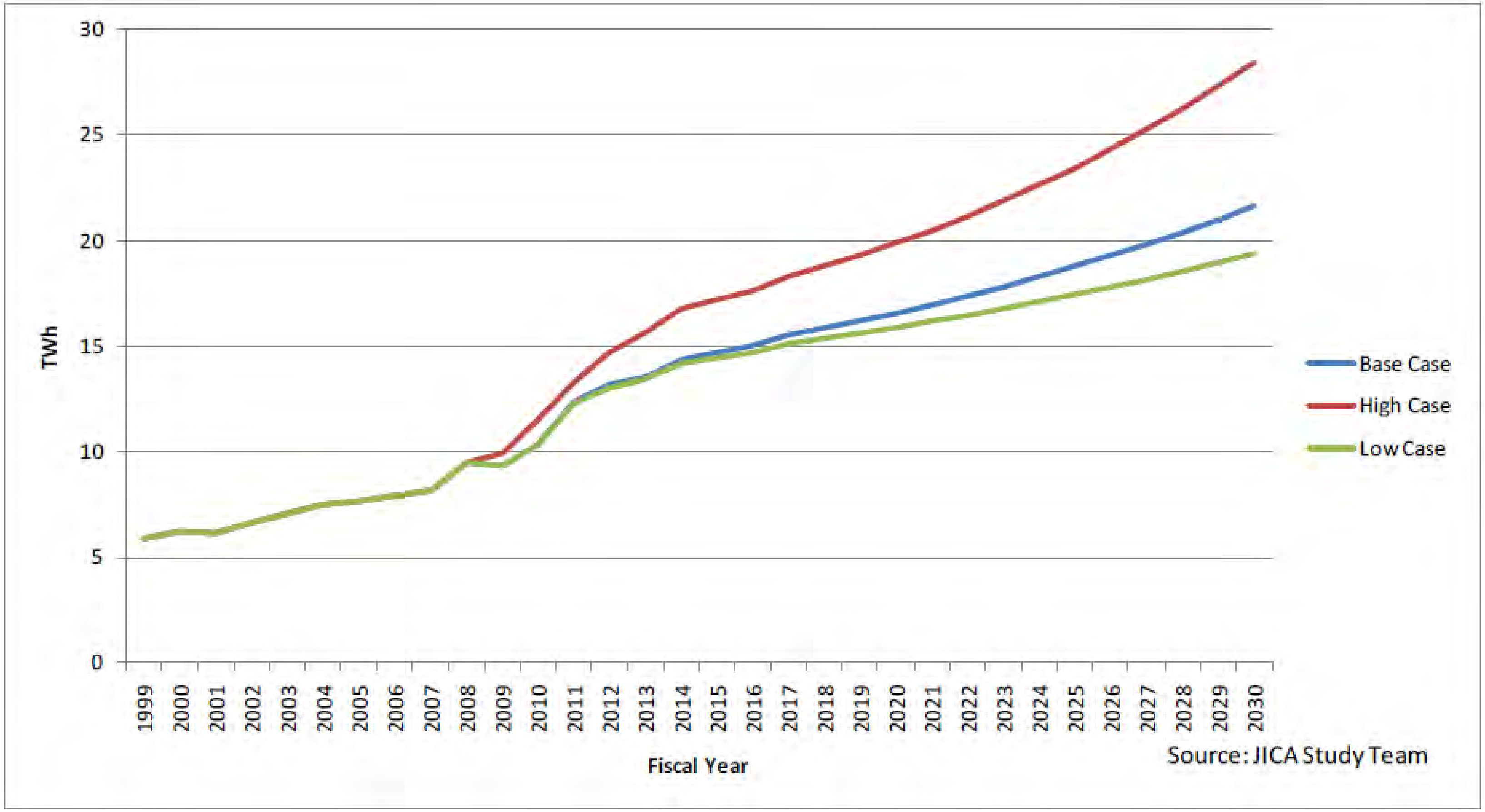
ZESCO Limited

The Zambian electricity power system is operated as part of an interconnected power system linking South Africa, Zimbabwe, and Democratic Republic of Congo (DRC). Currently there are six major electricity suppliers including: ZESCO Limited, which generates, transmits, distributes and supplies electricity throughout Zambia; Copperbelt Energy Corporation (CEC) in Kitwe which is a net transmitter of electricity purchased from ZESCO at high voltage and distributed to the mining industry based on the Copperbelt; and four Independent Power Producers (IPPs), that is, Lunsemfwa Hydro Power Company (LHPC) owning and operating two hydropower plants with a combined capacity of 56 MW, Ndola Energy Company Limited (NECL) that operates a 50 MW Heavy Fuel Oil (HFO) power plant commissioned in 2013, Maamba Collieries Limited (MCL) that owns and operates a 300 MW thermal power commissioned in 2016 and Itezhi-Tezhi Power Corporation (ITPC) that owns and operates a 120 MW hydropower plant commissioned in 2016. All the major IPPs sell the generated power to ZESCO Limited under the agreed Power Purchase Agreements.

There is also the Rural Electrification Authority (REA) which deals with the cause for increasing access to electricity in the rural areas and the Energy Regulation Board which is the regulator of the energy sector in Zambia. Other participants in the industry include small-scale generators and solar based energy services companies supplying power to some rural areas.

(1) Electricity Regulation Board, 2017: Energy Sector Report for 2016.
(2) Africa-EU Renewable Energy Cooperation Programme (RECP), 2018: Stand-Alone Solar Businesses in Zambia, a Guide for Venture Developers and Investors.

Figure 3.2 Comparison of Demand under Three Demand Forecast Scenarios



Source: JICA (2010)

Sources of Energy

The current installed capacity of power generation facilities in Zambia is approximately 2,909 MW. The main sources of energy in Zambia include biomass, electricity, petroleum, coal and renewables, specifically solar, wind and hydropower. Of this installed capacity, ZESCO owns the majority of plants totalling about 2,211 MW, followed by the Maamba Collieries Limited (MCL) with 300 MW, Itezhi-Tezhi Power Corporation (ITPC) with 120 MW, Copperbelt Energy Corporation (CEC) with 80 MW, Lunsemfwa Hydro Power Company (LHPC) with 56 MW and Ndola Energy Company Limited (NECL) 50 MW.

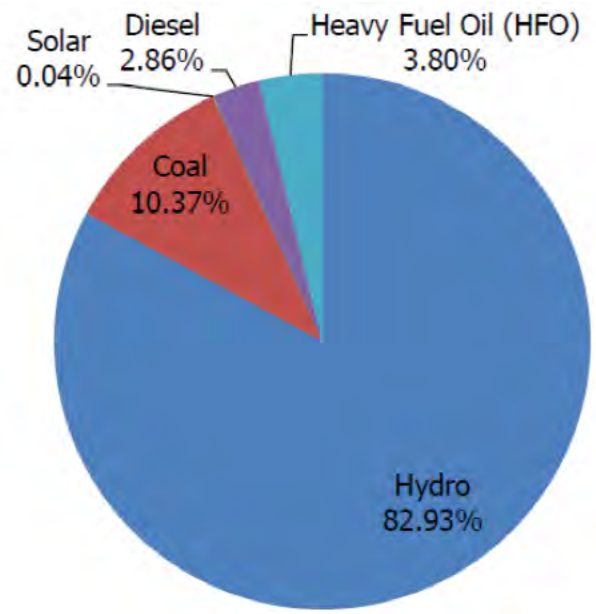
Biomass

Electrification levels in Zambia are low with only about 31.2% of the population connected to the electricity grid (1). Therefore, the country's energy consumption is mainly wood fuel, that is, firewood and charcoal, which accounts for over 70% of total primary energy supply, putting strong pressure on forestry resources with a low energy consumption per capita of around 700 kWh /capita.

Hydropower

The Zambia Energy Regulation Board (ERB, 2016) (2) and Zambia's Ministry of Energy (3) state that hydro-power is the most important energy source in the country, after wood fuel. According to the Ministry of Energy, hydropower contributed 82.93% of the total installed electricity in 2018 (*Figure 3.3*).

Figure 3.3 ***National Installed Electricity Generation Capacity by Technology, 2018***



Source: Ministry of Energy: Scaling-up Renewable Energy Programme Investment Plan for Zambia, December 2018.

(1) Scaling-up renewable energy supplies in developing countries: Investment plan for Zambia. Downloaded on 01st March 2019 at 11:00 am from http://www.moe.gov.zm/wp-content/uploads/2019/02/Zambia-SREP-IP.pdf

(2) Zambia Electricity Regulation Board (2017) *Zambia Energy Sector Report for 2016*

(3) Ministry of Energy: Scaling-up Renewable Energy Programme Investment Plan for Zambia, December 2018.

In 2016, ZESCO owned four major hydropower plants, namely – Kariba North Bank, Kariba North Bank Extension, Kafue Gorge, and Victoria Falls. Electricity generated from ZESCO's large hydro power plants declined significantly by 19.3% in 2016 due to continued poor rainfall experienced during the 2014/2015 and 2015/2016 rainy seasons. Furthermore, ZESCO owns and operates five Mini Hydropower Plants. These mini plants include: Lusiwasi, Musonda Falls, Chishimba Falls, Lunzua River and Shiwang'andu. These plants were initially developed as power sources for independent power networks in rural areas of Zambia. They have been upgraded in order to allow greater energy generation. In particular, the electricity generation capacity at Lunzua and Shiwang'andu recorded significant increases of 134.5% and 51.4%, respectively in 2016 mainly due to the ramped up generation capacity; in the previous years, these plants operated well below capacity.

IPPs with considerable contribution towards hydropower generation are Itezhi-Tezhi Power Corporation and Lunsemfwa Hydro Power Company (LHPC).

Of the total installed electricity generation capacity of about 2,872 MW, approximately 2,416 MW were from hydropower plants (approx. 84.5% of total national energy production), coal (300 MW), heavy fuel oil (105 MW) and diesel (88 MW) (Ministry of Energy, 2018). *Table 3.1* presents the breakdown of the installed electricity generation capacity in Zambia.

Table 3.1 ***Installed Generation Capacity in Zambia***

No	Power Station	Installed Capacity (MW)	Type of Generation	Operator
1	Kafue Gorge	990	Hydro	ZESCO
2	Kariba North Bank	720	Hydro	ZESCO
3	Kariba North Bank Extension	360	Hydro	ZESCO
4	Victoria Falls	108	Hydro	ZESCO
5	Lunsemfwa and Mulungushi	56	Hydro	Lunsemfwa Hydro Corp
6	Small Hydros (Lusiwasi (12 MW), Chishimba (5 MW), Musonda (10 MW), Lunzua (14.8 MW), and Shiwa Ngandu (1 MW))	31	Hydro	ZESCO
7	Isolated Generation less than 1 MW	1	Diesel	ZESCO
8	Gas Turbine (stand by only)	80	Diesel	Copperbelt Energy Corp
9	Maamba thermal power plant	300	Coal	Maamba Collieries Limited
10	Itezhi-Tezhi hydropower plant	120	Hydro	Itezhi-Tezhi Power Corporation
11	Ndola Power Plant 50 MW	105	HFO	Ndola Energy Company Limited
12	Zengamina off -grid mini-hydro plant	0.75	Hydro	Zengamina Power Limited
	Total Installed Capacity	2,871.75		

Source: ZDA, 2014. Zambia Energy Sector Profile; Updated with information from Zambia Energy Sector Report (Electricity Regulation Board 2017) and Scaling-up Renewable Energy Programme Investment Plan for Zambia (Ministry of Energy, December 2018).

Coal Fired Power Stations

Coal accounts for 10.37 % of national installed electricity generation capacity (*Figure 3.3*). There is only one coal-fired thermal plant owned and operated by

Maamba Collieries Limited, an IPP, who also have the largest coal mining concession in Zambia, adopting modern, eco-friendly mining and processing methods. The electricity generated from the 300 MW coal-fired thermal power plant is sold to ZESCO under a long term power purchase agreement.

Diesel Generators

According to the Ministry of Energy (2018), Diesel Power Plants contributed 88MW (3.1 % of total national energy production) in 2018. This includes a stand by diesel driven turbine, with an installed power capacity of 80MW and the isolated generation plants owned and operated by ZESCO (*Table 3.1*). The following are Diesel Power Stations owned and operated by ZESCO:

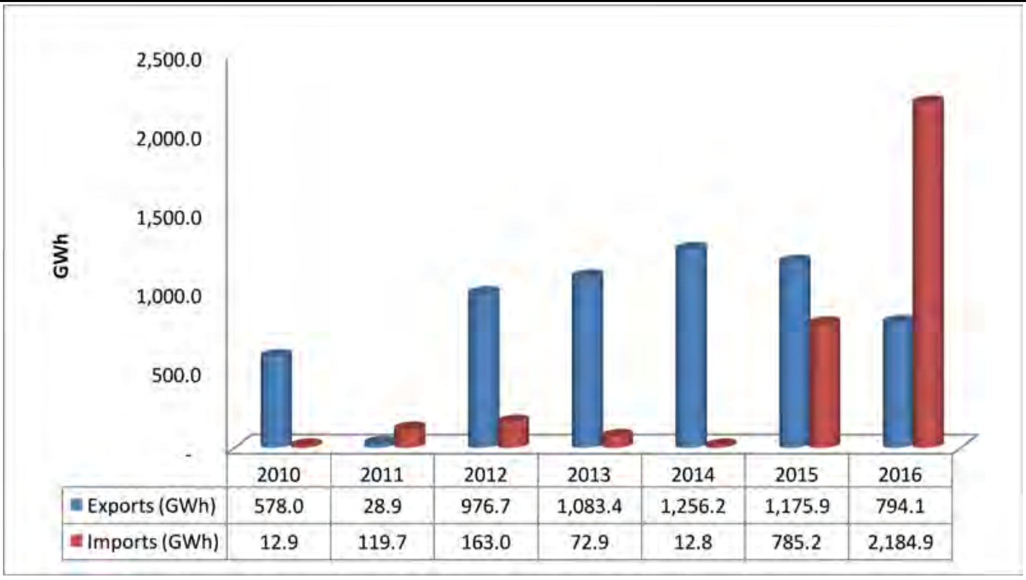
- Shang'ombo;
- Luangwa ;

Note: In September 2016, the Mwinilunga diesel power plant was decommissioned following the connection of Mwinilunga District to the national electricity grid.

Electricity Imports/Exports

Zambia's electricity exports and imports are made through the Southern African Power Pool (SAPP) and bilateral markets. Due to the power deficit that is currently being experienced in the country, ZESCO currently only exports excess off-peak and low voltage power. Since 2010, total annual electricity exports have been generally higher than imports except in 2016 when the exports significantly decrease by 32.5% (from 1,175.9 GWh in 2015 to 794.1 GWh in 2016) due to a reduction in the country's hydropower generation capacity attributed to the continued poor rainfall experienced during the 2014/2015 and 2015/2016 rainy seasons. Consequently, electricity imports increased exponentially by 178.3% to 2,184.9 GWh in 2016 from 785.2 GWh recorded in 2015. *Figure 3.4* shows Zambia's electricity imports and exports from 2010 to 2016.

Figure 3.4 *Zambia's Electricity Imports and Exports (2010 to 2016)*



Source: Zambia Electricity Regulation Board (2017) Zambia Energy Sector Report for 2016

Future Generation Capacity

The ZDA states that as of 2014, there had not been any major addition to the country's generation capacity in previous 20-30 years, despite the huge potential in hydropower resources. However, in 2016, two major power plants, a 300 MW coal-fired thermal power plant and a 120 hydropower plant were commissioned. ZDA estimates that even though Zambia possesses 40 % of the water resources in the Southern African Development Community (SADC), the Country has about 6,000 MW of unexploited hydropower potential; currently about 2,416 MW has been developed, as was indicated in *Table 3.1*.

Several power generation projects are planned for Zambia to fulfil the current and future energy needs. *Table 3.2* shows the major power plants currently planned.

Table 3.2 ***Future Power Generation Development Plans***

Project	Capacity / MW	Status	Percentage of work done
Lusiwasi Upper	15	Project about to move to implementation phase	85%
Lusiwasi Lower	88	Project about to move to implementation phase	0%
Chishimba Falls	15	Procurement of main consultant underway	0%
Luapula River Hydro scheme	1,200	Project feasibility studies about to commence	0%
BGHES	2,400	Project at feasibility study stage	0%
Kafue Gorge Lower	750	Implementation Phase in progress	59%

Source: Electricity Regulation Board, 2017: Energy Sector Report for 2016.

3.2.3 *Electrification (Zambia)*

In Zambia, despite some, albeit small levels of energy exports, the household electrification rate in 2015 stood at approximately 31 % at the national level, with access rates in urban areas at 67.3 % compared to only 4.4 % in rural areas [1].

Zambia's Vision 2030 envisions universal access to clean, reliable and affordable energy at the lowest total economic, financial, social and environmental cost consistent with national development goals by 2030. Towards this national vision, Government has set electrification targets at 90% for urban areas and 51% for rural areas and having an additional 4,333 MW of electricity generation capacity by the year 2030. In the medium term, Government intends to increase capacity by 1,000 MW and improve electrification in rural areas from current 4.4% to 8% by 2021 (Ministry of Energy, December 2018).

3.3 *ENERGY PRODUCTION AND CONSUMPTION IN ZIMBABWE*

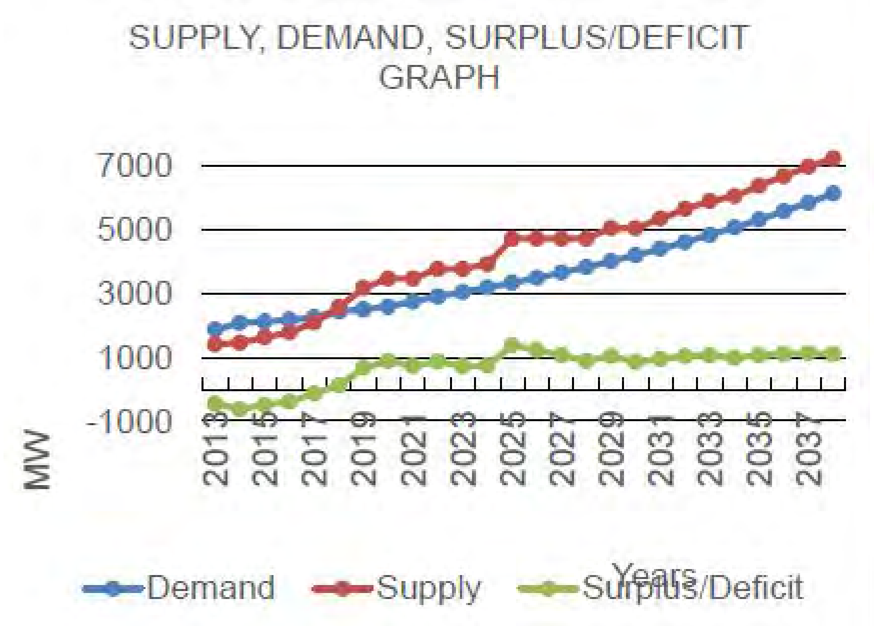
3.3.1 *Energy Consumption (Zimbabwe)*

According to the Ministry of Energy and Power Development's National Energy Policy of 2012, there is a net deficit in the supply of electrical power in Zimbabwe. The country requires nearly 2,200 MW in winter at peak, but generation locally can't meet the demand as on average 1,400 MW are being produced; energy imports and load shedding is used to cover for the deficit, with extensive dependency on load shedding [2]. The power sector in Zimbabwe, has according to the Zimbabwe Energy Regulatory Authority (ZERA, 2015), been facing many challenges, that include lack of investment, lack of capital, and old equipment.

(1) Ministry of Energy - Renewable Energy Feed in tariff Strategy, 2017

(2) http://www.zimbabwesituation.com/news/zimsit_government-lethargy-on-power-investment-costly/

Figure 3.5 ***2010 - 2030 Supply: Deficit graph for Zimbabwe***



Source: ZETDC (2015)

3.3.2 *Energy Production (Zimbabwe)*

Zimbabwe Electricity Supply Authority (ZESA)

The Ministry of Energy and Power Development has overall responsibility for the energy sector in Zimbabwe. The Ministry supervises and oversees the performance of state-owned enterprises such as Zimbabwe Electricity Supply Authority (ZESA). ZESA represents Zimbabwe in the Southern African Power Pool.

ZESA is a state-owned company whose task is to generate, transmit, and distribute electricity in Zimbabwe. ZESA however delegates this responsibility to its subsidiaries; namely, the energy generating company Zimbabwe Power Company (ZPC), and the Zimbabwe Electricity Transmission and Distribution Company (ZETDC).

ZPC incorporates all the power generation plants of Hwange, Kariba and various small thermal power stations (Harare Power Station, Bulawayo and Munyati Power Stations). ZETDC, on the other hand, develops the Transmission and Distribution Network, and transmits, distributes and supplies electricity to consumers.

In addition to ZPC, there are also IPPs in Zimbabwe. According to ZERA (2015), although there are currently 12 licensed IPPs in Zimbabwe, only six are currently operational [(1)]. Out of the six operational IPPs, three are mini IPPs, while the other three IPPs are co-generators (meaning they produce for their consumption as well as for sale).

(1) https://www.newsday.co.zw/2013/04/25/six-ipps-functional-out-of-the-12-licensed/

The three operating mini hydro-stations include Nyamingura (1.1 MW), Pungwe (2.7 MW) and Duru (2.2 MW). Co-generators include Triangle, Hippo Valley and Chisumbanje. Hippo Valley and Triangle have a combined installed capacity of 81.5 MW but the power generated is for their own use and feeding into the national grid if they have excess (1), while Chisumbanje has a capacity of 18 MW, with a capacity to sell 10 MW to the national grid. In addition, over 16 MW can be generated using wood waste from various sawmill sites and a 500 kW system under Border Timbers is already operational.

There is also the Rural Electrification Agency (REA) and the rural electrification programme has seen more than 5,000 rural institutions, farms, villages, borehole, dam points and irrigation schemes electrified to date (2).

Sources of Energy

The main sources of energy used in Zimbabwe comprise wood fuel which provides the bulk of the total energy supply (61%) (3). Most rural areas are facing fuel-wood shortages as a result of agricultural land use and unsustainable harvesting. Demand for wood fuel already exceeds supply in Manicaland, Mashonaland East, the Midlands and Masvingo provinces, which are heavily populated. Mashonaland Central and Matabeleland North are fast reaching the same situation.

Generation capacity is currently provided mainly by hydropower and coal. *Table 3.3* shows current available dependable generation capacities of existing local power plants.

Table 3.3 Current Available Dependable Generation Capability Incorporated by ZPC

Dependable Plant Capabilities (Maximum)	Installed Capacity(MW)	Available Capacity(MW)
Hwange (1-6)	920	720
Harare	90	30
Bulawayo	90	25
Munyati	120	25
Total Thermal Capacity (MW)	**1,220**	**800**
Kariba South Bank	1,050	1,050
Total Hydro Capacity (MW)	**1,050**	**1,050**
Total Local Capacity (MW)	**2,270**	**1,850**

Source: ZPC (2018): 2017 Annual Report

The Kariba South hydropower plant has a total installed capacity of 1,050 MW. The Kariba South Power Station has an operational efficiency of above 90 %. Depending on inflows into the lake, the station can operate at the full capacity of 1,050 MW with a load factor of 80 %.

(1) Netherlands Enterprise Agency, July 2017: Renewable Energy Market Study Report – Zimbabwe.
(2) Zimbabwe Ministry of Energy and Power Development (2014), Rural Electrification Programme http://www.energy.gov.zw/index.php/power-development/rural-electrification-programme
(3) Zimbabwe Ministry of Energy and Power Development (2012) National Energy Policy

Although the coal power plants have a generation capacity of 1,220 MW, they were all operating below capacity by the end of 2017 as indicated in *Table 3.3* and only had an available capacity of 800 MW. In terms of thermal capacity, most of the thermal fleet is approaching or has exceeded its economic life, and are running below their installed capacities shown in *Table 3.3* due to age related constraints (ZETDC, 2015). The coal market is dominated by Makomo Resources and the Hwange Colliery Company.

The Hwange Power Station is the largest coal-fired power station in Zimbabwe with 920 MW installed capacity, but a current operational capacity of 720 MW. This power station is the 14th largest thermal station in the Southern African region. The station was built in two stages. The 4 x 120 MW units were commissioned between 1983 and 1986 and the 2 x 220 MW were commissioned in 1986 and 1987. The station's design largely represents technologies of the late 1960s. All six units are available and the station currently generates about 40 % of the country's electricity needs.

The Hwange Power station operates as a base load station, with its availability averaging 80 % (1).

Future Generation Capacity

Zimbabwe's electricity generation capacity and energy exported is expected to improve significantly in 2022 after the completion of a number of planned new energy developments. According to the ZPC, short term projects, which are projects with short construction lead times that can effectively address load shedding, and identified as part of the Rapid Results Approach (RRA), are included in *Table 3.4*.

Table 3.4 Short Term Generation Projects

Plant	Capacity (MW)	Expected Start Year	Expected Completion Year
Kariba South Expansion	300	2014	2018 (2)
Gwanda Solar Power Project	100	2019	2020
Bulawayo Repowering	100	2017	2019
Munyati Repowering	100	2019	2020
Harare Repowering	60	2018	2019
Munyati Solar Project	100	2021	2022
Insukamini Solar Project	Not indicated	2021	2022
Gairezi Hydropower Plant	30	2019	2022
Hwange Expansion	600	2018	2021
Hwange plant improvements and rehabilitation	920	2017	2021
Batoka	Not indicated but most likely part of the 2,400 MW planned in Zambia	2018	2023

(1) http://www.zpc.co.zw/powerstations/1/hwange-power-station
(2) This has already been completed as per ZPC's Annual Report, 2018.

Plant	Capacity (MW)	Expected Start Year	Expected Completion Year
Peaking/Emergency Power Plant	120	2018	2019

Source: ZPC (2018): 2017 Annual Report

In addition to the above projects, Coal Bed Methane (300 MW) and Coke Oven Gas have been identified as prospective projects.

Power Imports

As can be seen in *Table 3.5* there is currently not a significant amount of dependable power for import within the SAPP utilities, with only 50 MW imported as firm supply, and the balance, which varies according to availability.

Table 3.5 Zimbabwe Import Contracts

Source	Status of Contract	Contract Capacity (MW) and Nature of Capacity
HCB	Firm and Non-Firm	50 MW firm
	Expires	Non-firm Varies on availability
SNEL	Firm	0 MW
	Expired 28 February 2013	
ESKOM	Non-firm	Non-firm Varies from 0 to 450 MW, depending on availability
	PPA valid up to march 2015	
ZESCO	Non-firm	Non-firm Varies from 0 to 300 MW depending on availability
NamPower Exports	150 MW	150 MW
Total Firm		50 MW

Source: ZETDC, 2015

Energy Efficiency and Demand Side Management (DSM)

A study commissioned by ZERA recently established that the country could save 250 MW, about a quarter of the country's current average generation, by implementing energy efficiency measures in key sectors of the economy.

The ZETDC is currently engaged in Demand Side Management (DSM) activities that are expected to realise substantial energy savings that would go a long way in alleviating the current energy deficit. Activities being carried out to influence energy consumption patterns are summarised in *Table 3.6*.

Table 3.6 DSM and Energy Efficiency Initiatives Summary

Initiative	2015 MW	2016 MW	2017 MW	2018 MW	Total MW
LED lighting	110	110			220
LED Commercial lighting	30	30			60
Solar water heaters	10	10	10		30
Potential savings (MW)	171	170	30	15	386

Source: ZETDC, 2015

Diesel Plants

The ZPC diesel plant is engine based and has favourable construction lead times and short payback periods, characteristics that make it suitable for short-term power supply shortage mitigation. Beyond the short term period, this plant can viably serve as an emergency, reserve and peaking power plant, owing to its attractive operational characteristics (ZEPTC, 2015).

Hydropower

The Ministry of Energy and Power Development (2012) states that the development of large-scale and small-scale hydropower must be prioritised as a strategy for increasing the share of renewable energy, as required by the Energy Regulatory Authority (ERA) Act; Chapter 13:23, and international obligations for environmentally sustainable energy services.

Large-scale hydropower on the Zambezi and small-scale hydropower on internal dams and perennial rivers represent a significant renewable energy resource for meeting local and regional electricity demand.

Expansion works commenced at Kariba South in 2014, and were completed in early 2018, adding 300 MW to the national grid (ZPC, 2018).

Small-scale hydropower development projects, which include in-land dams and smaller run-of-river schemes, have the potential to add up to 120 MW to the national grid. According to the current plans, development of one of them, the 30 MW Gairezi Hydropower Plant, is planned to commence in 2019 (*Table 3.4*).

Coal

There are four operational coal power plants in Zimbabwe with a total installed capacity of 1,220 MW; however, in 2017, they all operated below capacity (total available capacity in 2017 was only 800 MW) due to age-related constraints and unavailability of coal at the small thermal plants. As indicated in *Table 3.4* improvements (rehabilitation and expansion)/ repowering of the operational coal power projects is planned and already on-going at some plants to make them operate at the installed capacity as much as possible. All of the major power stations in Zimbabwe are old with the small thermal plants commissioned between 1942 and 1957, Kariba in 1959-1962 and Hwange in 1983-1987. Timely rehabilitation of the ZPC thermal fleet therefore is a critical path activity of the generation system development plan.

An IPP who is at an advanced stage of project planning, with most agreements signed, and moving to the construction phase of a 660 MW power plant at Gwayi (100 km from Hwange), is looking to exploit coal resources that are deep underground through inclined shaft mining (as opposed to open cast mining that is employed by both Makomo Resources and Hwange Colliery), as a way of ensuring coal supply security and stability for their 660 MW power plant and the market.

A 1,000 MW Coal Ash power station is also currently being proposed by an IPP to exploit millions of tonnes of coal ash that has accumulated since the initial commissioning of the Hwange Power Station in 1983. This technology will utilise waste coal ash from Hwange Power station, thereby helping to clean up the environment and reduce the subsequent environmental damage due to current rates of coal ash deposition.

Solar Energy

Zimbabwe's solar energy potential of 16–20 megajoules (MJ)/m^2/day is greatly underexploited. There is an enormous potential for use of solar photovoltaic (PV) and solar water heaters that has not yet been exploited. The ZERA and ZETDC have registered an increasing interest from IPPs to invest in solar power.

According to the ZETDC (2015), like for like capacity, with all the competing technologies, solar has consistently shown to be undesirable. This is mainly due to a high capital cost per KW to plant factor ratio that erodes the overall investment efficiency of the resultant generation fleet and technology mix. As such, ZETDC, ZERA and the Ministry of Energy are encouraging increased uptake of demand connected solar technologies in all forms (solar thermal, roof top solar panels etc.).

There is however, a high demand for solar energy systems, especially in remote rural areas where there is no power grid, however the cost is prohibitive. Solar energy can, however be harnessed for pumping drinking water for rural communities, powering lights and appliances at rural institutions (schools and clinics), and water heating in urban areas. Local production of systems is being encouraged by the government to reduce the cost of solar equipment (ZETDC, 2015).

Despite the above challenges associated with developing solar power projects, ZPC Has identified and plans to develop three solar power projects with a total installation capacity of about 300 MW by 2022 to contribute towards meeting the country's energy needs (*Table 3.4*).

Liquid Petroleum Gas (LPG)

Zimbabwe is experiencing a steep increase in the use of LPG gas currently, especially for cooking in urban residential and service sectors. This business sector has grown significantly over the past three years with new and major players emerging on the market.

3.3.3 *Electrification (Zimbabwe)*

37 % of households in Zimbabwe have access to electricity that is connected via power lines and in urban areas 83 % of households have electricity, compared with 13 % in rural areas (Ministry of Energy and Power Development; 2012). It is estimated that rural communities meet 94 % of their cooking energy requirements from traditional fuels (mainly firewood) and 20 % of urban

households use wood as the main cooking fuel. The majority of urban households use electricity for cooking (73 %), while only 6 % of rural households use electricity (Ministry of Energy and Power Development; 2012).

3.4 *PROJECT MOTIVATION*

3.4.1 *The Hydropower Potential of the Zambezi Basin*

The Zambezi Basin has considerable potential for hydropower development.

A total capacity of 4,684 MW (about 10 % of the total potential) has been developed in the Zambezi River Basin, of which 75 % is on the Zambezi River itself, producing an average of almost 33,000 GWh per year.

According to estimates, the unused hydropower potential in the Zambezi Basin is 13,000 MW (*Table 3.7*). The table is a long list of possible systems, whose feasibility in terms of water/energy productivity, social, environmental and financial viability varies widely. Several sites have been identified, some at reconnaissance levels, others at pre-feasibility and feasibility level.

The foreseeable future will involve increased development of hydropower in the region to cope with the increased demand for energy in the Zambezi Basin countries, and the SADC region as a whole. However, the full development indicated in *Table 3.7* is unlikely to be realised over the next decades, as more detailed technical, economic and environmental feasibility of the schemes is established. The construction of the Katombora barrage upstream of the Victoria Falls, for example, would regulate the falls, which is a World Heritage site, and is one example of a project that may not be feasible on account of its environmental impacts.

Zimbabwe and Zambia are currently experiencing significant power shortages with Zimbabwe depending unsustainably on load shedding to cover the deficit. Zimbabwe's economy has been significantly affected by power shortages and unreliable power supplies. Both countries are experiencing significant costs of unserved energy. Increased technology penetration and access in all sectors, and the mechanisation of the industrial and the agriculture sectors, is driving rapid demand growth in both countries.

Development and exploitation of BGHES has the following advantages:

- Provides significant capacity and energy to both countries at more competitive energy tariffs than most of the alternative energy sources available to fill in the deficit.
- Unlocks the design operational flexibility at Kariba that is currently limited due to usage of Kariba for base load power production.

Table 3.7 *Hydropower Potential of the Zambezi Basin*

Sub-basin	Power plant/ reservoir	River	Capacity	Mean annual generation		FSL ****	Surface area ****	Annual evaporation	
			(MW)	(GWh)	(%)	(m)	(km²)	(Mm³)	(%)
2	Cahora Bassa II	Zambezi	1,200	6,800	12.6				0.0
	Mepanda Uncua	Zambezi	2,000	10,524	19.5	205	80	174	0.9
	Boroma	Zambezi	444	3,240	6.0	142	30	65	0.3
	Luapata	Zambezi	654	4,960	9.2	125	335	730	3.7
	Ancuaze- Sinjal I	Zambezi	330	2,230	4.1	98			0.0
	Ancuaze- Sinjal II	Zambezi	600	4,460	8.2				0.0
	Chemba	Zambezi	1,040	8,740	16.2	98	1,400	3,052	15.5
	5.8	Revubue	36	155	0.3	600	80	174	0.9
	5.9	Revubue	110	310	0.6	520	8	17	0.1
	5.13	Revubue	85	380	0.7	260	100	218	1.1
	7.6	Lula	267	600	1.1	300	100	218	1.1
	7.11	Capoche	60	250	0.5	440	220	480	2.4
3	Kapichira II	Shire	64		0.0				0.0
	Lower Fufu	S. Rukuru/ N. Rumphi	90	570	1.1	820	0.3	1	0.0
	Songwe	Songwe	150	930	1.7				0.0
	Masigira	N. Ruhuru	118	630	1.2	938			0.0
	Rumakali	Ruhuru	222	1,320	2.4		1.8	3	0.0
		Rumakali			0.0	2,055	13	14	0.1
4	Mpata Gorge	Zambezi	640		0.0		1,190	2,380	12.1
5	Lusiwasi Ext.	Lusiwasi	40	49	0.1		7.5	12	0.1
6	Victoria Falls Ect.	Zambezi	390		0.0				0.0
	Victoria Falls (Zim)	Zambezi	300		0.0				0.0
	Kariba North** Ext.	Zambezi	300		0.0				0.0
	Kariba South*** Ext.	Zambezi	300		0.0				0.0
	Katombora	Zambezi			0.0	940	7,733	10,826	55.1
	Batoka Gorge	Zambezi	1,600	4,700	8.7	770	37.3	56	0.3
	Devil's Gorge	Zambezi	1,240 *		0.0	595	762	1,219	6.2
7	Lower Kafue	Kafue	600	3,000	5.5	582	0.3	1	0.0
	Itezhi- Tehzi	Kafue	80		0.0				0.0
12	1	Lumbage	1	11	0.0				0.0
	2	Zambezi	4	32	0.1				0.0
	3	Zambezi	2	19	0.0				0.0
	4	Luvua	1	10	0.0				0.0
	5	Luizavo	11	100	0.2				0.0
	6	Ludevu	3	26	0.0				0.0
	7	Lumache	1	5	0.0				0.0
	8	Lufuige	2	16	0.0				0.0
	9	Macondo	3	25	0.0				0.0
Total			*12,988*	*54,092*	*100*		*12,098*	*19,640*	*100*

Source: https://energypedia.info/wiki/Zimbabwe_Energy_Situation

The World Bank (2010) report on the multi-sectoral investment opportunity analysis for the Zambezi River basin [(1)] reports that the coordinated operation of the existing system of hydropower plants in the Zambezi Basin could increase firm energy from 22,776 to 24,397 GWh/year, a gain of 7.1 %. According to the World Bank (2010), the gain from coordinated operation would make it possible to postpone additional capital investment to meet these deficits. The coordinated system could operate at an even higher level of output if more interconnections were available. One such interconnection is under construction between Malawi and Cahora Bassa, but to operate efficiently and

(1) The World Bank (2010). The Zambezi River basin: A Multi-sector Investment Opportunities Analysis; Volume 1: Summary report.

share benefits equitably, the whole system should be interconnected. This viable investment option is a medium-term objective of the SAPP. The estimated benefit from coordinated operation of the existing hydropower system could be as high as $585 million over a 30-year period (1).

3.4.2 *Economic Ranking of the potential Power Generation projects*

In terms of the priority for construction of the proposed power generation projects in Zambia and Zimbabwe, as listed in *Table 3.2* and *Table 3.4*, priority should be given to the plants with the least unit generation cost whilst some of the most expensive plants could be postponed (SP, 2015).

SP (2015) list the rankings of all planned plants in Zambia in terms of the unit generation costs, as derived from JICA (2010). These are provided in *Table 3.8* below.

Table 3.8 Unit Construction Cost and Unit Generation Cost of the Planned Projects in Zambia

Project	Capacity (MW)	Annual Energy (GWh)	Capacity Factor (%)	Project Cost (million S)	Unit Capital Cost (S/kW)	Levelized capital cost (c/kWh)	O&M cost (c/kWh) Fixed / Variable	Fuel cost (c/kWh)	Unit generation cost (c/kWh)
Kariba North Extension	360	380	12.0	358	994	9.50	0.94	-	10.44
Itezhi Tezhi	120	611	58.1	170	1,417	2.81	0.28	-	3.08
Lusiwasi Extension	80	200	28.6	134	1,675	6.74	0.67	-	7.410
Mutinondo	40	188	53.6	77	1,925	4.13	0.41	-	4.54
Luchenene	30	139	52.9	75	2,500	5.44	0.54	-	5.98
Lunsemfwa	55	462	95.8	271	4,927	5.92	0.59	-	6.50
Mkushi	65	223	39.1	141	2,169	6.38	0.63	--	7.01
Kabompo Gorge	34	176	59.1	115	3,382	6.59	0.65	-	7.24
Kabwelume Falls	62	624	59.6	140	2,258	4.36	0.43	-	4.79
Kundabwika Falls	101	533	60.2	226	2,238	4.28	0.42	-	4.70
Kafune Gorge Lower	750	2,400	36.5	1,745	2,327	7.33	0.73	-	8.06
Mambilima Falls Site	124	609	56.0	481	3,879	7.97	0.79	-	8.76
Mambilima Falls Site	202	1,003	56.6	708	3,505	7.12	0.71	-	7.83
Mumbotuta Falls	301	1,449	54.9	510	1,694	3.55	0.35	-	3.90
Batoka Gorge	2,400	4,372	62.3	1,462	1,828	3.37	0.33	-	37.1
Devils Gorge	500	2,802	63.9	904	1,808	3.25	0.32	-	3.58
Mpata Gorge	543	3,785	79.5	1,221	1,808	3.25	0.32	-	3.58
Total Hydro	4,168	19,656	53.8	8,738	2,097	4.484	0.445	-	4.928
Coal Thermal Power	200	1,459	83.2	240	1,200	1.74	0.110 / 0.142	2.885	4.88

In terms of the ranking in Zambia, the proposed BGHES is amongst the five best projects in terms of unit generation cost, with a unit generation cost of 3.71 c US/KWh, and of these five best projects, it should be noted that the proposed BGHES is by far the largest one.

(1) The World Bank (2010). The Zambezi River basin: A Multi-sector Investment Opportunities Analysis; Volume 1: Summary report.

The ranking of the planned power plants in Zimbabwe in terms of both capital and unit generation cost, is included in *Table 3.9*.

Table 3.9 Ranking of Planned Power Projects in Zimbabwe, Based on Unit Generation Cost

Project	Levelized Capital Cost [c$/kWh]	Levelized O&M Cost c$/kWh]	Levelized Fuel Cost [c$/kWh]	Levelized Cost of Electricity [c$/kWh]	Ranking
Batoka Gorge [2400]	*3,33*	*0,36*	-	*3,69*	*# 1*
Batoka Gorge [1600]	*3,48*	*0,32*	-	*3,80*	*# 1*
Devil's Gorge	4,64	0,37	-	5,01	# 2
Kariba South Ext.	5,17	0,37	-	5,54	# 3
Munyati Repower.	1,51	0,36	9,34	11,21	# 4
Bulawayo Repower.	1,53	0,36	9,34	11,23	# 5
Harare 11 Repower.	1,61	0,36	9,34	11,30	# 6
Lusulu	2,92	0,36	9,34	12,61	# 7
Hwange 7-8	3,46	0,36	9,34	13,16	# 8
Gokwe North	4,20	0,36	9,34	13,90	# 9
Southern Energy	4,23	0,36	9,34	13,93	# 10
ZPC	13,08	2,01	-	15,09	# 11
CASECO	5,57	0,36	9,34	15,26	# 12
Gairezi	15,85	0,52	-	16,37	# 13
Lupane	3,38	0,47	18,16	22,01	# 14

The installed power in Zimbabwe foreseen for coal plants (4,520 MW) represents about 65 % of the overall planned capacity, whilst the foreseen capacity of hydropower projects in Zimbabwe (1,790 MW), represents about 26 % of the planned installed power (*Table 3.9*).

The unit generation cost of the repowering of the coal projects in Zimbabwe is about 11 c$/kWh, lower than the new coal projects due to a lower investment cost. The new coal power plants have a unit generation cost that ranges from 12,61 c$/kWh (Lusulu) to 15,26 c$/kWh (CASECO).

The proposed BGHES is the most convenient planned plant, especially the 2,400 MW alternative, as the unit generation costs of the proposed thermal plants are from three to six times higher than that of the proposed BGHES (SP, 2018).

3.4.3 *Hydropower and the SAPP Power Expansion Plan*

The Southern African Power Pool presents a Regional Generation and Transmission Expansion Study for the entire SAPP region (Nexant 2007), where a Base Case and an Alternative Case is proposed.

Both cases provide a reasonable set of generating unit additions balanced among peaking, mid-range, and base load units. For the entire SADC Region, the Base Case adds about 39,300 MW with greater emphasis on conventional coal fuelled steam plants.

The Alternative Case instead adds about 36,600 MW with greater emphasis on hydro projects and the transmissions needed to move the power to areas of demand. This Alternative Case over the period up to 2025 envisages development of almost all power plants in the Kariba Sub-basin (No. 6), those in the Shire River/Lake Malawi/Nyasa/Niassa Sub-basin (No. 3), Kafue Sub-basin (No. 7) and the two major power sites (Cahora Bassa II and Mepanda Uncua) in Tete Sub-basin (No. 2); refer to *Table 3.7*. This set of power plants would permit an integrated generation and transmission expansion plan, offering full benefits of power pooling through the region in terms of capacity balance, energy balance, system reliability and economies in investment costs and operation and maintenance.

By adopting this development package as the total expansion of the hydropower system, the total power development is estimated at approximately 53 % (6,616 MW) of the total hydropower potential of the Zambezi Basin, and only about 1 % (249 Mm^3) of the annual evaporation. The SAPP power expansion plan, in addition, envisages development of 24 MW of small hydro per year over the period 2006 – 2025.

3.4.4 *The Proposed BGHES in Relation to the SAPP Power Expansion Plan*

As far as hydropower development in the Zambezi Basin is concerned, the difference between the SAPP Base Case and the Alternative Case is mainly in the timing of the construction of the proposed BGHES. The total additional installed capacity of the proposed BGHES would be in both cases between 1,600 – 3000 MW. The Kariba extensions will only provide peaking power and reserve capacity; they will not increase overall firm energy before the construction of the proposed BGHES. The 750 MW Lower Kafue Gorge scheme and the 1,600 - 3000 MW proposed BGHES can therefore make a substantial contribution to power supply.

3.4.5 *Conclusion: The Proposed BGHES and Energy Security in Both Zambia and Zimbabwe*

Despite Zambia and Zimbabwe's vast renewable and non-renewable energy sources, little of these have been utilised to improve the attractiveness of the energy sector and transfer the benefits for industrial expansion, employment creation and poverty reduction in both countries. The energy market structure and consumption shows that traditional wood fuels (biomass), such as firewood and charcoal sourced from natural woodlands and agricultural lands dominate the energy market.

Investment in energy is a prerequisite to achieving commercial and industrial development in Zambia and Zimbabwe. The use of solar power is favourable in providing rural and urban areas with access to power; however, if both countries are to achieve those targets and goals detailed in their Vision 2030 and Vision 2040, and other complimentary plans (such as the System Development Plans), these countries will require private sector investment in energy technology that is efficient, sustainable and reliable. The generation of energy through hydropower is a proven technology that is sustainable and which is actively being promoted at a national level in both Zambia and Zimbabwe. With a vast hydropower energy potential, hydropower is considered the most feasible and reasonable electrification option for both countries.

Preliminary investigations, geographical exploration as well as the 1993 and 1998 ESIA studies have concluded that the proposed BGHES with a proposed installed capacity of 2,400 MW is the least cost solution and has the least adverse environmental impacts. The site for the proposed scheme has been chosen as the most viable compared to the other sites investigated (*Chapter 6* of this Report) and has been ranked as the first major hydroelectric development on the Zambezi River since the construction of the Kariba Dam (IUCN, 1992).

The objective of the proposed BGHES is to increase power generation capacity in both Zambia and Zimbabwe, reduce power outages and reduce reliance on coal fired power stations. Once completed, the proposed BGHES will contribute significantly to the electricity supply of both countries, and also serve to distribute power to southern African countries, thanks to several planned projects under the coordination of the Southern African Power Pool (SAPP) aimed at increasing transfer limits through boundary connections.

The motivation for the proposed BGHES therefore is that it would provide electricity at a cost that would be considerably lower than most of the reasonable alternatives:

- In Zambia the proposed BGHES:

    - is expected to generate the fourth cheapest electricity of the seventeen planned power plants in Zambia;
    - is only slightly more expensive than the cheaper options; and
    - is the largest planned power generation plant estimated to produce electricity less than half the price of electricity produced by Kafue Gorge Lower, the other large planned power station.

- In Zimbabwe:

- the cost of electricity generation from large coal fired power stations (such as CASECO and Hwange) would be up to four times higher than the proposed BGHES; and
- in addition, and since the unit generation costs in Zambia are favourable when compared to other planned generation projects, and in Zimbabwe, are much lower than the ones of all the other thermal plants, the implementation of the proposed BGHES should be given priority in both Zambia and Zimbabwe.

The implementation of the proposed BGHES is therefore a good option to satisfy the energy needs of both Zambia and Zimbabwe.

4 INSTITUTIONAL AND LEGISLATIVE FRAMEWORK, DEVELOPMENT POLICIES, AND INTERNATIONAL TREATIES AND GUIDELINES

4.1 INTRODUCTION

This *Chapter* sets out the relevant legal and policy context applicable to the development of hydropower projects in the Republics of Zambia and Zimbabwe. Specifically, this chapter summarises the following:

- The relevant institutional framework in Zambia and Zimbabwe involved in the regulation of this Project;

- Relevant Zambian and Zimbabwean environmental and social laws and Regulations which are applicable to the Project;

- Development policies applicable to the Project for both Zambia and Zimbabwe;

- International treaties, conventions and protocols relevant to the Project and to which Zambia and/ or Zimbabwe is a signatory;

- Environmental and social guidelines and standards developed by the Southern African Power Pool (SAPP), and international organisations such as the International Finance Corporation (IFC) and the World Bank, with which the Project will need to align; and

- Other international guidelines and standards directly applicable to dam-building and hydropower projects, which are considered international good practice (such as the World Commission on Dams (WCD) Guidelines and Recommendations).

To indicate how the proponent of the BGHES development intends to comply with the cited legislation, policies, guidelines and international treaties, the respective summary tables presented below, i.e. *Tables 4.1, 4.2, 4.3* and *4.5*, have columns describing the measures to be taken to fulfil the requirements.

4.2 ZAMBIAN INSTITUTIONAL FRAMEWORK

4.2.1 *Ministry of Lands and Natural Resources*

The Ministry of Lands and Natural Resources is charged with the critical responsibility of land administration, natural resource management on behalf of the people of Zambia.

The following Departments fall under this Ministry:

- Lands and Deeds;
- Lands Department;
- Forestry Department;
- Natural Resources Management.
- Human Resource and Administration;
- Survey Department; and
- Planning and information.

4.2.2 *Zambia Environmental Management Agency*

The Zambia Environmental Management Agency (ZEMA), falls under the Ministry of Water Development, Sanitation and Environmental Protection. ZEMA, previously known as the Environmental Council of Zambia (ECZ), (1) is the umbrella environmental institution in Zambia and the main lead agency on matters pertaining to Environmental Impact Assessment (EIA). It is empowered by the Environmental Management Act (No. 12 of 2011) (EMAct) to, inter alia, identify projects for which an EIA is necessary. **Note that to accord with the World Bank Environmental and Social Safeguard Policies and the IFC performance standards, the term Environmental and Social Impact Assessment (ESIA) is used throughout this documentation to refer to the EIA being carried out specifically for the BGHES**.

The general functions of the ZEMA are to ensure the sustainable management of natural resources, the protection of the environment, and the control of pollution, as provided under Section 9(1) of the EMAct. However, more specifically, the ZEMA serves *inter alia* to:

- Co-ordinate the implementation of activities of all government ministries, appropriate authorities and conservancy authorities in matters relating to the environment;

- Develop standards and guidelines relating to the protection of air, water, land and other natural resources;

- Provide for environmental monitoring and auditing as well as establishing and managing of the environmental fund;

- Develop and enforce measures aimed at preventing and controlling pollution;

- Advise the government on the formulation of policies on all aspects of the environment and make recommendations for the sustainable management of the environment;

(1) The Environmental Council of Zambia (ECZ) was a statutory body created under an Act of Parliament, the Environmental Protection and Pollution Control Act (EPPCA) of 1990, Cap 204 of the Laws of Zambia. The EPPCA has since been repealed and replaced by the Environmental Management Act (No. 12 of 2011) (EMAct). Under the EMAct, the ECZ has been renamed as the Zambian Environmental Management Agency (ZEMA).

- Advise on all matters relating to environmental conservation, protection and pollution control, including necessary policies, research, investigations and training;

- Initiate, conduct and promote research, surveys, studies, training and investigations in the interests of environmental management;

- Identify projects, plans and policies that need environmental impact assessments;

- Monitor trends with respect to natural resources, their use and impact on the environment and make necessary recommendations to the appropriate authority;

- Undertake general education programmes for the purpose of creating public awareness of the environment;

- Provide for public consultation in environmental decision – making and access to environmental information;

- Request information on proposed projects and advise stakeholders on projects, programmes, plans and policies for which environmental assessment is necessary; and

- Facilitate the implementation of international environmental agreements and conventions to which Zambia is a party.

The services provided by the ZEMA specifically in relation to EIA studies include:

- Assisting the developer to determine the scope of EIA studies;

- Reviewing project briefs, terms of reference, and environmental impact statements (EIS) and decision-making;

- Disclosure of the EIS to the public through the media;

- Holding public hearing meetings to discuss the EIS with stakeholders;

- Conducting verification surveys of the affected environment;

- Monitoring the project once implemented;

- Conducting compliance audits of the project between 12 and 36 months after implementation; and

- General administration of all the Regulations under the Environmental Management Act.

ZEMA has a number of units which control various aspects of environmental pollution planning and environmental management. These have been organised under two departments:

- *The Pollution Control Inspectorate*, which is responsible for all pollution and regulation issues pertaining to waste, emissions and toxic substances. This inspectorate also has a dedicated unit responsible for EIAs.

- *The Planning and Information Management Department*, which comprises units in charge of planning, monitoring, education, communication, information, documentation and data management.

The Zambezi River Authority (ZRA), as the project proponent of the proposed BGHES which "*may have an effect on the environment*" (1), are required to submit an EIA to the ZEMA for approval before "undertaking" this Project, and are required to abide to the "*conditions imposed by ZEMA in that approval* (2)."

4.2.3 Ministry of Tourism and Arts

The Ministry of Tourism and Arts was created on 10 July 2011 after realignment of Government Ministries by His Excellency Mr. Michael Chilufya Sata, the President of Republic of Zambia. This brought together the portfolio functions of tourism from former Ministry of Foreign Affairs and Tourism and the portfolio functions of Culture from the Ministry of Chiefs and Traditional Affairs. This was done in order to streamline and rationalise the functions and operations of the tourism and cultural sector.

Department of National Parks and Wildlife
The Department was established in terms of section 5 of the Zambian Wildlife Act (No. 14 of 2015). The Department replaces the former Zambia Wildlife Authority (ZAWA).

The primary objectives of Department are:

- Control, manage, conserve, protect and administer National Parks, Community Partnership Parks, bird and wildlife sanctuaries and Game Management Areas and coordinate activities in these areas;

- In partnership with local communities, share the responsibilities of management in Community Partnership Parks and Game Management Areas;

- Adopt methods to ensure the sustainability, conservation and preservation in the natural state of eco-systems and biological diversity in the National Parks, Community Partnerships Parks, bird and wildlife sanctuaries and

(1) Section 29 of the Environmental Management Act (EMAct), 2011
(2) Section 29 of the EMAct, 2011

Game Management Areas;

- Encourage the general development of National Parks, Community Partnership Parks, bird and wildlife sanctuaries and Game Management Areas, including the development of facilities and amenities within these areas in accordance with the management plans for those areas;

- Sensitise and educate the general public on the necessity of wildlife conservation and the importance of wildlife to foster appreciation of the economic and aesthetic value of wildlife as natural assets;

- Undertake measures to ensure the proper balance between the sustainable use of wildlife and the management of eco-systems in National Parks, Community Partnership Parks, bird and wildlife sanctuaries and Game Management Areas;

- Enhance the economic and social well-being of local communities in or around Community Partnership Parks and Game Management Areas;

- Prepare and implement management plans for National Parks, Community Partnership Parks, bird and wildlife sanctuaries and Game Management Areas in consultation with relevant stakeholders;

- Issue licences, certificates and permits under this Act;

- In partnership with local communities, grant hunting concessions to hunting outfitters and non-consumptive tourism operators in Game Management Areas;

- Assist and advise the boards in the management of human and natural resources in Game Management Areas and open areas which fall under their jurisdiction;

- Formulate and advise the Minister on the regulations for the preparation and implementation of general management plans for National Parks, Community Partnership Parks, bird and wildlife sanctuaries and Game Management Areas;

- Ensure the systematic management of financial, human and natural resources for wildlife conservation so that the abundance and diversity of species is maintained at optimum level;

- Advise the Minister on the regulations required to conserve, protect and manage wildlife in National Parks, Community Partnership Parks, bird and wildlife sanctuaries, Game Management Areas, open areas and private wildlife estates;

- Pay out monies into a fund established by a board and regulate the use of the funds from profits accrued from the revenues payable under this Act in respect of licences, certificates and permits issued, hunting concessions granted and services rendered from the use of wildlife within an area of a board as the Minister may prescribe, in consultation with the Director;

- Regulate trophy hunting operations and non-consumptive tourism operations in Game Management Areas;

- Grant and regulate tourism block concessions in tourism blocks;

- Co-operate with persons and organisations with an interest in the activities of the Department and are prepared to assist the Department on a voluntary basis and comply with the requirements set by the Ministry;

- Regulate private wildlife estates;

- Carry out commercial activities related to consumptive and non-consumptive tourism; and

- Carry out any other activities relating to wildlife conservation and management that are necessary to the performance of its functions under this Act.

The proposed BGHES lies downstream of the Mosi-oa-Tunya National Park on the Zambian side of the Zambezi River. Department of National Parks and Wildlife are key stakeholders in the ESIA process, with an interest in potential impacts to wildlife and to vegetation as a result of inundation as a result of the Project.

4.2.4 The National Heritage Conservation Commission

The National Heritage Conservation Commission (NHCC), formally known as the Commission for the Preservation of Natural and Historical Monuments and relics (National Monuments Commission), is the national institution mandated to manage and conserve Zambia's cultural and natural heritage resources, including significant:

- Historic/architectural/buildings;
- Historic sites;
- Anthropological sites;
- Archaeological sites;
- Geomorphological sites;
- Geophysical sites;
- Paleontological sites; and
- Ecological and other sites.

Although ZEMA is mandated to review the ESIA in its entirety, the NHCC are a key stakeholder in the review of the cultural heritage impact assessment; comments of which will be submitted to ZEMA, and which need to be incorporated into the ESIA.

4.2.5 *The National Museum Board*

The National Museum Board of Zambia (NMB) is a corporate body which has the principal role of preserving the nation's history and movable heritage.
The Board is mandated to collect, document, present to the public and to preserve for posterity Zambia's movable heritage.

4.2.6 *Ministry of Mines and Minerals Development*

The Ministry of Mines and Minerals Development is responsible for the development and management of mineral resources in a sustainable manner for the benefit of the people of Zambia. The Ministry comprises six departments; namely:

- Geological survey;
- Human Resource and Administration;
- Mining Cadastre;
- Mines Development;
- Mines Safety; and
- Planning and Information.

4.2.7 *Ministry of Energy*

The Ministry of Energy (MoE) was established in 2016 following the Republican President's directive to re-align the Ministry from the then Ministry of Energy and Water Development (MEWD). This was during the President's address to Parliament in September, 2016.

The Ministry of Energy comprises of six departments. Those departments are as follows:

- Department of Energy;
- Department of Petroleum;
- Department of Planning and Information;
- Human Resources and Administration;
- Department of Finance; and
- Office for Promoting Private Power Investment.

The function of the Department relevant to the Project (i.e. the Department of Energy) is described below.

Department of Energy

The functions of the Department of Energy are:

- Facilitate the development and review of policies and legislation on energy in order to provide an appropriate framework for the effective management and implementation of programmes;

- Facilitate the construction, rehabilitation and maintenance of energy infrastructure in order to ensure security of supply;

- Promote the development and utilization of climate resilient and renewable energy technologies;

- Coordinate safely and environmental protection measures and programmes relating to nuclear power generation;

- Conduct and undertake research and development in the energy sector;

- Maintain a data base on energy resources ,production, distribution, consumption and pricing;

- Coordinate regional and international energy programmes;

- Formulate and review energy strategy and action plans in order to facilitate resources mobilization and attainment of set objectives;

- Provide technical guidance and support to stakeholder institutions on matters relating to efficient management and conservation of energy;

- Collaborate with stakeholders in planning and implementation of energy development programmes in order to ensure a harmonized approach to Programme execution;

- Develop and implement programmes on transboundary power projects in order to foster regional integration; and

- Monitor and evaluate the implementation of energy programmes and programmes and projections in order to recommend appropriate interventions and ensure attainment of set goals.

4.2.8 Ministry of Water Development, Sanitation and Environmental Protection

The Ministry of Water Development, Sanitation and Environmental Protection is responsible for the development and management of water resources, sanitation and the environment in a sustainable manner. The Ministry comprises the following Departments:

- Department of Water Resource Development;
- Department of Planning and Information;
- Department of Environmental Management; and
- Department of Water Supply and Sanitation

4.2.9 The Energy Regulation Board

The ERB has the mandate of regulating the energy sector in line with the provisions of the Energy Regulation Act of 2003. The ERB has the responsibility of ensuring that power generating utilities earn a reasonable rate of return on their investments that is necessary to provide a quality service at affordable prices to the consumer.

In order to carry out this role, the ERB, among other functions, ensures that all energy utilities in the sector are licensed, monitors levels and structures of competition, and investigates and remedies consumer complaints.

The unit price of the electricity generated by the proposed BGHES will be regulated by the ERB.

4.2.10 ZESCO Limited

ZESCO Limited is a parastatal, with the main function of producing power in Zambia. ZESCO produces approximately 80 % of the electricity consumed in the country and has historically been the main player in the generation, transmission and distribution of electricity in Zambia. In addition, ZESCO represents Zambia in the Southern African Power Pool. Due to the ever increasing demand for electricity both in Zambia and in the region, ZESCO is currently being forced to source more electricity from independent power producers (IPPs) such as Lunsemfwa Hydro Power Company (LHPC). The electricity produced by the proposed BGHES will be sold to the national grid, which is managed and maintained by ZESCO.

4.2.11 Water Resources Management Authority

Due to the increase in population, the demand for water for power generation, direct consumption and other uses of water has increased in Zambia. As such, the Water Resources Management Authority was developed in response to these often conflicting demands for water. The Water Resources Management Authority is essentially an executive wing of government which provides necessary information for the control of abstractions from water bodies in Zambia. Any person who wishes to store or divert water from public streams and waterways for primary, secondary, or tertiary use must obtain permission from the Water Resources Management Authority.

4.2.12 Other Line Ministries

Environmental and social issues cut across a wide variety of sectors and there are a number of government institutions and agencies which are involved in environmental and social management. Some of the ministries, sectoral agencies and authorities that may also need to be consulted as part of the proposed BGHES include:

- Ministry of Agriculture;
- Ministry of Fisheries and Livestock;
- Ministry of Health;
- Ministry of Higher Education
- Ministry of Local Government;
- Ministry of Chiefs and Traditional Affairs; and
- Ministry of Transport and Communications.

The relevant institutions have been consulted with as part of the public participation process, as described in *Chapter 7*.

4.3 ZAMBIAN ENVIRONMENTAL AND SOCIAL LAWS AND REGULATIONS

4.3.1 The Zambian Environmental Management Act

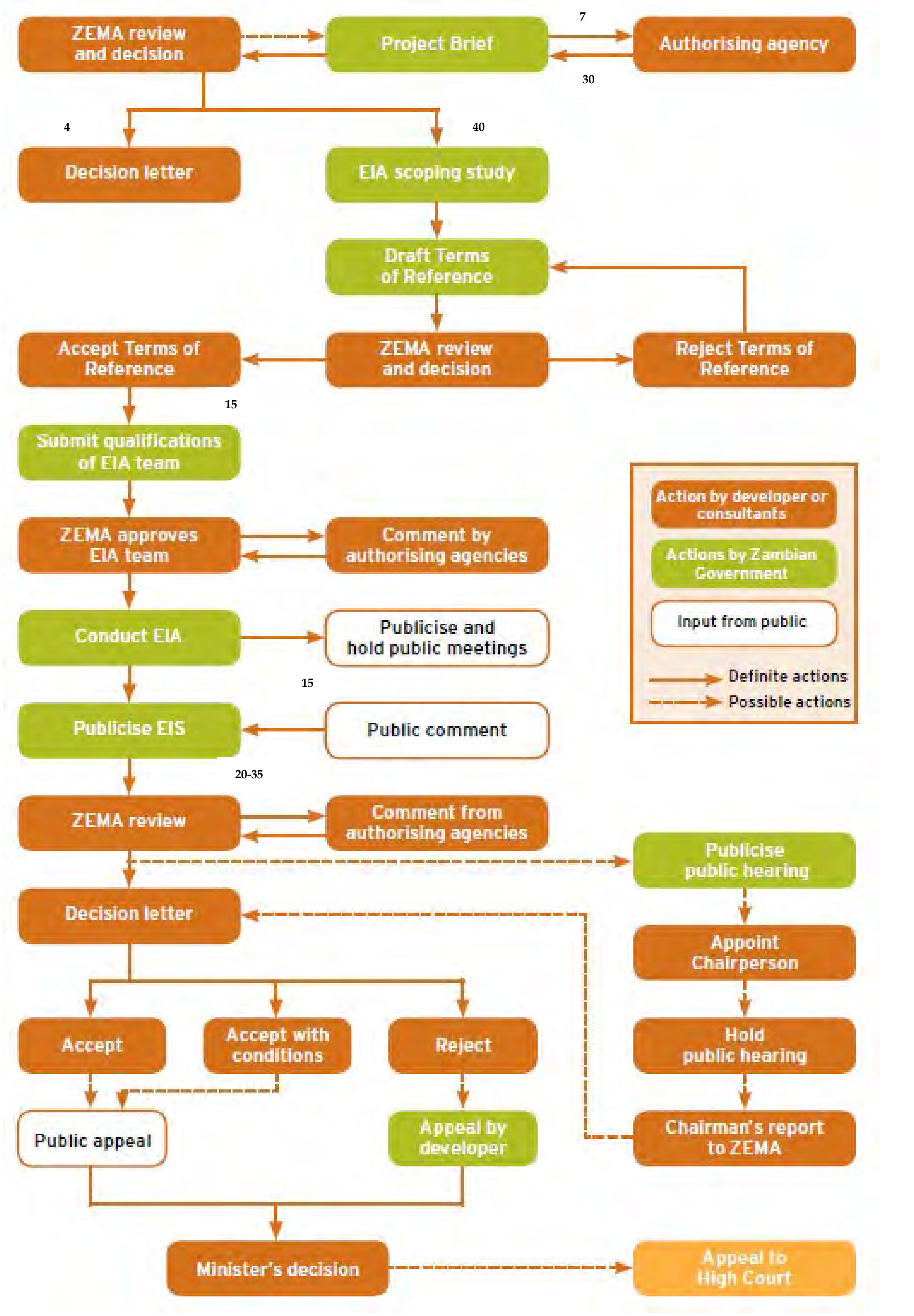
The Zambian Environmental Management Act (EMAct) (Act 12 of 2011) (EMAct) is the principal law on integrated environmental management in Zambia. The Zambian EMAct was enacted in April 2011 to repeal and replace the Environmental Protection and Pollution Control Act (No. 12 of 1990) (EPPCA) and its Amendments.

4.3.2 Environmental Impact Assessment Regulations

The Environmental Impact Assessment (EIA) Regulations (Statutory Instrument No. 28 of 1997) was promulgated in terms of Section six and ninety-six of the EPPCA. The Regulations provides the framework for conducting and reviewing EIA's for any Project within Zambia. The Regulations enacted under the EPPCA are still in force and will remain in force until such time as the Minister enacts new Regulations under the Zambian EMAct (No. 12 of 2011).

The EIA process (with associated timeframes) to be undertaken for this Project is illustrated in *Table 4-1*.

Table 4-1 Zambia EIA Process



Source: SAIEA (2012)

4.3.3 *The Environmental Management (Licensing) Regulations*

The Environmental Management (Licensing) Regulations (S.I. No. 112 of 2013) were published under the Zambian EMAct and provide for the licensing requirements pertaining to specific subject areas, including:

- Air and water pollution;
- Waste management;
- Hazardous waste;
- Pesticides and toxic substances; and
- Ozone depleting substances.

The Seventeenth Schedule of the Environmental Management (Licensing) Regulations (S.I No. 112 of 2013) provides for the repeal of the following legislation:

- The Waste Management (Licensing of Transporters of Wastes and Waste Disposal Sites) Regulations, S.I. No. 71 of 1993;

- The Water Pollution Control (Effluent and Waste Water) Regulations, S.I. No. 72 of 1993;

- The Pesticides and Toxic Substances Regulations, S.I. No. 20 of 1994;

- The Air Pollution Control (Licensing and Emission Standards) Regulations, S.I. No. 141 of 1996;

- The Environmental protection and Control (Ozone Depleting Substances) Regulations, S.I. No. 27 of 2001; and

- The Hazardous Waste Management Regulations, S.I. No. 125 of 2001.

4.3.4 *Other Relevant Environmental and Social Legislation in Zambia*

Environmental issues span across a wide variety of sectors, as such there are numerous pieces of legislation in Zambia, which have a bearing on the environment and should be considered during ESIA decision-making. *Table 4-1* presents a summary of the most relevant national legislation, which may be applicable to the Project.

Table 4-2 Summary of Relevant Zambian Environmental and Social Legislation

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
Natural Resources and Heritage			
Water Resources	• *Water Resources Management Act, No 21 of 2011*	*Provides for the management of water resources within Zambia.*	*The Environmental and Social Impact Assessment has considered project activities that may result in effluent discharge. The Environmental and Social Management Plans (ESMPs) include measures to manage such discharge and should include provisions to ensure that no person discharges or disposes of –* • *Any organic or inorganic matter, including water containing such matter, into a water resource, whether directly or through drainage or seepage, so as to cause pollution of the water resource; or* • *Any effluent or wastewater, which has been produced by, or results from, the use of water for any purpose, into a water resource, whether directly or through drainage or seepage.* *Please note that dilution of effluents using water is an activity that requires a licence. The licensing process is beyond the scope of this report.*
	• *Water Supply and Sanitation Act, No 28 of 1997*	*Provides for the supply of clean water and adequate sanitary conditions.*	*The ESIA has consider the need for a clean potable water supply. The ESMPs include measures to ensure sanitary conditions relating to the use of such water.* *Please note that all water service providers need to be licence and therefore before sourcing water from such a provider check that they are in possession of a licence.*
Wildlife and Natural Resources	• *Zambian Wildlife Act, No. 14 of 2015*	*Provides for the removal of the Zambian Wildlife Authority and the establishment of the Department of National Parks and Wildlife in the Ministry responsible for tourism. The Act provides for the regulation of National Parks and the protection of certain species of fauna and flora.*	*The ESIA has considered the impacts on flora and fauna within national parks, conservation and protected wildlife areas. The ESMPs includes measures for the management of impacts upon such fauna and flora.*
	• *Forests Act, No 4 of 2015*	*Provides for the establishment and management of National and Local forests, Conservation and protection of forests and trees, and licensing and sale of forest products. In addition, the Act provides for the implementation of the following international conventions:* • *United Nations Framework Convention on Climate Change;*	*The ESIA considers the possible impacts upon national or local forests and protected tree species. The ESMPs include measures associated with trees within such areas are not damaged or removed and that protected tree species, no matter their location, are not negatively impacted upon.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
		• Convention on International Trade in Endangered Species of Wild Flora and Fauna; *• Convention on Wetlands of International Importance, especially as Water Fowl Habitat;* *• Convention on Biological Diversity; and* *• Convention to Combat Desertification.* *The Act provides for the repeal of the former Forests Act, 1999.*	
Fisheries and Wetlands	• *Fisheries Act, No 22 of 2011*	*Provides for the protection and sustainable utilization of fish in natural water bodies and control of fish farming.*	*The ESIA considers impacts upon the fishing industry and that such persons are involved in consultations. The ESMPs include measures for the management of impacts upon such persons as far as is reasonably possible and a livelihood restoration plan which will be compiled as part of the RAP will also ensure the minimisation of impacts.*
	• *National Policy on Wetlands Conservation, September 2001*	*Provides for the protection of wetlands.*	*The ESIA considers project activity impacts upon any designated and non-designated wetlands and includes measures to avoid impacting upon wetlands as far as is reasonably possible.*
Noise & Vibration	• *Part IV of EMAct,No.12 of 2011*	*Provides for noise emission standards to be established and requires permits to exceed said emissions.*	*The ESIA considers possible noise impacts resulting from related project activities. The ESMPs include measures to manage such activities to ensure noise levels are kept within the legally prescribed thresholds.*
Explosives	• *Explosives Act (No 10 of 1974) Regulations are in draft stage.*	*Provides for the handling, storage and general management of explosives used for blasting in the mining and construction industry.*	*The ESIA and ESMPs consider possible handling, storage and use of explosives during project activities.*
Air	• *Part IV of EMAct,No.12 of 2011*	*Provides air quality standards.*	*Section 52 of Division 3 (Part IV) of the Act states that ambient air quality standards and guidelines shall be established under this Division and published.*
	• *Section 37, 46 and 96 – The Air Pollution Control (Licensing and Emission Standards) Regulations, S.I. 141 of 1996*	*Provides a table of guideline limits for ambient air quality emissions.*	*This regulation provides a table of guideline limits for ambient air quality pollutants including Sulphur Dioxide, Total Suspended Particulate, Particulate Matter, Carbon Monoxide, Ambient Lead and Dust Fall.* *The ESMPs have considered these regulations and associated ambient air quality standards.*
Energy			
Energy	• *Energy Regulation Act, No. 16 of 1995*	*Provides for the control in the pricing of energy products in the country as well as the quality.*	*No direct issues to be complied with; however, the Energy Regulator is a key stakeholder and therefore needs to be included in consultations relating to the ESIA.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
	• *The Petroleum Act, No. 28 of 1930*	*The areas of the Petroleum Act of relevance to this project are regulations for the conveyance and storage of petroleum, inflammable oil and liquids.*	*The ESMPs consider the possible use of petroleum products, and include measures to ensure that such products are handled, stored and transported in accordance with this Act.*
	• *The Electricity Act, No. 15 of 1995*	*Regulate the transmission, distribution and supply of electricity.*	*The ESIA considers electrical transmission activities.*
Socioeconomic, Archeology and Cultural Heritage			
Health	• *Public Health Act, No 22 of 1995*	*Provides for the prevention of diseases, drainage, latrine and disposal of sewerage and treatment systems.*	*The ESIA and ESMPs consider sewerage disposal activities and include measures for environmentally acceptable sewerage disposal methods.*
Archaeological, Historical and Cultural	• *National Heritage and Conservation Act, No. 23 of 1989*	*The National Heritage Conservation Commission Act (CAP 173 of 1989) provides for the conservation of ancient cultural and natural heritage, relics and other objects of aesthetic, historical, pre-historical, archeological or scientific interest. Sections 35 and 36 of this Act require a developer to state the nature and extent of the development and to report to the Commission any new discoveries of items of archaeological or historical nature. This requirement applies to both the pre- and post-construction stage, particularly for archaeological resources, which might not have been identified in pre-construction studies. Under this statute, the Commission has established Standards and Guidelines, and premised upon these, the significance of heritage resources (sites and objects) is determined.*	*The ESIA considers the impacts upon cultural heritage and the ESMPs include measures such that no person is allowed to alter, remove, destroy, damage, and excavate any ancient heritage or relic or part of it without authorisation. The associated licencing process is beyond the scope of this Chapter.*
Roads and Land Use Planning			
Roads	• *Roads and Road Traffic Act (Cap 464)*	*An Act to make provision for the care, maintenance and construction of roads in Zambia, for the control of motor traffic, for the licensing of drivers and motor vehicles, for the compulsory third party insurance of motor vehicles, for the licensing and control of public service vehicles and public services, and for other miscellaneous provisions relating to roads and motor traffic.*	*The ESIA considers the use of motor vehicles and their appropriate licensing requirements.*
Land Use Planning Issues	• *The Urban and Regional Planning Act, No. 3 of 2015*	*Provides for development, planning and administration principles, standards and requirements for urban and regional planning processes*	*The ESIA considers project activities that will impact upon any areas included in existing development plans. The ESMPs also consider project activities are in adherence with such developed plans as far as is reasonably possible.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
		and systems. Furthermore, provides for a framework for administering and managing urban and regional planning and provides for a planning framework, guidelines, systems and processes for urban and regional planning for the Republic. *The Act also provides for the repeal of the former Town and Country Planning Act, 1962 and the Housing (Statutory and Improvement Areas) Act, 1975.*	
	• *Lands Conversion of Titles Act*	*Provides for alienation, transfer, disposition and charge of land.*	*The ESIA considers impacts upon on all land occupiers (lawful or unlawful). The ESMPs include provisions for the development and implementation of a Resettlement Act Plan.*
	• *Lands and Deeds Registry Act, No. 38 of 1994*	*An Act to provide for the registration of documents; to provide for the issue of Provisional Certificates of Title and Certificates of Title; to provide for the transfer and transmission of registered land; and to provide for matters incidental to or connected with the foregoing.*	*The ESIA considers impacts upon on all land occupiers (lawful or unlawful). The ESMPs include provisions for the development and implementation of a Resettlement Act Plan that should take into account the provisions of this Act.*
	• *Lands Act, No. 29 of 1995*	*The Act guarantees peoples' right to land while enhancing development. The Act recognises the holding of land under customary tenure and the Chief's role has been legally recognised, such that land cannot be converted or alienated without approval of the chief.*	*The ESIA considers impacts upon on all land occupiers (lawful or unlawful). The ESMPs include provisions for the development and implementation of a Resettlement Act Plan that should take into account the provisions of this Act.*
	• *Land Acquisition Act, No. 2 of 1970*	*The Act sets out regulations for compulsory acquisition of land and property and compensation for such acquisition.*	*The ESIA considers impacts upon on all land occupiers (lawful or unlawful). The ESMPs include provisions for the development and implementation of a Resettlement Act Plan that should take into account the provisions of this Act.*
	• *Agricultural Lands Act, No. 57 of 1960*	*Provides for the establishment of the Agricultural Lands Board and provides for tenant farming schemes.*	*The ESIA consider impacts upon on all agricultural land. Ministers will need to be consulted as well as affected farmers.*
	• *The Local Government Act, No 19 of 1992*	*Provides for the establishment of Councils or Districts, the functions of local authorities and the local government system. Some of these functions relate to pollution control and the protection of the environment in general.*	*The ESIA considers impacts upon local or district council areas and the Council's jurisdiction over these areas.*
Mining Regulations			
Quarries and Borrow Pits	• *Mines and Minerals Development Act No 11 of 2015*	*Regulates the law relating to mines and minerals. The Act provides for the granting of or, renewal and termination of mining rights. It also provides for the control of mining activities with regard to environmental protection.*	*The ESIA considers any potential mining or quarry related activities and the ESMPs provide for measures to mitigate the impacts thereof.* *Please note that such activities will require licenses; however, the associated process is beyond the scope of this report.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
		The Act provides for the repeal of the former Mines and Minerals Development Act, 2008	
Investments, Energy Regulation, and Development			
Tourism	• *Tourism and Hospitality Act, No 13 of 2015*	*Provides for the promotion of tourism activities both locally and internationally.*	*The ESIA considers project activity impacts on the tourism industry and the ESMPs include measures to manage such impacts as far as is reasonably possible.*
Investment and Taxes	• *Public – Private Partnership Act, No 14 of 2009*	*Provides for the encouragement of private sectors partnering with the government in the development and execution of certain nationally important projects*	*No direct issues to be complied with.*
	• *Zambia Development Agency Act, No 11 of 2006*	*An Act to foster economic growth and development by promoting trade and investment in Zambia through an efficient, effective and coordinated private sector led economic development Strategy.*	*No direct issues to be complied with.*
	• *Standards Act, No. 4 of 2017*	*Provides for the adherence to prescribed standards in all works.*	*No direct issues to be complied with.*
Employment and Compensation	• *Citizens Economic Empowerment Act, No 9 of 2006*	*Provides for the encouragement and support of citizens of Zambia to get involved in business activities for wealth creation and support of livelihoods.*	*The ESIA considers the impacts upon labour in the region. The ESMPs include requirements for local content and local labour supply is utilised where possible.*
	• *The Employment Act, No. 57 of 1965*	*Provide for the employment of persons on contracts of service and for the form of and enforcement of contracts of service, appointment of officers of the Labour Department and for the conferring of powers on such officers and upon medical officers and protection of wages of employees as well as control of employment agencies.*	*The ESIA considers labour and occupational health and safety impacts upon the workforce involved in project related activities. The ESMPs include measures for employment of employees that are in accordance with the Act and that labour conditions provide for a safe and healthy environment.*
	• *Workers Compensation Act, No. 10 of 1999*	*Provides for the establishment and administration of a Fund for the compensation of Workers disabled by accidents to, or diseases contracted by, such Workers in the course of their employment, and for the payment of compensation to dependants of Workers who die as a result of such accidents or diseases.*	*The ESMPs include measures that provide for the contribution to the Fund for disabled workers as required.*
	• *Employment Code Act No. 3 of 2019*	*This Act regulates amongst other aspects the employment of persons, and prohibits discrimination when employing. Moreover, the Act provides for the engagement of persons on contracts of employment and provides for the form and enforcement of the contracts during the employment period. It includes provisions for employment entitlements and other benefits, and provisions for the protection of wages of*	*The ESIA and associated ESMPs have considered the relevant requirements pertaining to employment included in this Act.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
		employee. The Act also regulates the employment of children and young persons.	

4.3.5 *Zambian Development Policies*

The national development policies for Zambia that are of applicability to this Project are briefly outlined below.

National Policy on Environment

The Zambian National Policy on Environment, 2009 (NPE) was developed to safeguard the environment and to ensure the sustainable use of natural resources. The policy is premised on the basic principal of "*Polluter to pay and the need to conserve resources, reduce consumption and recycle and reuse material to the maximum extent possible*" while 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 NPE recognises the need to develop and promote alternative energy sources to reduce the use of fuel-wood and enhance carbon-sinks (*Section 11: c*). Specific objectives of the NPE include but are not limited to:

- Promote the sound protection and management of Zambia's environment and natural resources in their entirety, balancing the needs for social and economic development and environmental integrity to the maximum extent possible, while keeping adverse activities to the minimum; and

- Accelerate environmentally and economically sustainable growth in order to improve the health, sustainable livelihoods, income and living conditions of the poor majority with greater equity and self-reliance.

Other strategies relevant to the proposed Project include:

- Ensure that plans for development and construction of industries have adequate and appropriate waste disposal and pollution control facilities organised to meet international standards;

- Ensure that plans and incentives for voluntary waste disposal are enshrined in the production plans of all industries; and

- Promote use of environmental guidelines and EIA before sites are developed and ensure application of a monitoring and auditing system for operating industries.

Zambia Vision 2030

Vision 2030 expresses Zambia's aspirations in respect of economic growth, good governance and developing its people. One key basic principle of Vision 2030 is sustainable development. The vision is supported by key goals to ensure that by the year 2030:

- Zambia's rural and urban population has universal access to clean, reliable and affordable energy by the use of alternative, renewable energy sources such as hydropower.
- There is an upgrade of existing and construction of new infrastructure by developing and implementing private- public partnerships with both local and international industries.
- Zambia's biodiversity is protected in numerous national parks and local forest reserves. There is maintenance of a productive environment and well conserved natural resources to facilitate sustainable socio-economic development.
- There is effective utilisation of fresh water resources for a variety of purposes whilst maintaining the quality of the source.

Seventh National Development Plan 2017 - 2021

The Seventh National Development Plan (SNDP) aims to accelerate development efforts towards Vision 2030. The objectives of the SNDP are:

- Infrastructure development;
- Economic growth and diversification;
- Rural investment; and
- Poverty reduction and the enhancement of human development.

The SNDP contains sector plans that aim to assist in achieving these objectives. The sector plans most relevant to the Project and their objectives are summarised below.

Energy Sector Plan

- To increase electricity generation capacity by at least 1,000 MW and build appropriate transmission lines.
- To increase electrification levels in rural areas of Zambia to 15 %, particularly in the Central Province.
- To expand the use of renewable and alternative energy in the country's energy mix.
- To reduce greenhouse gas emissions from the energy sector and strengthen adaptation and resilience to climate change related stresses.

Water Sector Plan

- To achieve sustainable water resource development for social and economic development.
- To develop innovative approaches and appropriate technologies for the effective management of the nation's water resources.

Southern Province Regional Development Plan: 2011 - 2015

The Southern Province Regional Development Plan (as set out within the SNDP) provides for a variety of sector specific strategies and programmes to be achieved in the SNDP period. The objectives of some of these strategies and programmes applicable to the Project include:

- Infrastructure development for the movement of goods and services;
- Connecting rural areas to electricity power supply; and
- Expanding and improving infrastructure for electricity generation, transmission and distribution.

Energy White Paper (February 2010)

A national energy study was implemented by Chubu Electric Power Co., Inc. from November 2008 to February 2010, in order to formulate a countrywide power system development master plan. The study was undertaken cooperatively with the Zambian Ministry of Energy and Water Development.

The objectives of the study were to inform the Power System Development Master Plan until 2030, coordinating generation, transmission, and an interconnection plan for the stabilization of the power supply for Zambia and the southern African community. In addition to this, the study was intended to transfer technical skills.

4.4 *ZIMBABWEAN INSTITUTIONAL FRAMEWORK*

4.4.1 *Ministry of Environment, Tourism and Hospitality Industry*

The ministry with overall responsibility for environmental management in Zimbabwe is the Ministry of Environment, Tourism and Hospitality Industry, formerly known as the Ministry of Environment, Water and Climate, which was once the Ministry of Environment and Natural Resource Management, and the Ministry of Mines, Environment and Tourism. Among other pieces of legislation, the Minister of Environment, Water and Climate, through the Environmental Management Act (No. 13 of 2002), is mandated to:

- Regulate the management of the environment and promote, coordinate and monitor the protection of the environment and the control of pollution.

- Regulate the activities of all government agencies and other agencies in terms of their impact on the environment.

- Present to Parliament a report on the state of the environment every five years.

- Monitor the environment, trends in the utilisation of natural resources, and the impact of such utilisation on the environment.

- Coordinate the promotion of public awareness and education on environmental management.

- Ensure that persons and institutions responsible for causing environmental harm meet the cost of remedying that harm.

- Formulate policies for environmental management and facilitate their implementation.

- Recommend to the government which international and regional conventions and treaties on the environment Zimbabwe should become a party to, and secure their incorporation into domestic law.

Environmental management is regulated by three related agencies in the Ministry of Environment, Tourism and Hospitality Industry namely the National Environmental Council (NEC), the Environmental Management Agency (EMA) and the Environment Management Board (EMB).

National Environmental Council (NEC)

The functions of the NEC are as follows:

- Give advice on policy formulation and provide directions on the implementation of the Zimbabwean EMA.

- Give advice on national goals and objectives for the protection of the environment.

- Promote cooperation among public departments, local authorities, the private sector, non-governmental organisations and other organisations that deal with environmental issues.

- Review and recommend to the Minister guidelines for environmental management plans and environmental action plans.

- Review national environmental policies, plans and strategies.

Environmental Management Agency

The Environmental Management Act (No. 13 of 2002) provides for the establishment of the Zimbabwean Environmental Management Agency (EMA), formerly known as the Department for Natural Resources. The Agency is responsible for:

- Formulating quality standards on air, water, soil, noise, vibration, radiation and waste management;

- Assisting and participating in any matters pertaining to the management of the environment, such as:

  - Developing guidelines for National Plans, environmental management plans and local environmental action plans;

- Regulating and monitoring the collection, disposal, treatment and recycling of waste;

- Monitoring and regulating the discharge or emission of pollutants or hazardous substances into the environment;

- Keeping records in the form of registers of all licences and permits issued under the law;

- Monitoring and regulating the control of invasive alien species;

- Regulating, monitoring, reviewing and approving EIAs;

- Regulating and monitoring the management and utilisation of ecologically fragile ecosystems;

- Making bylaws within the jurisdiction of local authorities;

- Advising government on conventions and treaties that should be incorporated into national law;

- Coordinating the production of a five-year State of the Environment Report (SOER);

- Developing and implementing incentives for the protection of the environment;

- Carrying out periodic environmental audits of any projects, including projects whose implementation started before a fixed date, to ensure that their implementation complies with the requirements of the Act;

- Regulating and monitoring access by any person to biological and genetic resources; and

- Making recommendations to the Minister on the formulation of any regulations.

Environment Management Board

The Zimbabwean EMA is controlled and managed by the Environment Management Board (EMB), which is composed of experts from the areas of environmental planning and management, environmental economics, ecology, pollution, waste management, soil science, hazardous substances, water and sanitation. In addition, there is a legal representative and a secretary to the Ministry responsible for the environment.

Department of Water

The Department of Water within the Ministry is responsible for the oversight of the water sector. The functions of the Department include:

- Formulate and implement sustainable policies on the development, utilization and management of water resources in cooperation with user communities and institutions.

- Design, construct and maintain medium to large size dams and water supplies to satisfy present and future domestic, industrial and mining water requirements.

- Provide clear/treated water for urban areas in consultation with the Ministry of Local Government, Public Works and Urban Development.

- Design, construct and maintain dams, weirs and boreholes to meet present and future irrigation requirements.

- Take responsibility for the overall/national planning, management, regulation and standardisation of irrigation development and adoption of appropriate technology.

- Design, construct, maintain and manage irrigation schemes and projects.

- Develop sustainable underground water resources in consultation with the Ministry of Rural Housing and Social Amenities.

- Manage the water resources of the country (water in rivers, dams and ground water).

- Set tariffs for raw water, treated water and irrigation water in consultation with other line ministries, consumers and stakeholders.

- Manage and administer the Water Fund through the Zimbabwe National Water Authority.

- Oversight of the District Development Fund[1].

- Administer the Rural Capital Development Fund.

- Participate in the development and implementation of Southern African Development Community (SADC) and other regional and international organisations' water resources management frameworks.

[1] Note that the District Development Fund now falls under the Office of the President and Cabinet, who is responsible for its administration.

The Zimbabwe National Water Authority (ZINWA)

ZINWA is a parastatal, which acts as an operator and a regulator. ZINWA is responsible for the following functions at the national level:

- Water planning and implementation;
- Management of public dams;
- Supply of bulk water to the agriculture, industrial and mining sectors;
- Supply of bulk water to urban centres; and
- Coordination and supervision of the seven catchment councils.

ZINWA is responsible for water supply to urban centres, while the municipalities supply water to smaller urban settlements. Rural water supply and sanitation is coordinated by the National Action Committee for Water and Sanitation, which is an inter-ministerial committee chaired by the Minister of Local Government. Separating rural and urban domestic water supply into different ministries was identified by SADC (2003a) as leading to the rural water supply perspectives being isolated from the national water program.

The seven Catchment Councils (Gwayi, Manyame, Save, Runde, Mazowe, Sanyati and Mzingwane) established under the Zimbabwe National Water Authority Act are responsible for all aspects of water management within their responsive catchment areas. The Catchment Managers are employees of ZINWA, and not employed by the Catchment Council, which hinders the devolution of authority. Sub-Catchment Councils are under Catchment Councils and Water User Boards are the lowest tier.

4.4.2 *Ministry of Energy and Power Development*

The Ministry is the administering authority in regards to energy and power development in Zimbabwe. The Ministry comprises the following departments:

- Petroleum;
- Power Development;
- Policy And Planning;
- Energy Conservation and Renewable Energy;
- Finance Human Resources and Administration;
- Legal Services; and
- Internal Audit.

The Power Development Department

The Power Development Department is one of the technical departments of the Ministry. Its main role is to facilitate the improvement of availability of electricity to the populace, as well as the attainment of self-sufficiency in electricity generation. The achievement of the strategic goals is centred on the effective administration of the utilities under the Department's purview namely ZESA Holdings (Pvt) Ltd and its subsidiaries: Zimbabwe Power Company

(ZPC), Zimbabwe Electricity Transmission and Distribution Company (ZETDC), ZESA Enterprises (ZENT); the Rural Electrification Agency (REA); Zimbabwe Electricity Regulatory Commission (ZERC) and Zambezi River Authority (ZRA) which is a bilateral body owned by Zimbabwe and Zambia.

The Zimbabwe Energy Regulatory Authority

The Zimbabwe Energy Regulatory Authority (ZERA) was created in September 2011 following the promulgation of the Energy Regulatory Act (No. 3 of 2011). Its primary mandate is to regulate the Energy Sector in Zimbabwe. The functions of ZERA include:

- Regulatory and Licensing:
    - To regulate the procurement, production, transportation, transmission, distribution, importation and exportation of energy derived from any energy source.
    - To exercise licensing and regulatory functions in respect of the energy industry.
    - To ensure that prices charged by licensees are fair to consumers in the light of the need for prices to be sufficient to allow licensees to finance their activities and obtain reasonable earnings for their efficient operation.
    - To establish or approve operating codes for safety, security, reliability, quality standards and any other sector related codes and standards for the energy industry or any sector thereof.
    - To maintain and promote effective competition within the energy industry.
- Research and development:
    - To promote and encourage the expansion of the energy industry and the advancement of technology relating thereto.
    - To promote, identify and encourage the employment and development of sources of renewable energy.
    - To undertake such other thing that it considers is necessary or convenient for the better carrying out of or giving effect to the functions of the Authority.

- To increase access and security of supply:

  - To promote the procurement, production, transportation, transmission and distribution of energy in accordance with public demand and recognised international standards.
  - To ensure the maximisation of access to energy by all consumers that is affordable and environmentally sustainable.

  - To create, promote and preserve an efficient energy industry market for the provision of sufficient energy for domestic and industrial use.

  - To promote coordination and integration in the importation, exportation and pooling of energy from any energy source in the SADC and the Common Market for Eastern and Southern Africa (COMESA) region.

- Energy efficiency and environmental protection:

  - To advise and educate consumers and licensees regarding the efficient use of energy.

  - To assess, promote studies of and advise the Minister and licensees on the environmental impact of energy projects before licensing.

- Key stakeholder advisory role:

  - To advise the Minister on all matters relating to the energy industry.

  - To establish appropriate consumer rights and obligations regarding the provision of energy services.

  - To arbitrate and mediate disputes among and between licensees and consumers.

  - To represent Zimbabwe internationally in matters relating to the energy industry.

4.4.3 National Museums and Monuments of Zimbabwe

National Museums and Monuments of Zimbabwe (NMMZ) is Zimbabwe's premier heritage organization established under the National Museums and Monuments of Rhodesia Act, 1972 which is now called the National Museums and Monuments Act (No. 17 of 1972). NMMZ is a Parastatal, funded through grant by Central Government and previously falling under the Ministry of Home Affairs. In 2015 a new Ministry of Rural Development, Preservation and Promotion of Culture and Heritage was established, under which the NMMZ now falls. The Act established a Board of Trustees to provide for the establishment and administration of museums' and to provide for the preservation of ancient, historical and natural monuments, relics and other objects of historical or scientific value or interest.

The NMMZ is granted authority over all sites and structures of cultural, specified scientific, historical, archaeological and palaeontological significance. They set standards for reporting, evaluation and notification and should be consulted in advance of the implementation of any archaeological fieldwork undertaken in mitigation of the BGHES proposals.

4.4.4 *Other Line Ministries*

Due to the cross-sector impacts of the Project other Ministries and Agencies are also of relevance, such as:

- Ministry of Health and Child Care;
- Ministry of Industry and Commerce;
- Ministry of Lands, Agriculture and Rural Resettlement;
- Ministry of Local Government, Public Works and National Housing;
- Ministry of Public Service, Labour and Social Welfare; and
- Ministry of Transport and Infrastructure Development.

4.5 *ZIMBABWEAN ENVIRONMENTAL AND SOCIAL LAWS AND REGULATIONS*

4.5.1 *The Environmental Management Act (the Act) (Chapter 20:27), No. 13 of 2002*

The Zimbabwean Environmental Management Act (the Act) (Chapter 20:27), No. 13 of 2002, was enacted in 2002 and amended on March 25, 2006 and April 17, 2011. It aims to 'provide for the sustainable management of natural resources and protection of the environment; [and] the prevention of pollution and environmental degradation'.

The Act also provides for the establishment of the EMA and an Environmental Fund. The Act repeals the following former Acts:

- Natural Resources Act (Chapter 20:13);
- Atmospheric Pollution Prevention Act (Chapter 20:03);
- Hazardous Substances and Articles Act (Chapter 15:05); and
- Noxious Weeds Act (Chapter 19:07).

The Act is a general legislative framework and does not cover every environmental aspect. It is a framework law, which will be complemented by other laws and policies that are not in conflict with it. However, where there are conflicts, this Act will take precedence. The law will be supported by the setting up of the proposed institutions and the promulgation of Regulations by the Minister. Nevertheless, the Act provides the general environmental principles that should be followed in environmental management.

The provisions of the Zimbabwean EMA that relate to EIAs in particular are set out in Section 97 of the Act and summarised below:

- A person who proposes to embark on any of the projects listed in the First Schedule (prescribed activities) is expected to submit an EIA report to the Director-General.

- The developer can only embark on the project if s/he has obtained a certificate from the Director-General.

- Before undertaking an EIA study, the developer is expected to submit a prospectus to the Director-General with information on the assessment and the project.

- It is an offence for any person to knowingly implement a prescribed activity without a certificate showing that an EIA has been carried out and approved.

Some of the activities, land-use changes and sectors in which EIAs should be carried out include:

Activities
- Dams and man-made lakes;
- Drainage and irrigation;
- Housing developments;
- Tourist resorts and recreational developments;
- Waste treatment and disposal; and
- Water supply.

Land-use Changes
- Conversion of forest land into other use;
- Conversion of natural woodland to other use within the catchment area of reservoirs used for water supply, irrigation or hydropower generation or in areas adjacent to parks and wildlife estates.

Sectors
- Industry and Manufacturing;
- Mining and quarrying;
- Petroleum production, storage and distribution;
- Power generation and transmission.

4.5.2 *Environmental Management (Environmental Impact Assessments and Ecosystems Protection) Regulations, SI 7 of 2007*

The Environmental Management (Environmental Impact Assessments and Ecosystems Protection) Regulations (EIA Regulations) deal with the regulation of the EIA process and the protection of ecosystems. Part 11 of the Act stipulates that no industrial project shall be implemented without an EIA having been done. These Regulations provide the methodology for undertaking the EIA. Before undertaking an EIA study, the developer has to submit a prospectus to the EMA (see section 16.4.1), whom will advise the developer by way of letter to proceed with the EIA study should the prospectus be deemed satisfactory. The prospectus has to contain details of the environmental impacts of the project and the measures to be taken to contain or mitigate such impacts. In preparing an EIA, a developer is obliged to consult widely with all stakeholders. The EMA will not issue a licence if it is not satisfied that the developer consulted with all stakeholders in the preparation of the prospectus. It should also be noted that projects that began before the Act was promulgated are subject to periodic environmental audits by the EMA.

Section 10 (4 to 7) of the EIA Regulations state the following:

- Before any EIA report is furnished to the Director-General, the developer shall carry out wide consultations with stakeholders.

- During review of the prospectus and EIA report, the Director-General shall verify whether full stakeholder participation was undertaken when the EIA report was prepared (1).

- Expenses associated with the stakeholder consultation process should be borne by the developer.

- The Director-General may advertise in the print and electronic media when a prospectus or EIA report is being reviewed.

Since the Regulations do not stipulate the manner in which the consultation of stakeholders should be carried out or which stakeholders should be engaged, the requirements of international good practise and inclusivity have driven the BGHES ESIA stakeholder engagement process to date.

4.5.3 *Environmental Impact Assessment Policy (1997)*

In 1997, the then Ministry of Mines, Environment and Tourism published the Environmental Impact Assessment Policy. The goal of the policy is to encourage environmentally responsible investment and development in Zimbabwe. The policy views the EIA process as key to achieving this goal.

To support the 1997 Environmental Impact Assessment Policy, the Ministry published EIA Guidelines to facilitate the implementation of the EIA process. These guidelines are presented as 10 Volumes.

(Please note that guidelines are information documents and therefore do not have the same legal status as a law. The EIA Guideline has been included here as it is of direct

(1) Note: Proof of stakeholder consultation must be included in the EIA report (these include letters confirming public consultation from relevant Government Agencies). Obtaining proof of consultation from the relevant Government Agencies can be time consuming (and in some cases these Agencies request payment).

relevance to the EIA process and therefore this Chapter. Other guidelines have been omitted as they are considered beyond the ambit of this Chapter.)

Volume 1 provides guidance on the EIA Policy and General Guidelines under the following topics:

- Administering the EIA Policy;
- Preparing Terms of Reference (ToRs);
- Preparing EIA Reports;
- Consulting the Public [(1)];
- Environmental Management; and
- Evaluating the adequacy of EIA Reports.

In terms of consulting the public, Section 5 provides guidelines for the stakeholder consultation programme.

Volumes 2 to 10 provide guidance on sector-specific EIAs and cover the following sectors:

- Mining and quarrying
- Forestry
- Agriculture
- Transport
- Energy
- Water
- Urban infrastructure
- Tourism.

For each of these sectors, the guidelines provide examples of major activities that are likely to be undertaken for projects in that sector, the type of environmental impacts, possible measures for managing such impacts, sample Terms of Reference, and sources of information for use in an EIA study.

Volume 6: Energy is further differentiated into the sub-sectors of thermal power, hydropower and transmission lines. The last two sub-sectors are relevant in this case and the major activities typically related to each are listed in detail. These listings are presented for the planning, construction and operation phases respectively, and according to the types of major impacts, namely physical, biological, social and economic.

The EIA Guideline *Volume 6: Energy* was compiled from a review of international literature. Consequently, it can be understood to represent international best practice. Since the current ESIA is being undertaken

(1) According to the Environmental Impact Assessment Policy, public consultation is an integral component of the EIA process, and includes three principal elements:

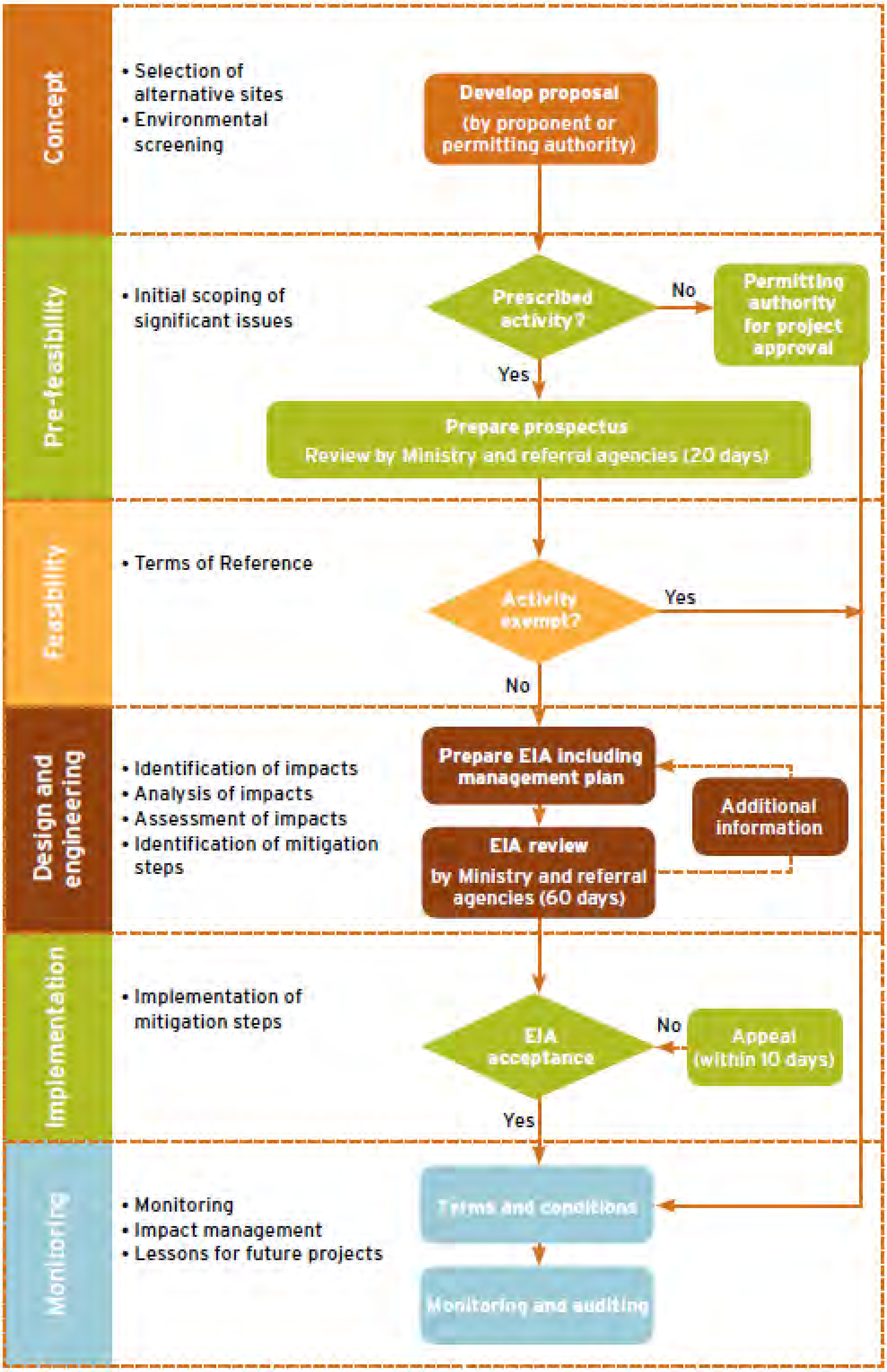
- Proponents are required to conduct public participation during the preparation of EIA reports;
- During the review of draft EIA reports, the Environment Management Board may conduct public meetings on an activity where warranted; and
- EIA documents will be available for public review and comment.

according to international guidelines and standards prescribed by the IFC and World Bank, meeting the expectations of the EIA Guideline *Volume 6: Energy* is self-evident and can be assured. In addition, the guidelines are supported by various appendices, which provide guidance on preparing ToRs, EIA methods, sources of information, etc.

The guidelines are used by Government authorities, developers and EIA practitioners as they provide valuable assistance with carrying out EIAs, guidance on the review of EIAs and the implementation of the EIA recommendations. In addition, the guidelines contribute to improving the quality of sector-specific EIAs.

The EIA Process in generalised terms is outlined in *Figure 4.2* below.

Table 4-3 Zimbabwean EIA Process Diagram



Source: SAIEA (2012)

4.5.4 *Other Relevant Environmental and Social Legislation in Zimbabwe*

Environmental issues cut across a wide variety of sectors, and as such there are numerous pieces of legislation in Zimbabwe, which have a bearing on the environment and should be considered in EIA decision-making.

Table 4-4 presents a summary of the most relevant Zimbabwean national legislation which may be applicable to the Project.

Table 4-4 Summary of Relevant Zimbabwean Environmental and Social Legislation

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
Environmental			
Water Resources	• *Water Act, 2003 (Chapter 20:24)*	*This Act updates the Water Act, No. 31 of 1998. It stipulates that the National Water Authority and Catchment Councils shall prepare an Outline Water Development Plan for each river system. The Act makes provision for the formation of Catchment Councils, which shall issue water use permits in terms of the Act. Such permits are valid for a period of 20 years unless otherwise stated by the relevant Catchment Council.*	*The Water Act prescribes certain measures in relation to the safety of dams and dam works. These should be taken into account at the dam design stage. The measures include:* • *Dam works can only commence once an approved engineer and other subject specialists have: prepared a dam design (together with plans and specifications); certified the safety and adequacy of the proposed dam works; the Secretary of National Water Authority has approved plans.* • *Appoint an approved civil engineer to prepare maintenance and operations instructions and such instructions need to be adhered to. This should include the requirement to submit detailed measurements and observations to the authorities at prescribed intervals.* • *Develop an emergency procedure to cater for any sudden or unprecedented flood or alarming or unusual circumstance or occurrence.* • *Should an emergency/ danger arise during dam works to the works or structure; immediate steps must be taken to address this even if there is no authorisation therefore in terms of section 99 and/ or 102. Such activity needs to be reported to the Secretary of the National Water Authority within 14 days after taking any action necessary to address the emergency/ danger.* • *This is the responsibility of the proponent and therefore is beyond the scope of this report.*
	• *Zimbabwe National Water Authority Act, 1998 (Chapter 20:25)*	*Establishes the Zimbabwe National Water Authority and to provide for its functions. Provides for the appointment and functions of a board of the Authority and for the raising of charges for the provision of water and other services by the Authority. In addition, the Act provides for the funds of the Authority and the imposition and*	*Administrative in nature and therefore no direct legal obligations imposed upon project proponent. However, the National Water Authority should be included in Environmental and Social Impact Assessment consultations as an interested and affected party.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
		collection of a water levy. The Act also repealed the Regional Water Authority Act.	
Wildlife and Natural Resources	• *Forest Act, 1948 (Chapter 19:05)*	*Provides for demarcating forests and nature reserves, conserving timber resources, regulating trade in forest produce, and regulating the burning of vegetation.*	*The ESIA and ESMPs have considered demarcated forest areas.*
	• *Parks and Wildlife Conservation Act, 1975 (Chapter 20:14)*	*Provides for the establishment of national parks, botanical reserves and gardens, sanctuaries, safari areas and recreational parks; provides for the conservation and control of wildlife, fish and plants; and designates specially protected animals and indigenous plants.*	*The ESIA has considered protected fauna and flora within protected areas listed in this Act (i.e. Parks and Wildlife Estates; National Parks; Botanical Reserves and Gardens; Sanctuaries; and Recreational Parks).*
	• *Communal Land and Forest Produce Act, 1988 (Chapter 19:04)*	*Controls the use of wood resources within communal lands. Such resources are only for the domestic use of the residents.*	*The ESIA considers trees situated upon communal lands that may be impacted by project activities as the local communities have use rights with regard to the use of trees. Compensation will be assessed as part of the Resettlement Action Planning process.*
Fisheries and Wetlands	• *GN 380 of 2013 (Protection of Wetlands) per Section 113 of the Environmental Management Act*	*This Section of the Act includes provisions for the protection of wetlands in Zimbabwe. Such controls include the preservation of beds, banks; controlling stormwater; restrictions of removing clays and deposits from wetlands; reducing pollution of any kind to wetlands and restoration of wetlands.*	*The management of surface water quality, aquatic environments (including aquatic vegetation) and terrestrial ecology (including fauna utilising wetland habits) has been considered in this ESIA.*
Noise and Vibration	• *The Environmental Management Act (the Act) (Chapter 20:27), No. 13 of 2002*	*Sections 79 to 81 (in Part IX of the Act) provide requirements around noise management. More specifically, the Act mentions the need for standards to be established for the emissions of noise and vibration pollution. Section 80 mentions that any person who emits noise in excess of the noise emission standards prescribed in terms of section seventy-nine shall be guilty of an offence.* *No reference to noise standards could be sourced and it appears as if these do not yet exist.*	*The ESMPs associated with this ESIA include noise mitigation measures.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
Air	• *Air Pollution Control Regulations SI 72, 2009 of the Environmental Management Act of 2002*	*Provides for prevention, control and abatement of air pollution to ensure clean and healthy ambient air. It provides for the establishment of emission standards for various sources such as mobile sources (e.g. motor vehicles) and stationary sources (e.g. industries) as outlined in the Air Pollution Control Regulations SI 72, 2009. It also covers any other air pollution source as may be determined by the Minister in consultation with the Environmental Management Agency.*	*The ESIA considers possible emission sources associated with proposed project activities and that they are below the prescribed emission standards. This may relate to, for example, motor vehicles and generators used during construction activities. As such, air pollution control measures have been included in the ESMPs.*
	• *The Environmental Management Act (the Act) (Chapter 20:27), No. 13 of 2002*	*Air quality standards*	*Section 63 of the Act mentions that ambient air quality standards need to be established.*
	• *Draft Air Quality and Emission Standards (draft number EN 005 - D977/2) of the Environmental Management Act of 2002*		*These have not been enacted; however, Section 4 of these draft standards provides ambient air quality in Zimbabwe. Moreover, Section 7 provides limit values for vehicle emissions.*
Waste	• *Effluent and Solid Waste Disposal Regulations SI 6, 2007 of the Environmental Management Act of 2002*	*Regulates the disposal of waste (solid waste and effluent). Implements the polluter pays principle through licensing which is according to four classes.*	*The ESIA and ESMPs consider activities that will result in disposal of waste into water sources. Such activities may require a license; however, the details of obtaining such a license are beyond the scope of this report.* *In addition, the ESIA and ESMPs consider the potential waste generated from project activities.*
	• *Hazardous Waste Management Regulations SI 10, 2007 of the Environmental Management Act of 2002*	*Provides for the licensing for generation, storage, use, recycling, treatment, transportation or disposal of hazardous waste. Regulates waste collection and management by local authorities. In addition, regulates the importation and exportation of hazardous waste and waste oils.*	*The ESIA considers the generation of hazardous wastes and the ESMPs include measures to include such wastes in the waste management plan and ensure that they are adequately licensed, stored, handled and transported.*
Explosives	• *Explosives Act (Chapter 10:08)*	*An Act to make further and different provision for regulating and controlling the possession, purchase, acquisition, delivery, manufacture, storage, use, conveyance and handling of explosives; and to provide for matters connected with or incidental to the foregoing.*	*The ESIA and ESMPs consider explosive related activities. The use and storage of explosives is dealt with in the ESMPs.* *Licenses for the use and storage of explosives may need to be obtained. The licensing process is beyond the scope of this Chapter.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
	• *Statutory Instrument No. 109 of 1990 (Mining (Management and Safety) Regulations of the Mines and Minerals Act of 1961*	*The Regulation provides requirements for the surface protection and protection of working places associated with mining works. Mining can be defined as a process of extracting or obtaining minerals, and any process directly (or indirectly) connected therewith.*	*Accordingly the requirements included in this Regulation will be of relevance to the Project Quarries.*
Hazardous Substances, Pesticides and Toxic Substances	• *Statutory Instrument No. 268 of 2018 of the Environmental Management Act of 2002*	*Provides for registration fees for manufacturers, importers, storage and users of hazardous substances per facility: manufacturer, importer, seller of hazardous substances*	*The ESIA considers the use of hazardous substances during project related activities. Such substances need to be managed through their inclusion in the ESMPs. Management provisions should include the obligation to ensure that no person packages hazardous substance (e.g. fuel) in a container unless the container and its closure:* • *Will not react chemically or physically with hazardous substances which it is to contain; and* • *Are of sufficient strength, under the ordinary risk of handling and transporting, to prevent the escape of its contents.*
Energy			
Energy	• *Electricity Act (Ch 13:19)*	*Provides for the establishment of the Zimbabwe Electricity Regulatory Commission and provides for its functions and management. Also provides for the licensing and regulation of the generation, transmission, distribution and supply of electricity.*	*This Act includes licensing provisions relating to the generation, transmission, distribution and supply of electricity. The licensing process is beyond the scope of this report.*
	• *Energy Regulatory Act (Chapter 13:23)*	*Provides for the creation of the Zimbabwe Energy Regulatory Authority (ZERA) and regulates the energy sector and other sections not provided for by the energy laws, the Electricity Act (13:19) and Petroleum Act (13:22). The Energy Regulatory Act repealed some sections especially those related to the formation of the regulatory institutions in the Electricity Act (Chapter 13:19) and Petroleum Act (Chapter 13:22). The mandate of ZERA is to regulate the Energy Sector in Zimbabwe.*	*This Act includes licensing provisions relating to the generation, transmission, distribution and supply of electricity. The licensing process is beyond the scope of this Chapter.*
Socioeconomic, Archeology and Cultural Heritage			
Health and Safety	• *Public Health Act (Ch 15:09)*	*Provides for the establishment of the Zimbabwean public health system.*	*The ESIA considers health issues relating to potential diseases and sanitary conditions relating to the handling of food during project activities .The ESMPs include measures such as the obligation to:*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
			• *Notify the health authorities of an infectious disease and/ or any formidable epidemic disease outbreak in on-site residents.* • *Ensure that persons involved with the handling of food do not suffer from known infectious diseases.* • *Ensure that residents that contained a person's suffering from an infectious disease are efficiently disinfected before allowing access thereto.* • *Ensure that all food made available on-site is prepared and kept in a sanitary manner.*
	• *Plant Pests and Diseases Act, 1959 (Chapter 19:08)*	*The Act provides for the eradication and prevention of the spread of plant pests and diseases.*	*The ESIA considers potential plant pests and diseases and the ESMPs include steps necessary for the eradication, reduction or prevention of the spread of pests.*
	• *Factories and Works Act (Chapter 14:08)*	*This Act provides for the registration and control of factories, the regulation of conditions of work in factories, supervision of the use of machinery and precautions against accidental injury to persons employed on structural work.*	*This provisions of this Act have been considered in the ESIA and associated ESMPs with respect to the management of occupational health and safety of workers.*
	• *Pneumonoconiosis Act (Chapter 15:08)*	*This Act provides for the control and administration of persons employed in dusty occupations; and to provide for matters incidental to or connected with the foregoing. Part V of the Act requires that workers employed in dusty occupations have a current medical certificate. Part VI of this Act requires registration of employees working in dusty occupations in Zimbabwe. This register needs to include the date of engagement; the date of discharge; the nature of the worker's duties; the wages and allowances paid to the worker from time to time; the date of the last medical examination performed under this Act; the number and date of expiry of the current certificate. Part VI includes general provisions relating to worker benefits.*	*The provisions of this Act have been considered in the ESIA and associated ESMPs with respect to the management of occupational health and safety of workers.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
	• *Mining (Management & Safety) Regulations (S.I 109 of 1990) of the Mines and Minerals Act 1961*	*The regulation provides an interpretation of mining to be (amongst others), the extracting of any mineral by any mode or method. Part II and II of the regulation provide conditions for the protection of mines and safety requirements for mines.*	*The provisions of these Regulations have been considered in the ESIA and associated ESMPs.*
	• *Mining (Health & Sanitation) Regulations (S.I. 185 of 1995) of the Mines and Minerals Act 1961*	*Part I of this Regulation provides general health and sanitation requirements for mines in Zimbabwe, including (amongst others) the disposal of refuse; provisions for latrines; medical care and treatment of employees; and sanitation provisions. Part II of the Regulation includes (amongst others) provisions for accommodation of employees and other health aspects for employees.*	
Archaeological, Historical and Cultural	• *National Museums and Monuments Act (Chapter 25:11)*	*Zimbabwean legal requirements for the protection of cultural heritage is set out in the National Museums and Monuments of Zimbabwe (NMMZ) Act Chapter 25 (11), supported by various Statutory Instruments. The most recent additional legislation, Statutory Instrument 143 of 2011, must be read in conjunction with the institutional recommendations contained in a 1998 NMMZ publication entitled 'Archaeological Impact Assessments:* *Guidelines for Planning Authorities and Developers'.* *The Act established a board of trustees to administer museums and monuments in Zimbabwe; to provide for the establishment and administration of museums; to provide for the preservation of ancient, historical and natural monuments, relics and other objects of historical or scientific value or interest; to provide for the payment of pensions and other benefits to members of the staff of the board of trustees; and to provide for matters incidental to or connected with the foregoing.*	*The ESIA considers potential cultural heritage that may be affected by project activities. Should such items be discovered, the ESMPs include the obligation to notify the Trustees of the National Museums and Monuments ("the Board") upon discovery of any ancient monument or relic and to ensure that no excavation, alteration, or removal of monuments takes place without written consent of the Board.*
Land use planning issues	• *Communal Land Act (Chapter 20:04)*	*Provides for the classification of land in Zimbabwe as Communal Land and for the alteration of such classification; to alter and regulate the occupation and*	*The ESIA considers the possible impacts upon communal land including water use rights within such areas. Should such rights be interrupted the ESMPs make provision for due compensation to be given to affected parties.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
		use of Communal Land; and to provide for matters incidental to or connected with the foregoing.	
	• *Rural District Councils Act, 1989 (Chapter 29:13)*	*Provides for the establishment of Rural District Councils responsible for initiating and regulating development in rural areas.*	*The ESIA considers whether project activities will impact upon Rural District Council areas and, the ESMPs include the obligation to adhere to the By-laws developed by Rural District Councils.*
	• *Regional Town and Country Planning Act [Chapter 29:12]*	*Regulates regional planning and provides for the functions of Regional Planning Councils. The Act confers the land-use planning function on urban local authorities and regulates the development of master and local plans; subdivisions, consolidation, acquisition and disposal of land.*	*The ESIA considers whether project activities may impact upon any land which is designated as a park, wildlife and/ or forest lands. Moreover, the ESMPs include mitigation measures to manage the impact upon such areas.*
	• *Roads Act (Chapter 13:18)*	*Provides for the regulation of the standards applicable in the planning, design, construction, maintenance and rehabilitation of roads with due regard to safety and environmental considerations. Provides for road authorities and their functions and for the regulation of the erection of structures or the carrying out of works near certain roads, the entry upon roads from certain land and the acquisition of land and materials for road works.*	*The ESIA considers roads that may be impacted upon by project activities. The ESMPs include measures for unauthorised structures that affect the use of roads are removed and that authorisation is obtained for any road closures, diversions, obstructions etc.*
	• *Traditional Leaders Act (Chapter 29:17)*	*An Act to provide for the appointment of village heads, headmen and chiefs; to provide for the establishment of a Council of Chiefs and village, ward and provincial assemblies and to define their functions; to provide for the issue of village registration certificates and settlement permits. The Act also provides for the repeal of the Chiefs and Headmen Act (Chapter 29:01) and amends: the Criminal Procedure and Evidence Act (Chapter 9:07); the Communal Land Act (Chapter 20:04); and the Rural District Councils Act (Chapter 29:13).*	*The ESIA considers whether any tradition communities will be impacted by project related activities and, if so, that they are included in all consultations and the roles of these traditional leaders acknowledged through the consultation process.*
	• *Rural Land Act (Chapter 20:18)*	*An Act to provide for the acquisition of State land and the disposal of State land; to provide for the control of the subdivision and lease of land for farming or other purposes; to provide for limiting of the number of pieces of land that may be owned by any person and the sizes of*	*The ESIA considers the possible project activity impacts on rural land and the ESMPs include provisions for development and implementation of a Resettlement Action Plan, which should take into account the provisions of this Act.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
		such land, and for prohibiting or restricting the rights of non-residents to own, lease or occupy land in Zimbabwe, and to provide for other matters incidental to and connected with the foregoing.	
	• *Rural Land Occupiers (Chapter 20:26) (Protection from Eviction) Act 2002*	*Provides for the protection of certain occupiers of rural land from eviction, and regulates matters connected therewith or incidental thereto.*	*The ESIA considers the possible project activity impacts on rural land and the ESMPs include provisions for development and implementation of a Resettlement Action Plan, which should take into account the provisions of this Act.*
Mining Regulations			
Quarries and Borrow Pits	• *Mines and Minerals Act 1961 (Chapter 21:05)*	*Regulates the acquisition of mining rights, prospecting for and extraction of minerals, and decommissioning of mining works.*	*The ESIA considers any potential mining or quarry related activities and the ESMPs provide for measures to mitigate the impacts thereof.* *Please note that such activities will require licenses; however, the associated process is beyond the scope of this report.*
	• *Environmental Management (Environmental Impact Assessments and Ecosystems Protection) Regulations SI 7 of 2007 of the Environmental Management Act of 2002*	*Prohibits extraction, possession, transportation of sand and clay deposits for commercial purposes without a license issued by the Agency. This Statutory Instrument also provides for prevention of veld fires, protection of wetlands and public streams.*	*The ESIA and ESMPs consider the potential extraction, possession, transportation of sand and clay deposits; and the potential for activities to result in veld fires or the degradation of wetlands and/ or public streams.* *Please note that the extraction, possession, transportation of sand and clay deposits for commercial purposes will require a licence. The licensing process is beyond the scope of this report.*
Investments, Energy Regulation, and Development			
Tourism	• *Tourism Act (Chapter 14:20)*	*An Act to establish a Zimbabwe Tourism Authority and to provide for its functions; the appointment and functions of a board of the Authority; to establish a Zimbabwe Tourism Fund; the appointment of a Chief Executive of the Authority, licensing officers and other officers; the designation, registration and grading of tourist facilities and for the licensing of persons who provide services connected with tourism; the imposition and collection of levies in respect of designated tourist*	*The ESIA considers project activity impacts on the tourism industry and the ESMPs include measures for the management of such impacts as far as is reasonably possible.*

Component	Applicable Legislative Instrument	Description of Legislative Instrument	Measures Taken to Fulfill Requirements
		facilities; and matters connected with or incidental to the foregoing.	
Investment and Taxes	*No publically available legislation was obtained at the time of this study*		
Employment and Compensation	• *Labour Act (Chapter 28:01) as amended by Labour Act [Chapter 28:01] amended 2006 and the Labour Amendment Act, 2005 (Act 7/2005)*	*An Act to declare and define the fundamental rights of employees; to give effect to the international obligations of the Republic of Zimbabwe as a member state of the International Labour Organisation.*	*The ESIA considers the use of labour and the ESMPs provide for measures to ensure that labour is managed in a lawful manner and that labour rights are adhered to.*
	• *Indigenisation and Economic Empowerment Act [Chapter 14:33]*	*This Act provides support measures for the further indigenisation of the economy; to provide for support measures for the:* • *Economic empowerment of indigenous Zimbabweans;* • *National Indigenisation and Economic Empowerment Board and its functions and management;* • *Establishment of the National Indigenisation and Economic Empowerment Fund;* • *National Indigenisation and Empowerment* • *Charter;* • *Matters connected with or incidental to the foregoing.*	*Indigenous Zimbabweans can be defines as any person who, before the 18th April, 1980, was disadvantaged by unfair discrimination on the grounds of his or her race, and any descendant of such person, and includes any company, association, syndicate or partnership of which indigenous Zimbabweans form the majority of the members or hold the controlling interest. Indigenisation is a deliberate involvement of indigenous Zimbabweans in the economic activities of the country, to which hitherto they had no access, so as to ensure the equitable ownership of the nation's resources.* *The BGHES will need to subscribe to the requirements of this Act. Requirements included in this Act have been considered in the ESIA and associated ESMPs.*

4.5.5 *Zimbabwean Development Policies*

The national development policies for Zimbabwe that are potentially applicable to the Project are briefly outlined below.

Zimbabwe Agenda for Sustainable Socio-economic Transformation

In pursuit of a new trajectory of accelerated economic growth and wealth creation, Government formulated a plan known as the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (Zim Asset): October 2013-December 2018.

Zim Asset was crafted to achieve sustainable development and social equity anchored on indigenisation, empowerment and employment creation, which will be largely propelled by the judicious exploitation of the country's abundant human and natural resources.

This Results Based Agenda is built around four strategic clusters were set out to enable Zimbabwe to achieve economic growth and reposition the country as one of the strongest economies in the region and Africa. The four strategic clusters identified were: Food Security and Nutrition; Social Services and Poverty Eradication; Infrastructure and Utilities; and Value Addition and Beneficiation (1). Note that this economic policy is no longer active.

Zimbabwean Industrial Development Policy (2012-2016)

The policy's vision is to transform Zimbabwe from a producer of primary goods into a producer of processed value-added goods for both the domestic and export market. The policy mission statement is to create a vibrant, self-sustaining and competitive economy through promotion of viable industrial and commercial sectors as well as domestic and international trade.

The objectives of the policy include:

- The overall objective is to restore the manufacturing sector's contribution to the GDP of Zimbabwe from the current 15 % to 30 % and its contribution to exports from 26 % to 50 % by 2015. An average real GDP growth of 15 % is targeted under this Policy Framework of 2011-2015.

- To create additional employment in the manufacturing sector on an incremental basis as compared to the previous planning period of 2004 to 2010.

- To increase capacity utilisation from the current levels of around 43 % to 100 % by the end of the planning period.

(1) http://www.un.int/wcm/webdav/site/zimbabwe/shared/documents/press/Zim-Asset.pdf

- To re-equip and replace obsolete machinery and new technologies for import substitution and enhanced value addition.

- To increase the manufactured exports to the SADC and COMESA regions and the rest of the world.

- To promote utilisation of available local raw materials in the production of goods.

Zimbabwe's National Energy Policy

The National Energy Policy, 2012 (NEP) seeks to promote the optimal supply and utilisation of energy, for socio-economic development in a safe, sustainable and environmentally friendly manner.

The NEP is intended to fulfil Government's objective of ensuring that the energy sector's potential to drive economic growth and reduce poverty is fully harnessed. The policy therefore provides a guide to decision-makers, policy-makers and development managers in Government, the private sector, Non-Governmental Organisations and civil society, on Government's intended actions in the energy sector.

The policy recognises that regional cooperation is essential for the development of large-scale hydropower resources and that small-scale hydropower projects may not make a significant impact on national requirements but they help to develop skills and to speed up access for remote communities that are not likely to be connected to the national grid in the foreseeable future.

The policy also makes specific reference to the Zimbabwe Energy Regulatory Authority (ZERA) and states that the Authority is expected to create an enabling environment and establish fair play in the energy sector through licensing regulations, product and service standards and investment promotion.

Zimbabwe's National Climate Policy

The Government of Zimbabwe has released a trio of climate change policies designed to ensure the country is more resilient to climate change and assist in meeting its international carbon-cutting pledges. This process is being led by the Ministry of Environment, Tourism and Hospitality Industry

Zimbabwe's Vision 2030 (Towards an Upper-middle Income Economy by 2030)

This Policy Document seeks to share Zimbabwe's key reform initiatives and commitments on rebuilding and transforming Zimbabwe to become an Upper-Middle Income Economy by 2030. The aspiration of Vision 2030 will be realised through the following five cross cutting themes:

- Governance.

- Macro-economic Stability and Re-engagement.
- Inclusive Growth.
- Infrastructure and Utilities.
- Social Development.

Moreover, the aspirations are anchored by the following values and objectives:

- Improved Governance and the Rule of Law.
- Re-orientation of the country towards Democracy.
- Upholding Freedoms of Expression and Association.
- Peace and National Unity.
- Respect for Human and Property Rights.
- Attainment of Responsive Public Institutions.
- Broad based Citizenry Participation in national and socio-economic development programmes.
- Political and Economic Re-engagement with the global community.
- Creation of a Competitive and Friendly Business Environment.
- Enhanced domestic and foreign investment.
- An aggressive fight against all forms of Corruption.

The realisation of Vision 2030 will be through (amongst other programmes) the implementation of Zimbabwe's Transitional Stabilisation Programme (see below).

Zimbabwe's Transitional Stabilisation Programme, October 2018 to December 2020

The Transitional Stabilisation Programme over October 2018 to December 2020 contains and expresses the aspirations of the people of Zimbabwe, with reference to the Vision 2030. The Programme focuses on:

- Stabilising the macro-economy, and the financial sector.
- Introducing necessary policy, and institutional reforms, to transform to a private sector led economy.
- Addressing infrastructure gaps.
- Launching quick-wins to stimulate growth.

The Programme will prioritise quick-wins, and provide the necessary prelude to the two Five Year Development Strategies that will run from 2021 to 2030.

With reference to Section 129 (Protecting the Environment), the Transitional Stabilisation Programme targets protection, restoration and promotion of sustainable use of terrestrial ecosystems, sustainable management of forests, fighting the veld fire scourge, combating desertification, halting and reversing land degradation and loss of biodiversity.

The Programme identifies the BGHES as a priority Project to long-term economic growth, which will be implemented under the Programme.

Zimbabwe's International Re-engagement Policy

The Policy calls for commitment by the Zimbabwean Government to re-establish a democratic governance structure and sound economic development, and to re-engage with the international community.

The basic principles for re-engagement, agreed to by the international community include:

- Full access to humanitarian assistance
- Restoration of the rule of law
- Commitment to the democratic process
- Respect for human rights standards
- Commitment to macroeconomic stabilization

4.6 INTERNATIONAL TREATIES AND CONVENTIONS RELEVANT TO ZAMBIA AND ZIMBABWE

Zambia and Zimbabwe are signatory to a number of international conventions and agreements relating to industry, environmental management and energy. In certain cases these have influenced the promulgation of domestic policy, guidelines and regulations.

Both countries are typical dualist jurisdictions and therefore international treaties/ conventions must either be enacted or transformed into national law before they are considered to be legally binding on persons operating (i.e. the proponent to this project) in the respective country.

The starting point to this legal process usually begins with the signature of the relevant state. The signature qualifies the signatory state to proceed to ratification, acceptance or approval. It also creates an obligation to refrain, in good faith, from acts that would defeat the object and the purpose of the treaty. "Ratification" defines the international act whereby a state indicates its consent to be bound to a treaty. The institution of ratification grants states the necessary time-frame to seek the required approval for the treaty on the domestic level and to enact the necessary legislation to give domestic effect to that treaty. "Accession" is the act whereby a state accepts the offer or the opportunity to become a party to a treaty already negotiated and signed by other states. It has the same legal effect as ratification.

Therefore, although not all treaties/ conventions listed below have been enacted into domestic legislation; best practice would require that the ethos of each treaty be taken into consideration during the planning, construction and operations phases of the proposed development.

Table 4-5 below lists the relevant international conventions to which Zambia and Zimbabwe are signatory to (including indication of ratification or accession status) and its international body membership status. The table also includes issues that the need to be complied with in relation to the international conventions and treaties.

Table 4-5 Ratification of International Conventions

Name of Convention	Date of enactment and status	Measures Taken to Fulfill Requirements
Waste Management		
The Basel Convention on Trans-boundary Movement of Hazardous Waste The Basel Convention governs the generation, collection, storage, transportation, pre-treatment, treatment, disposal, export, import and trans-boundary movement of hazardous waste.	*Zambia: 15/11/1994 (Accession)* *Zimbabwe: 01/03/2012 (Accession)*	*The ESIA and ESMPs have considered hazardous waste that may be generated and the disposal thereof. The ESMPs include the obligation to develop a Waste Management Plan to ensure that proper disposal of such wastes.*
Bamako Convention on the ban on the Import into Africa and the Control of Transboundary Movement and Management of Hazardous Wastes within Africa *The Bamako Convention uses a format and language similar to that of the Basel Convention, but is much stronger in prohibiting all imports of hazardous waste. Additionally, it does not make exceptions on certain hazardous wastes (like those for radioactive materials) made by the Basel Convention.*	*Zambia: 03/08/2005 (signed)* *Zimbabwe: 10/07/1992 (ratified)*	
Cultural Heritage		
The Convention Concerning the Protection of the World's Cultural and Natural Heritage The Convention provides for the identification, protection, conservation, presentation and transmission to future generations of the cultural and natural heritage which are of outstanding universal value from the point of view of history, art or science.	*Zambia: 04/06/1984 (ratified)* *Zimbabwe: 16/08/1982 (ratified)*	*The ESIA considers the impacts upon any cultural heritage items and the ESMPs include mitigation measures in relation thereto.*
Statutes of the International Centre for the Study of the Preservation and restoration of Cultural Property Intergovernmental organisation dedicated to the conservation of cultural heritage. It has a worldwide mandate to promote the conservation of all types of cultural heritage, both movable and immovable.	*Zambia: not a member* *Zimbabwe: ratified*	
Biodiversity		
Convention on Biological Diversity The Convention has three main objectives; the conservation of biological diversity, the sustainable use of the components of biological diversity and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.	*Zambia: (ratified)* *Zimbabwe: (ratified)*	*The ESIA considers the impacts upon protected areas, species (fauna and flora) and sensitive ecological systems. The ESMPs include mitigation measures to ensure that*

Name of Convention	Date of enactment and status	Measures Taken to Fulfill Requirements
Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar) An international treaty for the conservation and sustainable utilization of wetlands. The treaty recognizes the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.	*Zambia: (ratified)* *Zimbabwe: (ratified)*	*such areas and species are protected as far as is reasonable possible.* *Refer to Annex F.3 for a list of Biodiversity species and IUCN status of such species found or potentially found in the Batoka Gorge project area.*
International Plant Protection Convection Is an international agreement on plant health, which aims to protect cultivated and wild plants by preventing the introduction and spread of pests.	*Zambia: (ratified)* *Zimbabwe: not a member*	
International Union for the Conservation of Nature and Natural Resources (IUCN) Encourages the preservation of wildlife, natural environments, and living resources and promotes research in the preservation of threatened species, ecology, sustainable development, and environmental law, education, and training.	*Zambia: member* *Zimbabwe: member*	
Statutes of the International Union for Conservation of Nature and Natural Resources (as amended) Intergovernmental organisation with the objective to influence, encourage and assist societies throughout the world to conserve the integrity and diversity of nature and to ensure that any use of natural resources is equitable and ecologically sustainable.	*Zambia: not a member* *Zimbabwe: ratified*	
Convention on International Trade in Endangered Species** of Wild Fauna and Flora **(CITES) CITES is an international agreement between governments to ensure that international trade in specimens of wild animals and plants does not threaten their survival.	*Zambia: 24/11/1980 (ratified)* *Zimbabwe: 19/05/1981 (ratified)*	
African Convention on the Conservation of Nature and Natural Resources Recognises the need to contribute to the conservation of nature and natural resources at a continent level.	*Zambia: signatory* *Zimbabwe: signatory*	
Agreement on Co-operative Enforcement Operations directed at Illegal Trade in Wild Fauna and Flora The objective of this Agreement is to reduce and ultimately eliminate illegal trade in wild fauna and flora and to establish a permanent Task Force for this purpose.	*Zambia: 9/11/1995 (ratified)* *Zimbabwe: not a member*	
Climate Change		
United Nations Framework Convention on Climate Change (UNFCCC) UNFCCC is an international agreement for the control of climate change.	*Zambia: 28 May 1993 (ratified)* *Zimbabwe: 3/10/1992 (ratified)*	*The ESIA and ESMPs have considered climate change and related impacts on the project.* *Refer to Annex H: Climate Change Risk review.*

Name of Convention	Date of enactment and status	Measures Taken to Fulfill Requirements
The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) An international treaty that sets binding obligations on industrialized countries to reduce emissions of greenhouse gases. The UNFCCC is an environmental treaty with the goal of preventing dangerous anthropogenic (i.e., human-induced) interference of the climate system.	*Zambia: 07/07/2006 (ratified)* *Zimbabwe: 30/06/2009 (ratified)*	
United Nation Convention to Combat Desertification (UNCCD) Recognises the need to control any form of desertification that may arise as a result of anthropogenic activities. The statutes of the UNCCD, encourages the control of desertification as a result of man's activities.	*Zambia: 19/09/1996 (ratified)* *Zimbabwe: 1997 (ratified)*	
Labour and Human Rights		
Convention concerning the Abolition of Forced Labour, 1957 (ILO) Cancels certain forms of forced labour still allowed under the Forced Labour Convention of 1930, such as punishment for strikes and as a punishment for holding certain political views.	*Zambia: 22/02/1965 (ratified)* *Zimbabwe: 27/08/1998 (ratified)*	*The ESIA considers the socio-economic impacts associated with the project including the use of labour. The ESMPs include measures to ensure that labour and human rights are upheld and that associated laws are adhered to.*
Convention concerning Discrimination in Respect of Employment and Occupation or Discrimination (Employment and Occupation) Convention (ILO) The convention requires states to enable legislation which prohibits all discrimination and exclusion on any basis including of race or colour, sex, religion, political opinion, national or social origin in employment and repeal legislation that is not based on equal opportunities.	*Zambia: 23/10/1979 (ratified)* *Zimbabwe: 23/06/1999 (ratified)*	
African Charter on Human and Peoples' Rights Is an international human rights instrument that is intended to promote and protect human rights and basic freedoms in the African continent.	*Zambia: 10/01/1984 (ratified)* *Zimbabwe: 30/05/1986 (ratified)*	
Convention Concerning the Protection of Workers against Occupational Hazards in Working Environments due to Air Pollution and Noise Vibrations Recognises the need to protect workers against hazards in working environments.	*Zambia: 19/08/ 1980 (ratified)* *Zimbabwe: not a member*	
Constitution of the International Labour Organisation A constitution detailing conditions and standards for acceptable labour practices.	*Zambia: (ratified)* *Zimbabwe: (ratified)*	

Name of Convention	Date of enactment and status	Measures Taken to Fulfill Requirements
Regional River Management		
Agreement on the Action Plan for the Environmentally Sound Management of the Common Zambezi River System Is an agreement aiming to develop regional co-operation on environmentally sound water resources management of the common Zambezi river system and to strengthen regional co-operation for sustainable development.	*Zambia: 28/05/1987 (ratified)* *Zimbabwe: 28/05/1987 (ratified)*	*This Agreement places obligations on the respective government institutions to develop cooperative agreements on the management of resources and therefore contains no direct obligations relating to the ESIA process.*

4.7 *REGIONAL AUTHORITIES: ZAMBEZI RIVER AUTHORITY*

As discussed in *Chapter 1*, the Zambezi River Authority (ZRA) is mandated by the governments of Zambia and Zimbabwe to operate and maintain the infrastructure on the Zambezi River, and are the project proponent for the proposed BGHES.

The ZRA is a statutory body jointly owned by the governments of Zambia and Zimbabwe. The ZRA was established on 1 October 1987 as a result of parallel legislation tabled before the parliaments of the Republics of Zambia and Zimbabwe, which followed the reconstitution of its predecessor, the Central African Power Corporation (CAPCO). Generating assets on the Zambezi River were subsequently handed over to the two national power utilities, the then Zambia Electricity Supply Corporation, now ZESCO Limited (ZESCO) and the then Zimbabwe Electricity Supply Authority now represented by Zimbabwe Power Company (ZPC). The ZRA has responsibility of the operation and maintenance of infrastructure on the Zambezi River, investigation and development of new dam sites on the Zambezi River and collecting, processing, analysing and disseminating hydrological and environmental information pertaining to the Zambezi River and Lake Kariba.

The ZRA is governed by a Council of Ministers consisting of four members from Zambia and Zimbabwe. The common Ministries in the council are those responsible for Energy and Finance. In terms of the Zambezi River Authority Acts, the Council of Ministers gives direction, through the ZRA Board of Directors, to the ZRA to ensure the most efficient use of the Zambezi River and any other infrastructure developed on it.

The ZRA has the following four main strategic functions, which are outlined in the schedule to the Zambezi River Authority Acts Nos. 17 and 19 of 1987 of Zambia and Zimbabwe, respectively:

1. *In consultation with the national electricity undertakings investigate the desirability of constructing new dams on the Zambezi River and make recommendations thereon to the Council;*
2. *Subject to the approval of the Council, construct, operate, monitor and maintain any other dams on the Zambezi River;*
3. *Make such recommendations to the Council as will ensure the effective and efficient use of waters and other resources of the Zambezi River; and,*
4. *Submit development plans and programmes to the Council for approval.'*

4.8 *INTERNATIONAL AND REGIONAL GUIDELINES AND STANDARDS*

There a number of international environmental and social guidelines and standards applicable to the proposed BGHES, especially with regards to International Finance Institutions (IFIs). The environmental and social guidelines and standards listed below have specifically been taken into account to guide the environmental and social assessment process:

- World Bank Environmental and Social Safeguard Policies;

- The International Finance Corporation (IFC) Performance Standards on Environmental and Social Sustainability (2012) (the IFC Performance Standards);

- IFC Environmental, Health and Safety (EHS) Guidelines (April 2007); and

- World Commission on Dams (WCD) Guidelines and Recommendations;

- The International Hydropower Association (IHA) Sustainability Guidelines and Sustainability Assessment Protocols; and

- The Southern African Power Pool (SAPP) Environmental and Social Impact Assessment Guidelines for Hydroelectric Projects and Transmission Infrastructure in the SAPP region.

Table 4-9 (refer to *Page 4-65*) outlines how the project has adhered to each of these guidelines and standards to date (*see column three of the Table*). For ease of reference, the obligations associated with each of these guidelines and standards have been categorised according to the following subject areas:

- Environmental and Social Impact Assessment;
- Labour and Working Conditions;
- Resource Efficiency and Pollution Prevention;
- Community Health, Safety and Security;
- Resettlement;
- Biodiversity Conservation;
- Indigenous Peoples (not of relevance to the project);
- Cultural Heritage;
- Dam and Hydropower Specific; and
- International Waterways.

For more detail on each of the above international guidelines and standards please refer to *Sections 4.8.1* to *4.8.8*.

4.8.1 World Bank Group Environmental and Social Safeguard Polices

The World Bank Group has ten Environmental and Social Safeguards (ESS) that allows for the better management of environmental and social risks of projects and to improve development outcomes. The ESSs were launched on 1 October 2018 and applies to all new World Bank investment project financing. The ESSs include the following:

- ESS1 - Assessment and Management of Environmental and Social Risks and Impacts;
- ESS2 – Labor and Working Conditions;
- ESS3 – Resource Efficiency and Pollution Prevention and Management;
- ESS4 – Community Health and Safety;

- ESS5 – Land Acquisition, Restrictions on Land Use and Involuntary Resettlement;
- ESS6 – Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- ESS7 – Indigenous People / Sub-Saharan African Historically Undeserved Traditional Local Communities;
- ESS9 – Financial Intermediaries; and
- ESS10 – Stakeholder Engagement and Information Disclosure.

The policies of relevance to the proposed BGHES are summarised in *Table 4-9*.

4.8.2 *The IFC Performance Standards*

The International Finance Corporation (IFC), a division of the World Bank Group that lends to private investors, has released a Sustainability Policy and set of Performance Standards on Social and Environmental Sustainability (January 2012) (see *Box 4.1*).

Please note that the Performance Standards require that in addition to meeting the requirements under the Performance Standards, clients must comply with applicable national law, including those laws implementing host country obligations under international law.

Box 4.1 Performance Standards on Social and Environmental Sustainability

- Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts;
- Performance Standard 2: Labour and Working Conditions;
- Performance Standard 3: Resource Efficiency and Pollution Prevention;
- Performance Standard 4: Community Health, Safety and Security;
- Performance Standard 5: Land Acquisition and Involuntary Resettlement;
- Performance Standard 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources;
- Performance Standard 7: Indigenous Peoples; and
- Performance Standard 8: Cultural Heritage.

These Standards are used to evaluate any project seeking funding through the IFC. The Equator Principles [1] which reflect the application by major international banking institutions of IFC-inspired environmental and social best practice guidelines in the financing of large projects have been revised to adhere to the new IFC Performance Standards. However, the Equator Principles Financial Institutions (EPFIs) do not use the IFC's Sustainability or Disclosure Policy, as these were not adopted by the banks. The EPFIs have their own sustainability and disclosure policies, and take the same approach, e.g. the

(1) The Equator Principles are a financial industry benchmark for determining, assessing and managing social & environmental risk in project financing. As of 01/01/2011, they had been adopted by 70 major banking institutions. The Equator Principles reflect a common set of international, IFC-inspired best practices guidelines to manage social and environmental risks related to the financing of large projects.

borrower's/client's project must comply with the Performance Standards and the applicable Environment, Health and Safety (EHS) Guidelines.

The Performance Standards underscore the importance of managing environmental, social and health issues throughout the life of a project. They identify the need for an effective social and environmental management system that is dynamic and continuous, '*involving communication between the client, its workers, and the local communities directly affected by the Project*'. They require '*thorough assessment of potential social and environmental impacts and risks from the early stages of project development and provides order and consistency for mitigating and managing these on an ongoing basis*'. (1) Through the Performance Standards, the IFC also requires that clients engage with affected communities through disclosure of information, consultation, and informed participation, in a manner commensurate with the risks to, and impacts on, the affected communities.

The IFC Performance Standards, and each of their objectives, are outlined in *Table 4-9*.

4.8.3 IFC Environmental, Health and Safety (EHS) Guidelines

The EHS Guidelines are technical reference documents, which address IFC's expectations regarding the industrial pollution management performance of its projects. They are designed to assist managers and decision makers with relevant industry background and technical information. This information supports actions aimed at avoiding, minimising, and controlling EHS impacts during the construction, operation, and decommissioning phase of a project or facility. The EHS Guidelines serve as a technical reference source to support the implementation of the IFC Performance Standards, particularly in those aspects related to Performance Standard 3: Pollution Prevention & Abatement, as well as certain aspects of occupational and community health and safety.

When the regulations of a host country (Zambia and/ or Zimbabwe) differ from the levels and measures presented in the EHS Guidelines, projects will be expected to achieve whichever is more stringent. If less stringent levels or measures are appropriate in view of specific project circumstances, a full and detailed justification for any proposed alternatives is required. However, there are no industry specific guidelines for hydropower projects, although guidelines do exist for electrical power transmission and generation.

General EHS Guidelines also exist which contain information on cross-cutting environmental, health, and safety issues potentially applicable to all industry sectors, as listed in *Box 4.2.*

(1) IFC, 2012.

Box 4.2 IFC General EHS Guidelines

General EHS Guidelines
1. Environmental
1.1 Air Emissions and Ambient Air Quality
1.2 Energy Conservation
1.3 Wastewater and Ambient Water Quality
1.4 Water Conservation
1.5 Hazardous Materials Management
1.6 Waste Management
1.7 Noise
1.8 Contaminated Land
2. Occupational Health and Safety
2.1 General Facility Design and Operation
2.2 Communication and Training
2.3 Physical Hazards
2.4 Chemical Hazards
2.5 Biological Hazards
2.6 Radiological Hazards
2.7 Personal Protective Equipment (PPE)
2.8 Special Hazard Environments
2.9 Monitoring
3. Community Health and Safety
3.1 Water Quality and Availability
3.2 Structural Safety of Project Infrastructure
3.3 Life and Fire Safety (L&FS)
3.4 Traffic Safety
3.5 Transport of Hazardous Materials
3.6 Disease Prevention
3.7 Emergency Preparedness and Response
4. Construction and Decommissioning
4.1 Environment
4.2 Occupational Health and Safety
4.3 Community Health and Safety

4.8.4 The African Development Bank Safeguards

The African Development Bank (AfDB) safeguards are also considered as part of this assessment, given the AfDB involvement in the Project.

There is significant overlap between the AfDB safeguards and the IFC Performance Standards, as indicated in *Table 4-6* below. Nevertheless, as the AfDB safeguards are also relevant to this Project, the assessment of environmental and social performance is also assessed against these Safeguards.

Table 4-6 African Development Bank Safeguards and their Comparison with the IFCs Performance Standards

AfDB Safeguard	Description	Relevant IFC PS
OS 1: Environmental and Social Assessment	Governs the process for determining a project's category and the resulting environmental and social assessment requirements: the scope of application; categorisation; use of an ESIA, where appropriate; Environmental and Social Management Plans; climate change vulnerability assessment; public consultation; community impacts; appraisal and treatment of vulnerable groups; and grievance redress mechanism.	PS 1 PS 4 PS 7 PS 8
OS 2, Involuntary Resettlement, Land Acquisition, Population Displacement and Compensation	Covers requirements for the provision of compensation at full replacement cost; the importance of a resettlement that improves standards of living and livelihoods; emphasises the need to ensure that social considerations, such as gender, age, and stakes in the project outcome do not disenfranchise particular project-affected people. OS 2 also addresses requirements to avoid or mitigate destruction or removal of cultural, religious and archaeological sites, as well as requirements for community consultation.	PS 1 PS 5 PS 8
OS 3: Biodiversity, Renewable Resources and Ecosystem Services	The overarching objective of this safeguard is to conserve biological diversity and promote the sustainable use of natural resources. OS 3 reflects the UN Convention on Biological Diversity, emphasising the need to "respect, conserve and maintain [the] knowledge, innovations and practices of indigenous and local communities… [and] to protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements	PS 6 PS 7
OS 4: Pollution Prevention and Control, Hazardous Materials and Resources Efficiency	Covers the range of impacts of pollution, waste, and hazardous materials for which there are agreed international conventions and comprehensive industry specific standards that other multilateral development banks follow, particularly the World Bank ESS standards. It also introduces vulnerability analysis and monitoring of greenhouse gas emissions levels and provides a detailed analysis of the possible reduction or compensatory measures framework.	PS 1 PS 3 PS 4
OS 5: Labour Conditions, Health and Safety	This safeguard establishes the Bank's requirements for its borrowers or clients concerning workers' conditions, rights and protection from abuse or exploitation.	PS 2

4.8.5 *World Commission on Dams*

The World Commission on Dams (WCD) was established in May 1998 in response to the escalating local and international controversies over large dams, with the mandate to:

i) Review the development effectiveness of large dams and assess alternatives for water resources and energy development; and
ii) Develop internationally acceptable criteria, guidelines and standards for the planning, design, appraisal, construction, operation, monitoring and decommissioning of dams. [1]

Members of the Commission were chosen to reflect regional diversity, expertise and stakeholder perspectives; and to serve in an individual capacity, as opposed to representing institutions or countries. In November 2000 the WCD's work culminated in the launch of its report entitled Dams and Development: a new framework for decision-making (World Commission on Dams, 2000). The report describes a framework for planning water and energy projects that is intended to protect dam-affected people and the environment, and ensure that the benefits from dams are more equitably distributed. The WCD framework covers key areas for improved planning of dams, including the need to fully assess all available options for meeting water and energy needs; addressing outstanding social issues from existing dams before building new ones, gaining public acceptance for key decisions, and the importance of protecting healthy rivers.

The WCD framework puts forward seven strategic priorities which are widely acknowledged as a framework for dialogue (see *Table*). These seven strategic priorities are each based on a set of policy principles. A set of 26 guidelines for good practice lay out specific actions for complying with the strategic priorities at five key stages of the project development process. Please refer to *Annex F* for more detail. Section N1 of Annex N reviews the ESIA report against the WCD's Guidelines for Good Practice.

Table4-7 World Commission on Dams Strategic Priorities

Strategic Priority 1 - Gaining Public Acceptance
In order to develop water and energy resources in an equitable and sustainable manner, it is essential that there is public acceptance of such initiatives. This entails recognising the rights, addressing the risks and safeguarding the entitlements of all interested groups, by ensuring that they are informed about the issues at stake, able effectively to participate in decision-making processes, and that there is demonstrable acceptance of key decisions. Particular care should be taken to include the most vulnerable parties, such as women, the poor and certain indigenous groups, and that decision-making processes are guided by their free, informed and prior consent.
Strategic Priority 2 - Comprehensive Options Assessment
The most appropriate development initiatives for a particular area can only be identified by assessing food, water and energy needs and clearly defining programme objectives. The full range of policy, institutional and technical options, which may well include alternatives to dams, should then be comprehensively assessed in a participatory process that accords the same significance to social and environmental considerations as to economic and financial factors. This process of assessment should continue throughout the planning, development and implementation of the project.

(1) World Commission on Dams (2000a)

Strategic Priority 3 - Addressing Existing Dams
Dams and the context in which they operate are not static over time. Their benefits and impacts may be transformed by changes in priorities for water use, physical and land use changes in the river basin, technological developments, and changes in public policy expressed in environmental, safety, economic and technical regulations. Management and operational practices should be continuously assessed and adapted to changing circumstances, in order to optimise the benefits, address social issues and improve measures to limit and restore damage to the environment. This process should extend beyond the life of the project, so that the performance, benefits and impacts of all existing large dams can be monitored and evaluated on a long-term basis, and appropriate action taken to improve all aspects of their service delivery.
Strategic Priority 4 - Sustaining Rivers and Livelihoods
Dams transform the landscapes they inhabit, with potentially irreversible effect. It is essential to understand, protect and restore ecosystems at river basin level, in order to minimise their negative impact, limit and mitigate harm to the health and integrity of the river system and those dependent upon it, and promote equitable human development and the welfare of all species. These are key issues when selecting sites and designing projects. Governments should develop national policies for maintaining in their natural state selected rivers with high ecosystem functions and values, and look for alternative sites on tributaries when assessing proposals for dams on undeveloped rivers.
Strategic Priority 5 - Recognizing Entitlements and Sharing Benefits
Rather than benefiting from them, many of those affected by dams are aware only of their negative impacts. To redress the balance, a process of joint negotiation with such groups is required, based on recognition of rights and assessment of risks. The aim of these negotiations is to agree on legally enforceable mitigation and development provisions, which recognise entitlements that improve livelihoods and quality of life. States and developers are responsible for resettling and compensating all affected people, and satisfying them that their livelihoods will be improved by moving from their current situation. Legal means, such as contracts and accessible recourse at national and international levels, should be used to ensure that responsible parties fulfil their commitments to agreed mitigation, resettlement and development provisions.
Strategic Priority 6 - Ensuring Compliance
In order to win and maintain public trust and confidence, governments, developers, regulators and operators must meet their commitments for planning, implementing and operating dams. Compliance with applicable regulations, criteria and guidelines, and project-specific negotiated agreements should be ensured at all critical stages of project planning and implementation. A set of regulatory and non-regulatory mechanisms, incorporating incentives and sanctions, and flexible enough to accommodate changing circumstances, is needed to enforce social, environmental and technical measures. A clear, consistent and common set of criteria and guidelines to ensure compliance should be adopted by sponsoring, contracting and financing institutions, and compliance subjected to independent and transparent review. Legislation, voluntary integrity pacts, debarments and other instruments should be used to eliminate corrupt practices.
Strategic Priority 7 - Sharing Rivers for Peace, Development and Security
The storage and diversion of water on transboundary rivers can cause considerable tension within and between countries. As specific interventions for diverting water, dams require constructive co-operation, and states or political units within countries need to agree on the use of resources in order to promote regional co-operation and peaceful collaboration. Rather than focusing on allocating water as a finite resource, states need to work on sharing rivers and their associated benefits. This will involve negotiating a wide range of issues, and making provision in national water policies for basin agreements in shared river basins. These agreements should be based on the principles of equitable and reasonable use, no significant harm, prior information and the Commission's strategic priorities. If an objection by a riparian state to a proposal for a new dam on a shared river is upheld by an independent panel, construction should not be carried out. Furthermore, where a government agency plans the construction of a dam on a shared river in contravention of the principle of good faith negotiations between riparians, external financing bodies should withdraw their support for projects and programmes promoted by that agency.

Source: World Commission on Dams (2001)

The WCD dissolved in 2001 having undertaken its assigned activities. The WCD framework, however, has become a key benchmark in international dam building. The World Bank, export credit agencies and the International Hydropower Association, while critical of specific recommendations, have endorsed the WCD's strategic priorities.

Please refer to Annex N for a more detailed background on the WCD.

4.8.6 *International Hydropower Association (IHA) Sustainability Guidelines*

The IHA Sustainability Guidelines (SGs) were published in February 2004, with the aim of promoting greater consideration of environmental, social, and economic sustainability in the assessment of:

- New energy projects;
- New hydropower projects; and
- The management and operation of existing hydropower facilities.

The principles set out in the SGs encompass a number of elements, which include:

- The role of governments;
- The decision making processes;
- Hydropower - environmental aspects of sustainability;
- Hydropower - social aspects of sustainability; and
- Hydropower - economic aspects of sustainability.

The IHA has put forward policy and sustainability criteria which encourage good governance within each country and collaboration between governments at an international level to ensure sustainable hydropower development prerequisites are met. According to the IHA, it is the responsibility of governments to:

- Have in place national and/or regional energy policies, which should:

  - Clearly set out energy development strategies;

  - Include a Strategic Assessment (SA) process that involves an assessment of cumulative impacts, determination of land use and environmental priorities, as well as goals for poverty alleviation and economic growth;

  - Be framed in the context of the global need to reduce greenhouse emissions;

  - Incorporate the three elements of sustainability -- economic, social and environmental -- in energy planning; and

- Be a participatory, streamlined process, focused on major issues, using common sense and readily available information, and with short and definite time limits for its completion.

- Evaluate alternative energy options using key sustainability criteria, prescribed by the IHA; and

- Evaluate hydropower project alternatives using key sustainability criteria, prescribed by the IHA.

In order to facilitate decision-making and to ensure the sustainability of hydropower projects, the IHA's policy position is that Environmental Assessments (EAs) should be applied at the project level from the pre-feasibility stage to the post-construction auditing stage. The IHA encourages governments and project proponents, through the use of key criteria, to ensure appropriate management of environmental and social issues throughout the life of the project by adopting strategies to maximise positive outcomes and reduce the severity or avoidance of negative social, economic and environmental impacts.

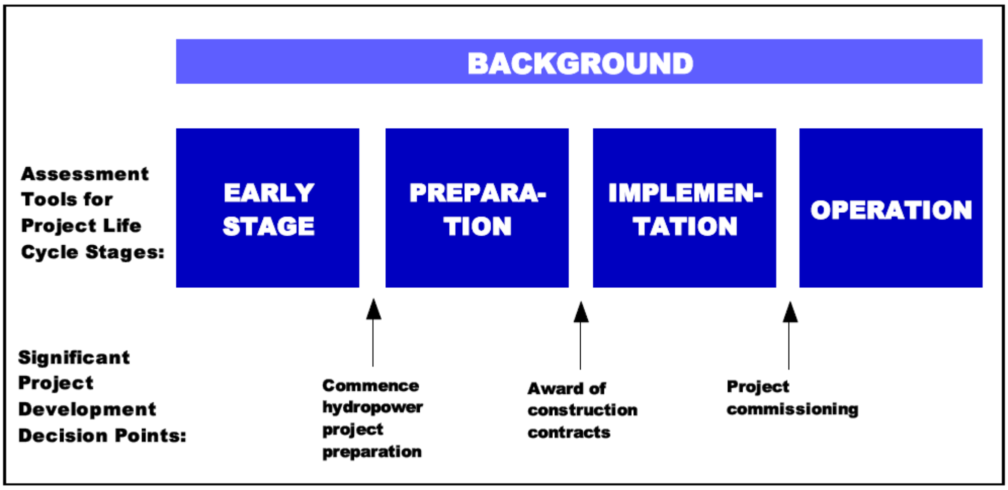
To support the IHA SGs, the IHA has also developed the Hydropower Sustainability Assessment Protocol, which was released in 2006 and updated in November 2010, to assist in assessing performance against the criteria set out in the IHA SGs.

Please refer to Annex N for a more detailed background on the IHA.

4.8.7 IHA Hydropower Sustainability Assessment Protocol

The IHA Hydropower Sustainability Assessment Protocol (the Protocol) is a sustainability assessment framework for hydropower development and operation. The intention of the Protocol is to enable the production of a sustainability profile for hydropower projects through the assessment of performance against sustainability topics. In particular, the Protocol comprises four assessment tools for the different stages of the project life cycle, as shown in *Table4-8*. Of current relevance to the proposed BGHES is the **Preparation** assessment tool.

Table4-8 Protocol Assessment Tools and Major Decision Points



These four assessment tools – Early Stage, Preparation, Implementation, and Operation, are designed to be stand-alone assessments applied at particular stages of the hydropower project life cycle.

The **Early Stage** assessment tool is a preliminary screening tool to assess the strategic environment from which proposals for hydropower projects emerge. It identifies project risks and opportunities at an early stage, in order to identify the challenges and management responses to proceed with a more detailed project investigation.

The **Preparation** assessment tool assesses the preparation stage of a hydropower project, during which investigations, planning and design are undertaken for all aspects of the project. This project stage is normally subject to national regulatory processes regarding project-specific EIA requirements as well as project management processes.

The **Implementation** assessment tool assesses the implementation stage of a hydropower project, during which construction, resettlement, environmental and other management plans and commitments are implemented.

The **Operation** assessment tool assesses the operation of a hydropower facility. This Protocol assessment tool can be used to inform the view that the facility is operating on a sustainable basis with active measures in place towards monitoring, compliance and continuous improvement.

Each assessment tool includes a list of topics, which when taken together, provide a list of issues that must be considered to confidently form a view on the overall sustainability of a hydropower project at a particular point in its life cycle. Within each topic, criteria are utilised for the scoring of each topic, these criteria include:

1. Assessment;

2. Management;
3. Stakeholder Engagement;
4. Stakeholder Support;
5. Conformance/Compliance; and
6. Outcomes.

These criteria allow the assessment of both the processes in place to ensure sustainability of the project or operation, and the performance of that project or operation on that particular sustainability topic.

Table 4-9 International and Regional Guidelines and Standards

Name of Standard/ Guideline	Objectives	Measures Taken to Fulfill Requirements
Environmental and Social Impact Assessment		
ESS1 Assessment and Management of Environmental and Social Risks and Impacts	Sets out the Borrower's responsibilities for assessing, managing and monitoring environmental and social risks and impacts associated with each stage of a project supported by the Bank through Investment Project Financing (IPF), in order to achieve environmental and social outcomes consistent with the Environmental and Social Standards (ESSs).	ERM has been appointed to undertake an ESIA in accordance with IFC PS 1, World Bank Operational Procedure 4.01 and SAPP Guidelines. This process has informed the developments of ESMPs as prescribed. The ESMPs apply to all project activities related to each phase of the project lifecycle.
IFC Assessment and Management of Environmental and Social Risks and Impacts Performance Standard 1 underscores the importance of managing social and environmental performance throughout the life of a project (any business activity that is subject to assessment and management).	The stated purposes of this standard are to: • To identify and evaluate environmental and social risks and impacts of the project. • To adopt a mitigation hierarchy to anticipate and avoid, or where avoidance is not possible, minimize, and, where residual impacts remain, compensate/offset for risks and impacts to workers, Affected Communities, and the environment. • To promote improved environmental and social performance of clients through the effective use of management systems. • To ensure that grievances from Affected Communities and external communications from other stakeholders are responded to and managed appropriately. • To promote and provide means for adequate engagement with Affected Communities throughout the project cycle on issues that could potentially affect them and to ensure that relevant environmental and social information is disclosed and disseminated.	
The Southern African Power Pool (SAPP) Environmental and Social Impact Assessment Guidelines for Hydroelectric Projects and Transmission Infrastructure in the SAPP region	The guidelines provide further guidance on the ESIA process to be undertaken, specifically regarding the components and format of an ESIA, and the stakeholder engagement required to be undertaken.	

Name of Standard/ Guideline	Objectives	Measures Taken to Fulfill Requirements
Labour and Working Conditions		
ESS2 Labor and Working Conditions	Recognises the importance of employment creation and income generation in the pursuit of poverty reduction and inclusive economic growth. Borrowers can promote sound worker-management relationships and enhance the development benefits of a project by treating workers in the project fairly and providing safe and healthy working conditions.	The potential use of labour associated with project activities has been considered in the ESIA and ESMPs, and has considered the requirements of the prescribed standards with respect to labour and working conditions.
IFC Labour and Working Conditions Performance Standard 2 recognizes that the pursuit of economic growth through employment creation and income generation should be accompanied by protection of the fundamental rights of workers.	The stated purposes of this standard are to: • To promote the fair treatment, non-discrimination, and equal opportunity of workers. • To establish, maintain, and improve the worker-management relationship. • To promote compliance with national employment and labour laws. • To protect workers, including vulnerable categories of workers such as children, migrant workers, workers engaged by third parties, and workers in the client's supply chain. • To promote safe and healthy working conditions, and the health of workers. • To avoid the use of forced labour.	
IFC General EHS Guideline 2. Occupational Health and Safety	Provides guidelines on occupational health and safety related matters including: • General Facility Design and Operation • Communication and Training • Physical Hazards • Chemical Hazards • Biological Hazards • Radiological Hazards • Personal Protective Equipment (PPE) • Special Hazard Environments • Monitoring	
IFC General EHS Guidelines 4. Construction and Decommissioning	Provides a guideline (4.1) on occupational health and safety matters related to construction and decommissioning activities.	

Name of Standard/ Guideline	Objectives	Measures Taken to Fulfill Requirements
Resource Efficiency and Pollution Prevention		
ESS3 Resource Efficiency and Pollution Prevention and Management	Recognises that economic activity and urbanization often generate pollution to air, water, and land, and consume finite resources that may threaten people, ecosystem services and the environment at the local, regional, and global levels. This ESS sets out the requirements to address resource efficiency and pollution prevention and management throughout the project life-cycle.	The possible project activity impacts on air, water and land have been taken into account in the ESIA. The ESMPs include measures for the management of such impacts as far as is reasonably possible.
IFC Resource Efficiency and Pollution Prevention Performance Standard 3 recognizes that increased economic activity and urbanization often generate increased levels of pollution to air, water, and land, and consume finite resources in a manner that may threaten people and the environment at the local, regional, and global levels.	The stated purposes of this standard are to: • To avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities. • To promote more sustainable use of resources, including energy and water. • To reduce project-related GHG emissions.	
IFC General EHS Guideline 1. Environmental	Provides guidelines on environmental conservation matters including: • Air Emissions and Ambient Air Quality • Energy Conservation • Wastewater and Ambient Water Quality • Water Conservation • Hazardous Materials Management • Waste Management • Noise • Contaminated Land	
IFC General EHS Guidelines 4. Construction and Decommissioning	Provides a guideline (4.1) on environmental conservation matters related to construction and decommissioning activities.	

Name of Standard/ Guideline	Objectives	Measures Taken to Fulfill Requirements
Community Health, Safety and Security		
ESS4 – Community Health and Safety	Addresses the health, safety, and security risks and impacts on project-affected communities and the corresponding responsibility of Borrowers to avoid or minimize such risks and impacts, with particular attention to people who, because of their particular circumstances, may be vulnerable.	The possible project activity impacts on the health and safety of communities and associated health and security risks have been taken into account in the ESIA. The ESMPs include measures for the management of such impacts as far as is reasonably possible.
IFC Community Health, Safety and Security Performance Standard 4 recognizes that project activities, equipment, and infrastructure often bring benefits to communities including employment, services, and opportunities for economic development.	The stated purposes of this standard are to: • To anticipate and avoid adverse impacts on the health and safety of the Affected Community during the project life from both routine and non-routine circumstances. • To ensure that the safeguarding of personnel and property is carried out in accordance with relevant human rights principles and in a manner that avoids or minimizes risks to the Affected Communities.	
IFC General EHS Guideline 3. Community Health and Safety	Provides guidelines on community health and safety matters including: • Water Quality and Availability • Structural Safety of Project Infrastructure • Life and Fire Safety (L&FS) • Traffic Safety • Transport of Hazardous Materials • Disease Prevention • Emergency Preparedness and Response	
IFC General EHS Guidelines 4. Construction and Decommissioning	Provides a guideline (4.3) on community health and safety matters related to construction and decommissioning activities.	
Resettlement		
ESS5: Land Acquisition, Restrictions on Land Use and Involuntary Resettlement	Triggered in situations involving involuntary taking of land and involuntary restrictions of access to legally designated parks and protected areas. The policy aims to avoid involuntary resettlement to the extent feasible, or to minimise and mitigate	The ESIA has considered community impacts by proposed project activities. The ESMPs include actions necessary to satisfy resettlement

Name of Standard/ Guideline	Objectives	Measures Taken to Fulfill Requirements
	its adverse social and economic impacts. In the event that involuntary resettlement is triggered, the Policy requires the task team and developer to: • assess the nature and magnitude of the likely displacement; • explore all viable alternative project designs to avoid, where feasible, or minimize displacement; • assess the legal framework covering resettlement and the policies of the government and implementing agencies (identifying any inconsistencies between such policies and the Bank's policy); • review past borrower and likely implementing agencies' experience with similar operations; • discuss with the agencies responsible for resettlement the policies and institutional, legal, and consultative arrangements for resettlement, including measures to address any inconsistencies between government or implementing agency policies and Bank policy; and • discuss any technical assistance to be provided to the borrower. The policy also promotes participation of displaced people in resettlement planning and implementation, and its key economic objective is to assist displaced persons in their efforts to improve or at least restore their incomes and standards of living after displacement. The policy also prescribes compensation and other resettlement measures to achieve its objectives and requires that borrowers prepare adequate resettlement planning instruments prior to Bank appraisal of proposed projects.	requirements. Such actions will include the drafting of a Resettlement Action Plan (RAP) to guide the entire resettlement process. Note that due to uncertainty regarding the extent of resettlement, i.e. the number of displaced people, the applicability of ESS5 and PS 5, per the World Bank and the IFC respectively, cannot be finalised.
Land Acquisition and Involuntary Resettlement Performance Standard 5 outlines that involuntary resettlement refers both to	The stated purposes of this standard are to: • To avoid, and when avoidance is not possible, minimize displacement by exploring alternative project designs.	

Name of Standard/ Guideline	Objectives	Measures Taken to Fulfill Requirements
physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or means of livelihood) as a result of project-related land acquisition	• To avoid forced eviction. • To anticipate and avoid, or where avoidance is not possible, minimize adverse social and economic impacts from land acquisition or restrictions on land use by (i) providing compensation for loss of assets at replacement cost4 and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected. • To improve, or restore, the livelihoods and standards of living of displaced persons. • To improve living conditions among physically displaced persons through the provision of adequate housing with security of tenure at resettlement sites.	
Biodiversity Conservation		
ESS6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Recognizes that protection and conservation of biodiversity and sustainably managing living natural resources are fundamental to sustainable development and it recognizes the importance of maintaining core ecological functions of habitats, including forests, and the biodiversity they support. ESS6 also addresses sustainable management of primary production and harvesting of living natural resources, and recognizes the need to consider the livelihood of project-affected parties, including Indigenous Peoples, who's access to, or use of, biodiversity or living natural resources may be affected by a project.	The ESIA has considered protected area and areas of ecological significance. The ESMPs include provisions on how to conduct activities in a manner that will least impact upon such areas as far as is reasonably possible.

Name of Standard/ Guideline	Objectives	Measures Taken to Fulfill Requirements
Biodiversity Conservation and Sustainable Management of Living Natural Resources Performance Standard 6 recognizes that protecting and conserving biodiversity (the variety of life in all its forms, including genetic, species and ecosystem diversity) and its ability to change and evolve, is fundamental to sustainable development	The stated purposes of this standard are to: • To protect and conserve biodiversity. • To maintain the benefits from ecosystem services. • To promote the sustainable management of living natural resources through the adoption of practices that integrate conservation needs and development priorities.	
Indigenous Peoples		
ESS7: Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities	Ensures that the development process fosters full respect for the human rights, dignity, aspirations, identity, culture, and natural resource-based livelihoods of Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities. ESS7 is also meant to avoid adverse impacts of projects on Indigenous Peoples/Sub-Saharan African Historically Underserved Traditional Local Communities, or when avoidance is not possible, to minimize, mitigate and/or compensate for such impacts.	This Performance Standard applies to communities or groups of Indigenous Peoples who maintain a collective attachment, i.e., whose identity as a group or community is linked, to distinct habitats or ancestral territories and the natural resources therein. It may also apply to communities or groups that have lost collective attachment to distinct habitats or ancestral territories in the project area, occurring within the concerned group members' lifetime, because of forced severance, conflict, government resettlement programs, dispossession of their lands, natural disasters, or incorporation of such territories into an urban area. Indigenous people may be impacted on as a result of the project if they are likely to be affected by physical or economic displacement. This will be ascertained further upon the commencement of the RAP.
Indigenous Peoples Performance Standard 7 recognizes that Indigenous Peoples, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalized and vulnerable segments of the population.	The stated purposes of this standard are to: • To ensure that the development process fosters full respect for the human rights, dignity, aspirations, culture, and natural resource-based livelihoods of Indigenous Peoples. • To anticipate and avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not possible, to minimize and/or compensate for such impacts. • To promote sustainable development benefits and opportunities for Indigenous Peoples in a culturally appropriate manner. • To establish and maintain an ongoing relationship based on Informed Consultation and Participation (ICP) with the Indigenous Peoples affected by a project throughout the project's life-cycle.	

Name of Standard/ Guideline	Objectives	Measures Taken to Fulfill Requirements
	• To ensure the Free, Prior, and Informed Consent (FPIC) of the Affected Communities of Indigenous Peoples when the circumstances described in this Performance Standard are present. • To respect and preserve the culture, knowledge, and practices of Indigenous Peoples.	Stakeholder consultation to date has been sensitive to the vulnerability of the affected communities and the requirements of PS7 will be carried forward into the RAP. The IFC Guide to Human Rights Impact Assessment and Management will also require consideration if there is an impact on Indigenous People.
Cultural Heritage		
ESS8: Cultural Heritage	Addresses physical cultural resources, which are defined as movable or immovable objects, sites, structures, groups of structures, and natural features and landscapes that have archaeological, paleontological, historical, architectural, religious, aesthetic, or other cultural significance. Physical cultural resources may be located in urban or rural settings, and may be above or below ground, or under water. Their cultural interest may be at the local, provincial or national level, or within the international community. Any project involving significant excavations, demolition, movement of earth, flooding, or other environmental changes are to take cognisance of this Standard in the EA.	The ESIA undertaken includes a specialist cultural heritage surveys in Zambia and Zimbabwe. The ESMPs include actions necessary to ensure the safeguarding of cultural heritage potentially impacted by project activities.
Cultural Heritage **Performance Standard 8** recognises the importance of cultural heritage for current and future generations	The stated purposes of this standard are to: • To protect cultural heritage from the adverse impacts of project activities and support its preservation. • To promote the equitable sharing of benefits from the use of cultural heritage. In paragraph 6 it calls for the implementation of international treaties and national laws relating to heritage protection, stating that clients '*will identify and protect cultural heritage by ensuring that internationally recognized practices for the protection, field-based study, and documentation of cultural heritage are implemented*'. In paragraph 7 it adds that '*where the risk and identification process determines that there is a chance of impacts to cultural heritage, the client will retain competent professionals to assist in the identification and protection of cultural heritage*'. In paragraph 9 it is also stated that:	

Name of Standard/ Guideline	Objectives	Measures Taken to Fulfill Requirements
	'The client is responsible for siting and designing a project to avoid significant adverse impacts to cultural heritage. The environmental and social risks and impacts identification process should determine whether the proposed location of a project is in areas where cultural heritage is expected to be found, either during construction or operations.' The standard goes on to specify that Affected Communities and relevant national regulatory agencies should be consulted. It favours the retention of cultural heritage in situ (paragraph 12), only permitting exceptions where there is no feasible alternative and the removal of the resource is carried out 'using the best available technique'. In paragraphs 13-15, the standard addresses impacts on 'critical cultural heritage' defined as: *(i) the internationally recognized heritage of communities who use, or have used within living memory the cultural heritage for long-standing cultural purposes; or (ii) legally protected cultural heritage areas, including those proposed by host governments for such designation.* It states that critical heritage should not be removed unless in exceptional circumstances where impacts are unavoidable. In such cases external experts should be retained to assist in its protection and assessment. Where there are legally protected sites, the client is required to comply with legal requirements related to their protection, consult stakeholders and implement additional programmes to promote and enhance their conservation.	
Dam and Hydropower Specific		
World Bank Operational Policy 4.37: Safety on Dams	Requires that experienced and competent professionals design and supervise construction, and that the borrower adopts and implements dam safety measures through the project cycle. The policy also applies to existing dams where they influence the performance of a project. The policy also recommends, where appropriate, that Bank staff discuss with the borrowers any measures necessary to strengthen the institutional, legislative, and regulatory frameworks for dam safety programs in those countries.	The ESIA takes into account the listed guidelines and standards and the ESMPs provide for the management of related impacts. For an example of how this ESIA meets the requirements prescribed by the WCD and IHA standards please refer to *Annex N* which also includes background detail to the respective institutions.

Name of Standard/ Guideline	Objectives	Measures Taken to Fulfill Requirements
World Commission on Dams (WCD) November 2000 Report "Dams and Development – A New Framework for Decision-Making" (Final Version of 17 November 2008)	Serving as an advisory tool, the WCD guidelines provide an overview of how to assess options and plan and implement dam projects to meet the Commission's criteria.	
International Hydropower Association's (IHA) Sustainability Guidelines (SGs)	The IHA Sustainability Guidelines promote greater consideration of environment, social, and economic sustainability in the assessment of new hydropower projects to assist with the evaluation and management of often competing environmental, social and economic issues that arise in the assessment, operation and management of hydropower projects. The Sustainability Guidelines suggest a number of environmental and social strategies to optimise environmental and social outcomes for Hydropower Schemes.	
International Hydropower Association's (IHA) Hydropower Sustainability Assessment Protocol	The IHA Hydropower Sustainability Assessment Protocol (the Protocol) is a sustainability assessment framework for hydropower development and operation. The intention of the Protocol is to enable the production of a sustainability profile for hydropower projects through the assessment of performance against sustainability topics. In particular, the Protocol comprises four assessment tools for the different stages of the project life cycle	
International Waterways		
World Bank Operational Policy 7.50: Projects on International Waterways	Requires that the borrower make appropriate agreements and arrangements with other the other riparian states prior to financing. The bank is willing to assist borrowers in achieving this end. The policy requires that the international aspects of a project on an international waterway are dealt with at the earliest possible opportunity. If such a project is proposed, the Bank requires the beneficiary state, if it has not already done so, formally to notify the other riparians of the proposed project and its Project/Program Details.	The ESIA process has taken into consideration the regulators and stakeholders of both countries and all such parties have been involved in consultations and agreements.

4.8.8 The Southern African Power Pool (SAPP) Environmental and Social Impact Assessment Guidelines for Hydroelectric Projects and Transmission Infrastructure in the SAPP region (1)

The Southern African Power Pool (SAPP)

The SAPP is a regional body formed in 1995 through a SADC treaty, with the objective of optimizing the use of available energy resources in the region and for SADC members to support one another during energy emergencies. The SAPP coordination centre is based in Harare, Zimbabwe. There are four governance documents covering the rights and obligations of the SAPP members. These are:

'i. Inter-governmental Memorandum of understanding (IGMOU), which grants permission for utilities to participate in the SAPP and enter into contracts and guarantees the financial and technical performance of the power utilities;
ii. Inter-utility memorandum of understanding (IUMOU) between parties, defining ownership of assets and other rights, e.g. provision for change in status from participating to operating member;
iii. Agreement between operating members (ABOM), which determines the interaction between the utilities with respect to operating responsibilities under normal or emergency conditions;
iv. Operating guidelines (OG), which defines the sharing of costs and functional responsibility for plant operation and maintenance including safety rules.'

The SAPP has the following vision.

- *'Facilitate the development of a competitive electricity market in the SADC region*
- *Give the end user a choice of electricity supplier*
- *Ensure that the southern Africa is the region for choice for investment by intensive energy users*
- *Ensure sustainable energy developments through sound economic, environmental and social practices.'*

Further top the SAPP vision, the SAPP has the following objectives.

- *'To provide a forum for the development of a world class, robust, safe, efficient, reliable and stable interconnected electricity system in the southern African region*
- *Coordinate and enforce common regional standards of quality of supply, measurement and monitoring of systems performance*
- *Harmonise the relationship between member utilities*
- *Facilitate the development of a regional expertise through training programmes and research*
- *Increase power accessibility in rural communities*
- *Implement strategies in support of sustainable development priorities'*

(1) Environmental and Social Impact Assessment Guidelines for Transmission Infrastructure for the SAPP Region, 2010.

Purpose of the SAPP ESIA Guidelines

The SAPP Environmental Sub-committee identified the need for ESIA guidelines for transmission infrastructure as a priority. Further to this the sub-committee also designed ESIA guidelines for thermal; plant and hydro scheme projects. The purpose of these guidelines is to assist stakeholders in Southern Africa participating in or undertaking ESIAs. SAPP guidelines recognise the need for a more streamlined ESIA process and improved co-ordination amongst SAPP members. It is noted that the SAPP guidelines are not intended to replace either the international funding requirements or the individual country's legislation with regard to ESIA requirements. The SAPP guidelines purpose is to supplement these mandates, or to provide guidelines in the absence of country legislation pertaining to a specific issue related to transmission infrastructure.

Goals, Objectives and Guiding Principles

The overall goal of the SAPP guidelines is to promote environmentally sustainable livelihoods and development.

The long-term objectives include:

- *Conservation and sustainable use of natural resources,*
- *Protection and enhancement of the quality of all forms of life,*
- *Promotion of public awareness on environmental issues,*
- *Strengthening and building capacities to carry out ESIA,*
- *Integration of environmental considerations in development planning process,*
- *Generation, storage, and dissemination of environmental information, and*
- *Linking grassroots development strategies to global and international initiatives.*
- *To improve the efficiency of electrical systems, by minimising the interaction between the infrastructure and the environment*

The short-term objectives (project specific) include:

- *To assess the nature, intensity and duration of impacts, positive and / or negative, to proposed development projects,*
- *To assist in decision-making with regard to costs and benefits of proposed development projects,*
- *To promote local community and public participation in the ESIA process, and*
- *To promote social and cultural considerations in project design.*

The guiding principles include:

- *Adoption of appropriate policies and legislation to guide the ESIA process,*
- *All development projects to be subjected to the ESIA process,*
- *Equity in allocation of and access to resources, poverty alleviation, and promotion of social justice,*
- *Popular participation of all affected and interested parties including grassroots communities, in the ESIA process,*

- *Accountability of all participating parties to the public,*
- *Transparency throughout the ESIA process,*
- *The ESIA process to take special consideration of the role played by women and children in resource management and any impacts on these groups,*
- *The ESIA process to be a tool in the promotion of sustainable livelihoods and sustainable living*.

The guidelines provide further guidance on the ESIA process to be undertaken, specifically regarding the components and format of an ESIA, and the stakeholder engagement required to be undertaken.

5 ESIA APPROACH AND METHODOLOGY

5.1 INTRODUCTION

The purpose of this ESIA is to examine how the proposed BGHES will lead to a measurable difference in the quality of the environment and the quality of life of impacted individuals and communities. Over the past decades, environmental impact assessments have expanded to include social impact assessments as well as public consultation/stakeholder engagement in the planning and decision-making process to avoid, reduce, or mitigate adverse impacts and to maximise the benefits of the project proposed. More recently, the emphasis has moved to the ESIA producing robust social and environmental management plans, which can effectively implement the recommended mitigation measures (developed in partnership with the proponent) identified in the ESIA during the life of the project and culminating with an effective decommissioning plan.

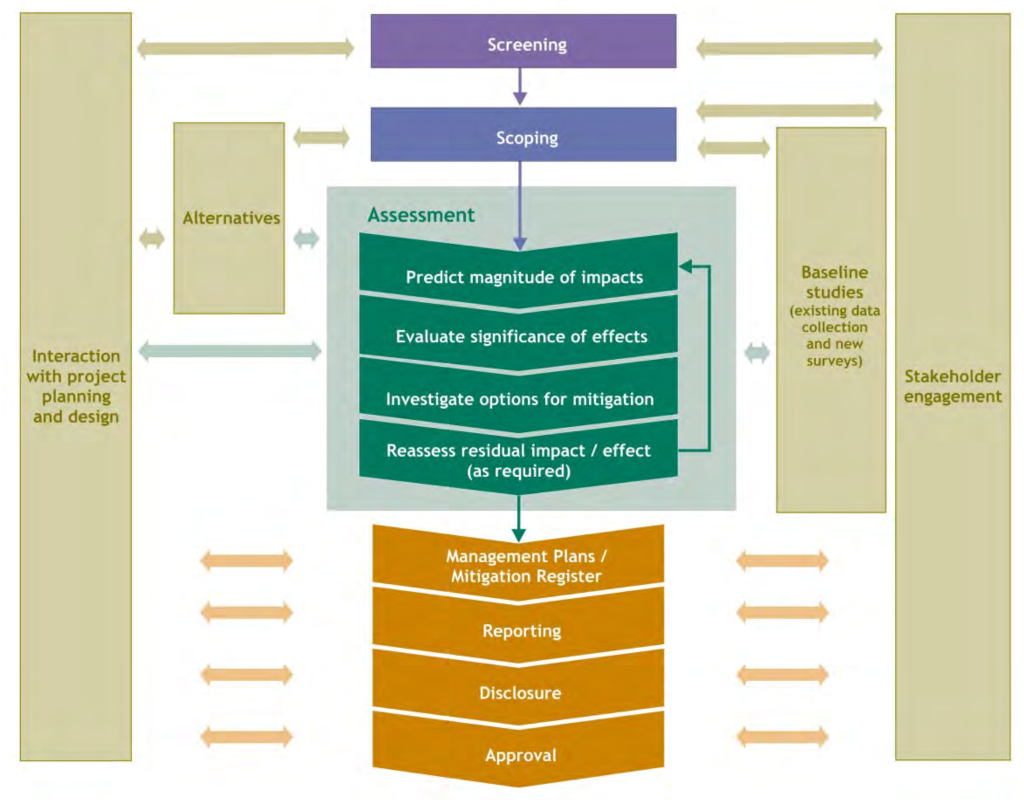
The key stages for this ESIA are:

- Screening;
- Scoping (and site screening/selection);
- Stakeholder engagement;
- Baseline data collection;
- Project description and interaction with design and decision-making bodies;
- Assessment of impacts and identification of mitigation measures;
- Integrated management system and plans;
- Reporting and disclosure; and
- Review and approval.

Figure 5.1 illustrates a *generic* overview of the ESIA process. It must be noted that this is not a linear process, but one where several stages are carried out in parallel and where the assumptions and conclusions are revisited and modified as the project and ESIA progress.

The following sections provide detail on how each stage of the ESIA process will be applied to the proposed Project.

Figure 5.1 The ESIA Process



5.2 *SCREENING*

Screening was undertaken in order to identify the need for the Project to be subject to the ESIA process, and was based upon a review of the likely Project activities, regulatory requirements and the sensitivities of the receiving environment within which the Project will take place.

In Zambia the Project falls under the Second Schedule of the Environmental Impact Assessment (EIA) Regulations, Statutory Instrument No. 28 of 1997, of the Environmental Protection and Pollution Control Act of 1990, which lists the requirements for an ESIA under the categories *Electrical Infrastructure* and *Electricity generation station* and under the category of *Dams, Rivers and Water Resources* which lists *Dams and barrages covering a total of 25 ha or more*.

As discussed in *Chapter 4*, *Section 4.3.2*, in Zimbabwe provisions of the Environmental Management Act (the Act) (Chapter 20:27), No. 13 of 2002 that relate to EIAs are set out in Section 97 of the Act. The Environmental Management Act (Chapter 20:27) First Schedule lists which activities trigger the need for an ESIA. Of relevance to this project are the categories *Dams and manmade lakes*; and *Power generation and transmission* which lists *hydropower schemes*; *and high-voltage transmission lines*. As such, a project prospectus was submitted to the Zimbabwean Environmental Management Agency (EMA) on 18 June 2014, and a response received on 25 June 2014, instructing ERM to proceed with the ESIA study (Project No 7090).

Once feedback on the project prospectus was obtained from the Zimbabwean EMA, and once it was determined that the Project triggered the need for an ESIA in both Zambia and Zimbabwe through the appropriate Acts, the scoping phase was initiated.

5.3 *SCOPING*

The purpose of the scoping phase was to identify key sensitivities and those activities with the potential to contribute to, or cause, potentially significant impacts to environmental and socio-economic receptors and resources and to evaluate siting, layout and technology alternatives for the Project proposed. The key objectives of scoping were to:

- Identify the potentially most significant impacts;
- Identify existing information sources and local knowledge;
- Identify project stakeholders;
- Obtain stakeholder views through consultation; and
- Determine the spatial and temporal boundaries for the ESIA studies;

- Develop the Terms of Reference (ToR) for the ESIA through consultation so as to ensure that the ESIA process and associated reporting output are focused on the key issues.

The ESIA process focuses on these key issues through the collection of information on existing environmental and social conditions; engagement with stakeholders (see *Box 5.1*); understanding the impacts to the physical, biophysical and social environment; and developing the measures to avoid/control and monitor these impacts.

The ToR for the ESIA (the Scoping Report), formed the basis for this ESIA. The Scoping Report was submitted to and approved by the Zambian Environmental Management Agency (ZEMA) on the 24th December 2015 (refer to *Annex A*). Given that the Zambian and Zimbabwean Environmental Management Authorities requested that a similar harmonised process be undertaken for the proposed BGHES (refer to C*hapter 1*), the Zimbabwean Environmental Management Agency (EMA) was also provided a copy of the report for review, although not a legal requirement.

Issues that were raised by stakeholders during the scoping phase were taken into account in the ESIA ToR. A Comments and Responses Report (CRR) is included in *Annex C*.

5.4 STAKEHOLDER ENGAGEMENT

The key principle of consultation is to ensure that the views of stakeholders are taken into account and reported throughout the ESIA process. The objective is to ensure the assessment is robust, transparent and has considered the full range of issues or perceptions, and to an appropriate level of detail.

Box 5.1 Definition of Stakeholders

Stakeholders include those individuals, groups or organisations who themselves could be directly affected by the proposed Project (Project affected people) and those individuals or organisations who, although not directly affected by the proposed Project, represent those affected or have a regulatory duty, an interest, influence or secondary involvement in the proposed Project (secondary stakeholders).

Detailed stakeholder engagement started during the scoping phase and will continue throughout the assessment ensuring that legislative requirements and Project standards (as defined in *Chapter 4*) are met, that stakeholder concerns are addressed in the assessment and that sources of existing information and expertise are identified.

Consultation has been (and will continue to be) undertaken at a number of stages during the development of the Project. A summary of the stakeholder engagement process is included in *Chapter 7* of this document.

5.5 *BASELINE DATA COLLECTION*

One of the main objectives of the ESIA process was to collect suitable data on the physical, biophysical and social environment, so as to understand what receptors and resources have the potential to be *significantly* affected by the proposed Project. *Chapters 8* and *9* describe the baseline conditions that have been used to make the assessment of both environmental and social impacts (the impact assessments are presented in *Chapter 10* and *11* respectively). The description of the baseline aims at providing sufficient detail to meet the following objectives:

- Identify the key conditions and sensitivities in areas potentially affected by the proposed Project;
- Identify environmental conditions which might influence project design decisions (e.g., route alignment and structural characteristics);
- Provide a basis for extrapolation of the current situation, and development of future scenarios without the proposed Project;
- Provide data to aid the prediction and evaluation of possible impacts of the proposed Project;
- Understand stakeholder concerns, perceptions and expectations regarding the proposed Project;
- Allow the Project proposed to develop appropriate mitigation measures later in the ESIA process; and
- Provide a benchmark to assess future changes and to assess the effectiveness of mitigation measures.

The methodologies utilised to collect biodiversity baseline data, as well as appropriate social data and data on cultural heritage, is presented in *Annex G* of this report.

The socio-economic baseline associated with this ESIA was prepared between September 2014 and March 2015. Given that substantial time has passed since the collection of primary data, and that there is likely to have been an update to secondary data since then, there is a need to assess the validity of this baseline data. Validation / updating of the socio-economic baseline has therefore been included as a requirement of this ESIA. It essential that this process of validation be undertaken prior to approval of this ESIA.

5.6 *INTERACTION WITH DESIGN AND DECISION-MAKING PROCESS*

The interaction between the ESIA team and the design and decision-making process is one of the key areas in which an ESIA can influence how a project develops. It includes involvement in defining the Project and identifying those activities with the potential to cause environmental and socio-economic impacts (e.g. physical presence, noise, workforce, traffic, local employment, procurement). Project planning, decision-making and refinement of the Project description continue throughout the assessment process as a result of the development of the proposed Project and in response to the identified impacts.

During the ESIA process, there was extensive liaison between Studio Pietrangeli (SP - the engineering consultants for the ZRA), the ZRA and ERM with regard to informing design, and identifying impacts and potential mitigation measures. Examples of key areas covered between ERM and SP include:

- Initially, the Environmental Flow Assessment work undertaken indicated impacts to downstream aquatic ecology based on three scenarios from run-of-river to daily peaking scenarios. In January 2019, ERM (together with the Environmental Flow team from Southern Waters) together with the ZRA and SP workshopped refinement of the operating rules for the Project with SP, using the Environmental Flow (eflow) model setup for the Project. This workshop and subsequent refinement of the operating rules served to find a balance between minimising environmental impacts downstream, together with maximising power output.

- Water Quality modelling results for both in-dam and downstream scenarios, which resulted in recommendations made to SP on the height of the offtake structures, to reduce the temperature impacts downstream from releasing colder water, especially applicable in the low flow season;

- Suggested options regarding the Full Supply Level (FSL), as well as suggested operating rules for the FSL, especially to accommodate white water rafting in the low flow season and back flooding of the Victoria Falls Power Station (VFPS) in the high flow season;

- Provision of guidance around positioning of project infrastructure, specifically roads, project townships, and transmission lines, and possible environmental, social and cultural heritage sensitivities.

5.7 *ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDY*

All potentially significant environmental impacts (physical, biological, socio-economic and cultural and heritage) associated with the proposed Project were identified during the scoping phase and (where applicable) have been further investigated and assessed within the ESIA study through specialist studies. *Chapter 10* and *11* provide the biophysical and social impact assessments respectively. Where required, mitigation measures have been proposed.

5.7.1 *Aim of the ESIA*

The ESIA aims to achieve the following:

- Provide an overall assessment of the physical, biological, socio-economic and cultural and heritage environments affected by the proposed Project;
- Assess the Project Area in terms of its environmental criteria;
- Identify and recommend appropriate mitigation measures for potentially significant negative environmental impacts and enhancement measures for potentially positive impacts; and
- Undertake a fully inclusive public participation process.

The adequate assessment and evaluation of the potential impacts and benefits that will be associated with the proposed Project necessitates the development of a scientific methodology that will reduce the subjectivity involved in making such evaluations. A clearly defined methodology is used in order to accurately determine the significance of the predicted impact on, or benefit to, the surrounding natural and/or social environment. For this the proposed Project must be considered in the context of the area and the people that will be affected.

Nonetheless, an impact assessment will always contain a degree of subjectivity, as it is based on the value judgment of various specialists and EIA practitioners. The evaluation of significance is thus contingent upon values, professional judgement, and dependent upon the environmental and community context. Ultimately, impact significance involves a process of determining the acceptability of a predicted impact to society.

The purpose of impact assessment is to identify and evaluate the likely significance of the potential impacts on identified receptors and resources according to defined assessment criteria, to develop and describe measures that will be taken to avoid, minimise, reduce or compensate for any potential adverse environmental effects, and to report the significance of the residual impacts that remain following mitigation.

There are a number of ways that impacts may be described and quantified. An impact is essentially any change to a resource or receptor brought about by the presence of the proposed Project component or by the execution of a proposed Project related activity.

5.7.2 *Assessment of Impacts and Mitigation*

The impact assessment stage comprises a number of steps that collectively assess the manner in which the proposed Project will interact with elements of the physical, biological, cultural or human environment to produce impacts to resources/receptors. The steps involved in the impact assessment stage are described in greater detail below and represent a standard methodology that has been successfully applied by ERM in numerous similar major capital projects.
The environmental impact assessment detailed below is an approach that combines *Impact Magnitude* and *Receptor Sensitivity* to determine **Impact Significance**.

The overall approach to the rating and evaluation of social (including visual) impacts is similar to what is detailed below; however, the impact criteria used to define cultural heritage sensitivities is disparate, and is described here and in more detail *Annex D* of this ESIA.

Impact Assessment

The impact characteristic terminology used is summarised in *Table 5.1*.

Table 5.1 Impact Characteristic Terminology

Characteristic	Definition	Designations
Type	A descriptor indicating the relationship of the impact to the Project (in terms of cause and effect).	Direct Indirect Induced
Extent	The "reach" of the impact (e.g., confined to a small area around the Project Footprint, projected for several kilometres, etc.).	Local Regional International
Duration	The time period over which a resource / receptor is affected.	Temporary Short-term Long-term Permanent
Scale	The size of the impact (e.g., the size of the area damaged or impacted, the fraction of a resource that is lost or affected, etc.)	[no fixed designations; intended to be a numerical value]
Frequency	A measure of the constancy or periodicity of the impact.	[no fixed designations; intended to be a numerical value]

In the case of *type*, the designations are defined universally (i.e., the same definitions apply to all resources/receptors and associated impacts). For these universally-defined designations, the definitions are provided in *Table 5.2*.

Table 5.2 Designation Definitions

Designation	Definition
Type	
Direct	Impacts that result from a direct interaction between the Project and a resource/receptor (eg, between occupation of a plot of land and the habitats which are affected).
Indirect	Impacts that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment (e.g., viability of a species population resulting from loss of part of a habitat as a result of the Project occupying a plot of land).
Induced	Impacts that result from other activities (which are not part of the Project) that happen as a consequence of the Project (eg, influx of camp followers resulting from the importation of a large Project workforce).
Extent	
Local	Defined on a resource/receptor-specific basis.
Regional	
International	

Designation	Definition
Duration	
Temporary	Defined on a resource/receptor-specific basis.
Short-term	
Long-term	
Permanent	

In the case of *extent* and *duration*, the designations themselves (shown in *Table 5.1*) are universally consistent, but the definitions for these designations will vary on a resource/receptor basis (e.g., the definition of what constitutes a "short term" duration for a noise-related impact may differ from that of a "short term" duration for a habitat-related impact). This concept is discussed further below.

In the case of *scale* and *frequency*, these characteristics are not assigned fixed designations, as they are typically numerical measurements (e.g., number of hectares affected, number of times per day, etc.).

The terminology and designations are provided to ensure consistency when these characteristics are described in an impact assessment deliverable. However, it is not a requirement that each of these characteristics be discussed for every impact identified.

An additional characteristic that pertains only to unplanned events (eg, traffic accident, operational release of toxic gas, community riot, etc.) is *likelihood*. The likelihood of an unplanned event occurring is designated using a qualitative (or semi-quantitative, where appropriate data are available) scale, as described in *Table 5.3*.

Table 5.3 Definitions for Likelihood Designations

Likelihood	Definition
Unlikely	The event is unlikely but may occur at some time during normal operating conditions.
Possible	The event is likely to occur at some time during normal operating conditions.
Likely	The event will occur during normal operating conditions (ie, it is essentially inevitable).

Likelihood is estimated on the basis of experience and/or evidence that such an outcome has previously occurred.

It is important to note that likelihood is a measure of the degree to which the unplanned event is expected to occur, *not* the degree to which an impact or effect is expected to occur as a result of the unplanned event. The latter concept is referred to as *uncertainty*, and this is typically dealt with in a contextual discussion in the impact assessment deliverable, rather than in the impact significance assignment process.

In the case of impacts resulting from unplanned events, the same resource/receptor-specific approach to concluding a magnitude designation is utilised, but the 'likelihood' factor is considered, together with the other impact characteristics, when assigning a magnitude designation. There is an inherent challenge in discussing impacts resulting from (planned) Project activities and those resulting from unplanned events. To avoid the need to fully elaborate on an impact resulting from an unplanned event prior to discussing what could be a very low likelihood of occurrence for the unplanned event, this methodology incorporates likelihood into the magnitude designation (ie, in parallel with consideration of the other impact characteristics), so that the "likelihood-factored" magnitude can then be considered with the resource/receptor sensitivity/vulnerability/importance in order to assign impact significance. Rather than taking a prescriptive (e.g., matrix) approach to factoring likelihood into the magnitude designation process, it is recommended that this be done based on professional judgment, possibly assisted by quantitative data (eg, modelling, frequency charts) where available.

Defining the Magnitude of an Impact

Once the impact characteristics are understood, these characteristics are used (in a manner specific to the resource/receptor in question) to assign each impact a *magnitude*. In summary, *magnitude* is a function of the following impact characteristics:

- Extent;
- Duration;
- Scale;
- Frequency; and
- Likelihood.

Magnitude essentially describes the degree of change that the impact is likely to impart upon the resource/receptor. As in the case of extent and duration, the magnitude designations themselves (ie, negligible, small, medium, large) are universally used and across resources/receptors, but the definitions for these designations will vary on a resource/receptor basis, as is discussed further below. The universal magnitude designations are:

- Positive;
- Negligible;
- Small;
- Medium; and
- Large.

The magnitude of impacts takes into account all the various dimensions of a particular impact in order to make a determination as to where the impact falls on the spectrum (in the case of adverse impacts) from *negligible* to *large*. Some impacts will result in changes to the environment that may be immeasurable, undetectable or within the range of normal natural variation. Such changes can be regarded as essentially having no impact, and should be characterised as having a *negligible* magnitude. In the case of *positive* impacts no magnitude will be assigned.

Defining the Sensitivity/Vulnerability/Importance of a Resource or Receptor

In addition to characterising the magnitude of impact, the other principal step necessary to assign significance for a given impact is to define the *sensitivity/vulnerability/importance* of the impacted resource/receptor. There are a range of factors to be taken into account when defining the sensitivity/vulnerability/importance of the resource/receptor, which may be physical, biological, cultural or human. Where the resource is physical (for example, a water body) its quality, sensitivity to change and importance (on a local, national and international scale) are considered. Where the resource/receptor is biological or cultural (for example, the marine environment or a coral reef), its importance (for example, its local, regional, national or international importance) and its sensitivity to the specific type of impact are considered.

Where the receptor is human, the vulnerability of the individual, community or wider societal group is considered. *Box 5.2* provides those social criteria used to assess levels of vulnerability.

Other factors may also be considered when characterising sensitivity/vulnerability/importance, such as legal protection, government policy, stakeholder views and economic value.

Box 5.2 ***Social Criteria Used to Assess Levels of Vulnerability (applicable to social impacts only)***

Vulnerability is underpinned by a low existing level of livelihoods assets (such as health or education) or inadequate access to structures and processes to protect or improve livelihoods. In order to identify vulnerable receptors, it is necessary to identify receptors that experience these circumstances. Stakeholder groups that should be considered specifically should be identified through stakeholder analysis, as informed by baseline data gathering and stakeholder engagement. They could include, but may not be limited to, the following:

- ethnic minorities, including those of a different race, religion, caste or language than the dominant population;
- women, particularly female headed households;
- the old, infirm or disabled;
- those with underlying chronic health conditions especially if there is stigma associated with the health condition (e.g., HIV/AIDS);
- those with differential rights, such as those without legal rights to land;
- those living below the poverty line / living wage;
- those without or with limited access to access to basic services such as water, sanitation, health care and education; and
- those living in areas with pre-existing levels of environmental contaminants

As part of the impact assessment process, the social and community health practitioner will need to summarise the vulnerability of the general population that will be impacted by the Project and to differentiate the vulnerability of particular groups that demonstrate a higher level of vulnerability.

As in the case of magnitude, the sensitivity/vulnerability/importance designations themselves are universally consistent, but the definitions for these designations will vary on a resource/receptor basis. The universal sensitivity/vulnerability/importance designations are shown in *Table 5.4*.

Table 5.4 Levels of Vulnerability

Level of Vulnerability	Definition
Low	Minimal vulnerability; consequently with a high ability to adapt to changes brought by the Project and opportunities associated with it.
Medium	Some, but few areas of vulnerability; still retaining an ability to at least in part adapt to change brought by the Project and opportunities associated with it.
High	Profound or multiple levels of vulnerability that undermine the ability to adapt to changes brought by the Project and opportunities associated with it.

Impact Significance as a function of Magnitude and Sensitivity/Vulnerability/ Importance

Once magnitude of impact and sensitivity/vulnerability/importance of resource/receptor have been characterised, the ***significance*** can be assigned for each impact.

Impact significance is designated using the matrix shown in *Table 5.5.*

Table 5.5 Impact Significances

		Sensitivity/Vulnerability/Importance of Resource/Receptor		
		Low	**Medium**	**High**
Magnitude of Impact	**Negligible**	Negligible	Negligible	Minor
	Small	Negligible	Minor	Moderate
	Medium	Minor	Moderate	**Major**
	Large	Moderate	**Major**	**Major**

The matrix applies universally to all resources/receptors, and all impacts to these resources/receptors, as the resource/receptor- or impact-specific considerations are factored into the assignment of magnitude and sensitivity designations that enter into the matrix. *Box 5.3* provides a context for what the various impact significance ratings signify.

Box 5.3 Context of Impact Significances

An impact of ***negligible*** significance is one where a resource/receptor (including people) will essentially not be affected in any way by a particular activity or the predicted effect is deemed to be 'imperceptible' or is indistinguishable from natural background variations.

An impact of ***minor*** significance is one where a resource/receptor will experience a noticeable effect, but the impact magnitude is sufficiently small (with or without mitigation) and/or the resource/receptor is of low sensitivity/ vulnerability/ importance. In either case, the magnitude should be well within applicable standards.

An impact of ***moderate*** significance has an impact magnitude that is within applicable standards, but falls somewhere in the range from a threshold below which the impact is minor, up to a level that might be just short of breaching a legal limit. Clearly, to design an activity so that its effects only just avoid breaking a law and/or cause a major impact is not best practice. The emphasis for moderate impacts is therefore on demonstrating that the impact has been reduced to a level that is as low as reasonably practicable (ALARP). This does not necessarily mean that impacts of moderate significance have to be reduced to minor, but that moderate impacts are being managed effectively and efficiently.

An impact of ***major*** significance is one where an accepted limit or standard may be exceeded, or large magnitude impacts occur to highly valued/sensitive resource/receptors. An aim of impact assessment is to get to a position where the Project does not have any major residual impacts, certainly not ones that would endure into the long term or extend over a large area. However, for some aspects there may be major residual impacts after all practicable mitigation options have been exhausted (ie ALARP has been applied). An example might be the visual impact of a facility. It is then the function of regulators and stakeholders to weigh such negative factors against the positive ones, such as employment, in coming to a decision on the Project.

For the assessment of ***Cultural Heritage*** impact significance, those sites both directly and indirectly impacted are also rated, as described in this *Chapter*, according to Magnitude and Sensitivity of impact. With respect to Cultural Heritage specifically, *Magnitude* refers to the extent that the site may be impacted in terms of the area that will be damaged and changes to current access to the site. *Sensitivity* considers the site's uniqueness; its local/national/international significance; the community values that it carries; and its scientific importance in terms of research potential.

Table 5.6 combines these attributes to provide an impact rating significance from which relevant mitigation proposals are established. This rating is shown in *Table 5.6*.

Table 5.6 Means by which to Determine Cultural Heritage Site Significance

			Cultural Heritage Site Sensitivity		
			Low	Medium	High
Definitions			**Defining Characteristic(s).** Site is not specifically protected under local, national, or international laws or treaties; site can be moved to another location or replaced by a similar site, or is of a type that is common in surrounding region; site has limited tor no cultural value to local national, or international stakeholders; and/ or site has limited scientific value or similar information can be obtained at numerous sites. (Replicable Cultural heritage)	**Defining Characteristic(s).** Site is specifically or generally protected by local or national laws but laws allow for mitigated impacts; Site can be moved or replaced, or data and artefacts recovered in consultation with stakeholders; Site has considerable cultural value for local and/ or national stakeholders; and/ or Site has substantial scientific value but similar information can be obtained at a limited number of other sites. (non-replicable Cultural Heritage)	**Defining Characteristic(s).** Site is protected by local, national, and international laws of treaties; Site cannot be moved or replaced without major loss of cultural value; Legal status specifically prohibits direct impacts or encroachment on site and/ or protection zone; Site has substantial value to local, national and international stakeholders; and/ or Site has exceptional; scientific value and similar site types are rate or non-existent. (Critical Cultural Heritage)
Magnitude of Impact	Negligible	No discernible change in the physical condition, setting, or accessibility of the site.	Negligible	Negligible	Negligible
	Small	Small part of the site is lost or damaged, resulting In a loss of scientific or cultural value; setting undergoes temporary or permanent change that has limited effect on the site's perceived value to stakeholders; Stakeholder/ public or scientific access to site id temporarily impeded; and/ or Historic building suffers minor, reparable, structural damage.	Negligible	Minor	Moderate
	Medium	A significant portion of the site is lost or damaged, resulting in a loss of scientific or cultural value; Setting undergoes permanent chance that permanently diminishes the site's perceived value to stakeholders; Site becomes inaccessible for the life of the Project to stakeholders including traditional users or researchers; and/or Historic building suffers major structural damage that is not reparable	Minor	Moderate	**Major**
	High	The entire site is damaged or lost, resulting in a nearly complete of complete loss of scientific or cultural value; Setting is sufficiently impact to cause site to lose nearly all or all cultural value or functionality; Site becomes permanently inaccessible to stakeholders including traditional users or researchers; and/or historic building suffers major structural failure.	Moderate	**Major**	**Major**

Mitigation of Impacts

Once the significance of a given impact has been characterised using the above mentioned methodologies for environmental, social and cultural heritage impacts, the next step is to evaluate what mitigation measures are warranted. The approach taken to defining mitigation measures is based on a typical hierarchy of decisions and measures, as described in *Box 5.4*.

Box 5.4 Mitigation Hierarchy

THE MITIGATION HIERARCHY FOR PLANNED PROJECT ACTIVITIES
Avoid at Source; Reduce at Source   **Avoiding or reducing at source is essentially 'designing' the Project so that a feature causing an impact is designed out (eg a waste stream is eliminated) or altered (eg reduced waste volume). Often called minimisation.**   ***Abate on Site***   **This involves adding something to the basic design to abate the impact - pollution controls fall within this category. Often called 'end-of-pipe'.**
Abate at Receptor   **If an impact cannot be abated on-site then measures can be implemented off-site - an example of this would be to use the stand-by vessel to help control the level of interference with fishing activity.**
Repair or Remedy   **Some impacts involve unavoidable damage to a resource, eg land disturbance. Repair essentially involves restoration and reinstatement type measures, such as base camp closure.**
Compensate in Kind   **Where other mitigation approaches are not possible or fully effective, then compensation, in some measure, for loss, damage and general intrusion might be appropriate.**

In keeping with the Mitigation Hierarchy, the priority in mitigation is to first apply mitigation measures to the source of the impact (ie, to avoid or reduce the magnitude of the impact from the associated project activity), and then to address the resultant effect to the resource/receptor via abatement or compensatory measures or offsets (ie, to reduce the significance of the effect once all reasonably practicable mitigations have been applied to reduce the impact magnitude).

It is important to have a solid basis for recommending mitigation measures. The role of any given ESIA is to develop a consentable project, and to help develop the project in a responsible manner. Impact assessment is about identifying the aspects of a project that need to be managed, and demonstrating how these have been appropriately dealt with. As key influencers in the decision making process, the role of the impact assessment is not to stop development or propose every possible mitigation or compensatory measure imaginable, but rather to make balanced judgements as to what is warranted, informed by a high quality evidence base.

Additional mitigation measures should not be declared for impacts rated as not significant, unless the associated activity is related to conformance with an 'end of pipe' applicable requirement. Further, it is important to note that it is not an absolute necessity that all impacts be mitigated to a not significant level; rather the objective is to mitigate impacts to an *as low as reasonably practicable* (ALARP) level.

Embedded controls (ie, physical or procedural controls that are planned as part of the project design and are not added in response to an impact significance assignment), are considered as part of the project (prior to entering the impact assessment stage of the impact assessment process).

Residual Impact Assessment

Once mitigation measures are declared, the next step in the impact assessment process is to assign residual impact significance. This is essentially a repeat of the impact assessment steps discussed above, considering the assumed implementation of the additional declared mitigation measures.

Cumulative Impacts/Effects

Cumulative impacts and effects are those that arise as a result of an impact and effect from the Project interacting with those from another activity to create an additional impact and effect. These are termed cumulative impacts and effects.

Chapter 12 qualitatively considers the cumulative impacts that would result from the combination of the proposed Project and other developments (actual or proposed) in the broader Project Area. The approach for assessing cumulative impacts and effects resulting from the proposed Project and another activity affecting the same resource/receptor is based on a consideration of the approval/existence status of the 'other' activity and the nature of information available to aid in predicting the magnitude of impact from the other activity.

Reporting and Disclosure

This draft ESIA report together with the various subsidiary management plans will be disclosed to the registered stakeholders.

A Grievance Redress Mechanism has been established for the Project and will provide long-term input to the proposed Project (see *Annex E*).

Uncertainty and Change Management

Even with a final design and an unchanging environment, impacts are difficult to predict with certainty, but in projects such as the proposed BGHES where the design process is currently in progress, uncertainty stemming from on-going development of the Project design is inevitable, and the environment is typically variable from season to season and year to year. Similarly, the organisational structure and roles and responsibilities may also change as the Project progresses. Where such uncertainties are material to ESIA findings, they should be clearly stated and conservatively approached ('the precautionary approach') in order to identify the broadest range of likely residual impacts and necessary mitigation measures.

The ESIA process does not stop with submission of the reports. Therefore, the ESMPs will require a mechanism to manage change. At times these changes may be material, potentially influencing the original findings of the ESIA, and hence, the basis for its approval. Such a mechanism to manage change, or a change management system, must ensure that changes to the scope of the proposed Project are subjected to a robust social and environmental assessment process. Any changes to Project scope will be evaluated for their degree of significance, and will be incorporated into the appropriate BGHES documentation as follows:

- Minor changes will be reflected in updates to the applicable Management Plans; and

- Substantive design / technology changes that might potentially alter the ESIA findings (i.e. those that result in changes to the predicted significance of environmental and socio-economic impacts) will be subject to re-assessment, further stakeholder consultation, supplementary reporting and revision of the Project's ESMPs. Typically, such substantive changes will be submitted as an addendum to this ESIA.

5.7.3 *Greenhouse Gas (GHG) Impact Assessment Methodology*

Introduction

A traditional impact assessment is conducted by determining how the proposed activities will affect the state of the environment described in the baseline. In the case of GHG emissions, this process is complicated by the fact that the potential impact of GHG emissions on the environment cannot be quantified within a defined space and time.

The greenhouse effect occurs on a global basis and the specific source of GHG emissions cannot be linked directly to the future potential impact on the climate or on the BGHES geography. In the absence of such causal links, this *Section* presents a methodology that provides an appropriate and practical link between the GHG emissions of the BGHES and the impact assessment process adopted in this ESIA.

The magnitude of GHG emissions from the BGHES has been compared to national and international (i.e. IFC) GHG emissions criteria (1).

Identifying Impact Magnitude

The magnitude of GHG emissions is defined as the tonnes of carbon dioxide equivalent (tCO_2e), emitted. GHG emissions which should be included in a GHG assessment, as stated by the GHG protocol Corporate Accounting &

(1) International Finance Corporation Performance Standard 3 – Resource Efficiency and Pollution Prevention (2012)

Reporting Standard, are the six greenhouse gases covered by the Kyoto Protocol. These are:

- Carbon dioxide (CO_2),
- Methane (CH_4),
- Nitrous oxide (N_2O),
- Hydrofluorocarbons (HFCs),
- Perfluorocarbons (PFCs), and;
- Sulphur hexafluoride (SF_6)

The quantity of these gases emitted must be multiplied by the gas' global warming potential (GWP) to convert this into tonnes CO_2e. *Table 5.7* shows the latest 100 year time horizon GWP's, relative to CO_2 are set out within the IPCC's Fifth Assessment Report, 2014 (AR5) (1).

Table 5.7 ***Global Warming Potential Values***

GHG	Fifth Assessment Report (AR5)
Carbon dioxide (CO_2)	1
Methane (CH_4)	28
Nitrous oxide (N_2O)	265
Hydrofluorocarbons (HFCs)	4 - 12,400
Perfluorocarbons (PFCs)	6,630 – 11,100
Sulphur hexafluoride (SF_6)	23,500

In the absence of national laws relating to the magnitude of GHG emissions from project developments, international standards are used to place Project emissions into perspective.

Table 5.8 shows a potential magnitude scale for project-wide GHG emissions that is derived from, and in line with, reporting thresholds adopted by a number of current international lender organisations or groupings, such as the IFC Standards, the European Bank for Reconstruction and Development (EBRD) GHG assessment methodology (2) and the Equator Principles (3).

Table 5.8 ***Magnitude Scale for Project-Wide GHG Emissions***

Project-Wide GHG Emissions / annum	Magnitude Rating
>1,000,000 tCO_2e	Very Large
100,000 – 1,000,000 tCO_2e	Large
25,000 – 100,000 tCO_2e	Medium
5,000 - 25,000 tCO_2e	Small

(1) IPCC's Fifth Assessment report, 2014 available online at https://www.ipcc.ch/assessment-report/ar5/
(2) EBRD Methodology for Assessment of Greenhouse Gas Emissions (2010)
http://www.ebrd.com/downloads/about/sustainability/ghgguide.pdf
(3) Available online at: http://www.equator-principles.com/index.php/ep3

Project-Wide GHG Emissions / annum	Magnitude Rating
<5,000 tCO_2e	Negligible

The IFC's Performance Standard 3 defines a reporting threshold for annual GHG emissions of 25,000 tonnes of CO_2 equivalent (tCO_2e) and requires clients to "*…consider alternatives and implement technically and financially feasible and cost-effective options to reduce project-related GHG emissions during the design and operation of the project*".

An annual GHG emissions threshold of 25,000 tCO_2e has also been adopted by the EBRD within its Environmental and Social Policy (1). This updated policy reduces the GHG reporting threshold within projects that the EBRD supports from 100,000 to 25,000 tCO_2e / year and requires annual client quantification and reporting of these emissions. EBRD guidance on assessment of GHG emissions also defines a series of categories and thresholds for different project types (shown in *Table 5.9*). Hydroelectric power generation projects are considered likely to fall into the EBRD's 'Low' category.

Table 5.9 EBRD GHG Emissions Reporting Categories

GHG Emissions / annum	Magnitude Description
> 1,000,000 tCO_2e	High
100,000 – 1,000,000 tCO_2e	Medium-High
20,000 – 100,000 tCO_2e	Medium-Low
< 20,000 tCO_2e	Low
Not defined	Negligible

The Equator Principles require all projects, in all locations, to conduct an alternatives analysis to evaluate less GHG intensive alternatives when combined Scope 1 and Scope 2 operational emissions are expected to be more than 100,000 tCO_2e annually. In addition, the Equator Principles require that "*the client (should) report publicly on an annual basis on GHG emission levels (combined Scope 1 and Scope 2 emissions) during the operational phase for Projects emitting over 100,000 tonnes of CO_2 equivalent annually. Clients will be encouraged to report publicly on Projects emitting over 25,000 tonnes.*"

Determining Significance

The receptor for GHG emissions is the global climate, and the natural and societal systems and infrastructure, which the climate will influence.

In order to conclude whether the potential impact from GHG emissions is deemed significant or not, a risk classification approach is used. The approach is derived from classic risk assessment terminology, which involves the expression of risk as the consequence of the event multiplied by the probability of that event. The environmental assessment equivalent is the magnitude of the impact multiplied by the likelihood of the impact. Impact magnitude is a

(1) EBRD Environmental and Social Policy, 2014. Available online at: https://www.ebrd.com/downloads/research/policies/esp-final.pdf

function of the potential intensity of the impact, moderated by the extent and duration of that impact. Expressed mathematically impact significance is:

Impact significance = (intensity + extent + duration) × likelihood

When considering GHGs, the extent and duration of the potential impact will always be the same. The extent is international as it is the total stock of world GHG emissions (leading to the greenhouse effect) that are directly increased due to the impact of a project. The greenhouse effect is transboundary and so global emissions and national emissions are both directly affected. The duration of the impact is regarded as permanent as the persistence of carbon dioxide in the atmosphere ranges between 100 and 300 years [(1)] and continues beyond the life of the project. Therefore, the magnitude of the potential impact is directly related to the intensity, or volume of emissions. Likelihood can be defined as 'Unlikely', 'Seldom/Occasional' or 'Likely' (refer to *Table 5.10*).

Table 5.10 Likelihood Definitions

Likelihood	Criteria
Unlikely	Reasonable to expect that the consequence will not occur at this facility during its lifetime.
Seldom/Occasional	Exceptional circumstances/conditions may allow the consequence to occur within the facility lifetime.
Likely	Consequence can reasonably be expected to occur within the life of the facility.

The magnitude of a potential impact and the likelihood have been assessed in combination to evaluate whether a potential GHG impact is significant and if so, its degree of significance. This is illustrated in *Table 5.11.*

Table 5.11 GHG Impact Significance Rating

		LIKELIHOOD		
		Unlikely	**Seldom/ Occasional**	**Likely**
MAGNITUDE	**High**	Major	Major	Major
	Medium-High	Moderate	Major	Major
	Medium-Low	Minor	Moderate	Major
	Low	Negligible	Minor	Minor
	Negligible	Negligible	Negligible	Negligible

(1) Carbon Dioxide Information Analysis Centre (CDIAC) - http://cdiac.ornl.gov/pns/current_ghg.html Last accessed: 30/01/2015

6 ANALYSIS OF ALTERNATIVES

Queries expressed by some stakeholders (refer to the Comments and Response Report in *Annex C*) include the following:

- *Why hydropower?*
- *Are there any alternatives to hydropower, such as other forms of renewable energy, specifically wind and solar power?*
- *Why is the site selected for the proposed BGHES not further downstream?*

This *Chapter* attempts to answer some of these queries. In addition, this *Chapter* presents the most recent alternatives that were considered for the proposed BGHES, and provides a motivation for choosing the preferred dam, power houses, waterways, access roads and project townships; as well as transmission system scheme. These alternatives are as presented in the Studio Pietrangeli (SP) Batoka Hydro-Electric Scheme Phase II – Layout: Option Assessment Report Rev. F (October 2018).

In addition, alternatives were considered for the Full Supply Level (FSL) of the scheme, taking into account not only power generation, but also areas of inundation and potential impacts as a result of backwaters on the viewsheds around Victoria Falls. Environmental Flows (EFs) are also considered where numerous scenarios were analysed to ensure operating rules maintain an acceptable balance between power generation and aquatic ecological health downstream of the BGHES.

Please Note:

This *Chapter* provides an overview of the Project alternatives that were considered for this ESIA, and is specific to the following Project components:

- Dam wall and impoundment, including a spillway;
- Surface power houses, one on each side of the river; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching areas).

For a more detailed overview of Project alternatives considered for Transmission Lines and Access Roads, refer to the standalone ESIAs for these Project components.

The following *Sections* discuss alternatives associated with dam location; project operating rules; dam height; dam type; spillway design; powerhouse and waterway design. Moreover, *Section 6.12* discusses alternatives associated with project townships.

6.1 POWER SUPPLY AND DEMAND

Both Zambia and Zimbabwe currently have an electricity deficit where demand exceeds the available supply. As discussed in *Chapter 3*, as of December 2012, total energy demand in Zambia exceeded internal generation capacity (1). This was as a result of the expansions in the mining and manufacturing sectors as well as overall expansions in the economy and population. The current power deficit has resulted in prolonged load shedding and power cuts, which have occasionally affected trade and production. At peak times supply is 1,700-1,800 MW and demand is 1,800-1,900 MW.

According to the Zimbabwean Ministry of Energy and Power Development's National Energy Policy of 2012, there is a net deficit in the supply of electrical power in Zimbabwe. The country requires nearly 2,200 MW in winter at peak, but generation locally cannot meet the demand as only 1,300 MW are being produced; energy imports and load shedding cover for the deficit.

According to SP (2018), the maximum power peak demand for the SAPP will increase from 45,124 MW in 2012 to 121,421 MW in 2045, corresponding to an annual increase of 3 %. Under the same scenario, the maximum power peak demand in Zambia will increase from 1,681 MW in 2012 to 10,015 MW in 2045 (corresponding to an annual growth rate of 5.6 %), while in Zimbabwe, the maximum power peak demand will increase from 2,029 MW in 2012 to 6,071 MW in 2045 (corresponding to an annual growth rate of 3.4 %).

6.2 *WHY HYDROPOWER?*

6.2.1 *Hydropower versus Alternative Power Options*

The Zambezi Basin has considerable potential for hydropower development. Presently, a total capacity of 4,684 MW (about 10 % of the total potential) has been developed in the Zambezi River Basin. According to estimates, the unused hydropower potential in the Zambezi Basin is 13,000 MW.

The Southern African Power Pool (SAPP) presents a Regional Generation and Transmission Expansion Study for the entire SAPP region (Nexant 2007), where a Base Case and an Alternative Case is proposed.

Both cases provide a reasonable set of generating unit additions balanced among peaking, mid-range, and base load units. For the entire SADC Region, the Base Case adds about 39,300 MW with greater emphasis on conventional coal fuelled steam plants. The Alternative Case instead adds about 36,600 MW with greater emphasis on hydro projects and the transmissions needed to move the power to areas of demand.

This Alternative Case over the period up to 2025 envisages development of almost all power plants in the Kariba Sub-basin, those in the Shire River/Lake Malawi/Nyasa/Niassa Sub-basin, Kafue Sub-basin and the two major power sites (Cahora Bassa II and Mepanda Uncua) in the Tete Sub-basin. By adopting

(1) Policy Monitoring and Research Centre (PMRC), 2013. *The State of the Energy Sector in Zambia: Implications for Industrial Development, Jobs and Poverty Reduction Background Note*

this development package as the total expansion of the hydropower system, the total power development is estimated at approximately 53 % (6,616 MW) of the total hydropower potential of the Zambezi Basin.

As far as hydropower development in the Zambezi Basin is concerned, the difference between the SAPP Base Case and the Alternative Case is mainly in the timing of the construction of the proposed BGHES. The total additional installed capacity at the proposed BGHES would be between 1,600 – 3,000 MW in both cases.

Investment in energy is a prerequisite to achieving commercial and industrial development in Zambia and Zimbabwe. The use of solar power is favourable in providing rural and urban areas with access to power; however, if both countries are to achieve those targets and goals detailed in their Vision 2030 and Vision 2040, and other complimentary plans, these countries will require private sector investment in energy technology that is efficient, sustainable and reliable. The generation of energy through hydropower is a proven technology that is sustainable and which is actively being promoted at a national level in both Zambia and Zimbabwe. With a vast hydropower energy potential, hydropower is considered the most feasible and reasonable electrification option for both countries.

In terms of electricity generation cost, proposed hydropower projects in Zambia consistently rank the most favourable in terms of unit generation cost (with the proposed BGHES having a unit generation cost of 3.71 c$/KWh). In Zimbabwe, the unit generation cost of the repowering of the coal projects is about 11 c$/kWh, and for new coal projects, the costs range from 12,61 c$/kWh to 15,26 c$/kWh (refer to *Chapter 3*). The unit generation costs of proposed thermal plants are therefore from three to six times higher than that of the proposed BGHES (SP, 2018).

Apart from thermal coal, other generation alternatives include the use of wind and solar power.

Although Zimbabwe has enormous solar energy potential, and the ZERA and ZETDC have registered an increasing interest from IPPs to invest in solar power, according to the ZEPTC (2015), when comparing like for like capacity with all the competing technologies, solar has consistently shown to be undesirable; this mainly due to a high capital cost per kW to plant factor ratio.

In the ZETDC's (2015) System Development Plan, solar photovoltaic (PV) has been placed consistently at the bottom of the ranking order for new power generation projects. This is also consistent with the ranking of SAPP power plants based on unit investment costs as listed in SP (2018), where no solar project is listed in the top 30 rankings of all generation projects proposed. This indicates that solar is presently an undesirable technology from an investment efficiency perspective when compared to other technologies. Development of solar PV can therefore for now only be supported by strong renewable energy polices rather than technology competitiveness. This is consistent with the penetration of solar technology in other electricity markets (ZETDC, 2015). Where solar PV has penetrated the market significantly, high electricity tariffs reflect the cost of energy.

ZETDC (2015) present a summary of the associated supply side challenges of solar PV:

- It will not alleviate load shedding as intended in the ZIM-ASSET policy.
- The technology is expensive relative to investment utilisation level.
  - Thermal $/kw 2,500 – 3,000: Plant Factor above 75 %.
  - Hydro $/kw 2,700: Plant Factor above 85 %.
  - Solar $/kw 2,500 – 4,000: Plant Factor 20 – 30 %.
- Changes output with weather elements.
- Not stable during disturbances.
- Cannot change output on demand and with demand.
- Requires large amounts of land.

There is however, a high demand for solar energy systems in Zimbabwe, especially in remote rural areas where there is no power grid; however the cost is prohibitive. Solar energy can, however be harnessed for pumping drinking water for rural communities, powering lights and appliances at rural institutions (schools and clinics), and water heating in urban areas. For these applications, local production of systems is being encouraged by the government to reduce the cost of solar equipment (ZETDC, 2015).

The situation with solar power is similar in Zambia, where solar penetration has remained relatively low due to high initial cost. As such the solar PV market in Zambia is dominated by donor funded projects, Government, NGOs and mission institutions for schools, clinics, related staff housing and water supply [(1)].

With regards to wind power, Zimbabwean meteorological records (with wind data available for periods of up to 30 years at some stations) do show that that wind power in some areas (Harare, Chivhu, Gweru, Bulawayo, and Chipinge) would be feasible for isolated local uses, and more can be developed with proper financing, but in general, winds are irregular, both by season and by area, and vary widely diurnally.

In Zambia, wind energy is relatively low. Wind data collected at 10 meters per second (m/s) above the ground indicate speeds of between 0.1 to 3.5 meters per second with an annual average of 2.5 m/s. These wind speeds are not particularly suitable for electricity generation, but are well suited for water pumping for household use and irrigation purposes. There are specific areas where wind regimes are said to be as high as 6 m/s in the Western Province of Zambia, and as such, the Department of Energy has plans to develop a wind atlas to identify areas where electricity can be generated from wind [(2)].

(1) Zambia Development Agency (2014); Energy Sector Profile
(2) Zambia Development Agency (2014); Energy Sector Profile

The increased use of solar power specifically in both Zimbabwe and Zambia, and to a lesser extent wind, should therefore be explored *in addition* to hydropower.

6.2.2 *Economic Feasibility of the Proposed BGHES*

In both Zambia and Zimbabwe, a number of new generation options are either being planned or commissioned. The proposed BGHES would provide electricity at a cost that would be considerably lower than most of the reasonable alternatives.

In Zambia, the proposed BGHES:

- Is expected to generate the fourth cheapest electricity option of the seventeen planned power plants in Zambia (SP, 2018);
- It is only slightly more expensive than the cheaper options;
- It is the largest planned power generation plant estimated to produce electricity at less than half the price of electricity produced by the Lower Kafue Gorge HPP, the other large planned power station.

In Zimbabwe:

- None of the power stations in Zimbabwe are expected to generate electricity at a lower cost than the proposed BGHES; and
- The cost of electricity generation from large coal fired power stations (such as CASECO and Hwange) would be up to four times higher than the proposed BGHES. These coal fired power stations are associated with ongoing and significant carbon emissions.

As part of the ESIA process, Stratecon Applied Economic Research (Stratecon) in 2015 carried an Economic Feasibility for the BGHES. The Stratecon (2015) evaluated the cost benefit for varying FSLs of the BGHES, including a (then) base operating level of 762 masl, and alternative operating levels of 757m, 740m and 730m. Following a decision to freeze the FSL in 2019, Stratecon (2019) updated their economic cost benefit analysis findings on a single FSL option of a scheme with a final reservoir level of 757 masl.

The updated economic assessment undertaken as part of this ESIA shows that the proposed BGHES is a financially feasible scheme with (for the base case scenario) an Internal Rate of Return (IRR) of 28%, a Benefit Cost Ratio (BCR) of 4.744 and a Nett Present Value (NPV) of US$ 10,643 million (Stratecon 2019). In terms of the macro-economic benefits to both Zambia and Zimbabwe, in aggregate, the proposed BGHES would have added a cumulative $771 million to the GDPs of the two countries by the end of construction, and by 2040, this cumulative contribution is estimated at US$20,237 million (Stratecon 2019).

The proposed BGHES does also come at a cost, with impacts to both the regional and local economic, social and biophysical environments, as elaborated in this *Chapter*. These need to be weighed up together with the positive contributions the proposed BGHES will provide to both countries.

The proposed BGHES shall be operated as a baseload plant on a runoff river regime with limited capacity for peaking for environment compliance. The efficiency of the proposed BGHES increases if the peak load could be generated and exported at a premium to the Southern Africa Power Pool (SAPP).

The Base Case was extended to assess the impact of droughts and climate change on the economic efficiency of the BGHES (Stratecon 2019). The worst drought since 1978 occurred in 1996 and lasted nearly five years (SP, 2018). The relevance of climate change, in this instance, would mean a lower water flow. This means that the effects of climate change and a drought can be investigated simultaneously. The updated economic assessment undertaken as part of this ESIA concluded that such events are unlikely to render the Project economically inefficient, and that the efficiency of the BGHES remains positive even with conservative estimates of drought and climate change.

An alternative to the Base Case was considered in the updated economic assessment, which assessed the case that the BGHES was built and used to operate emergency generators, which would substitute for some of the BGHES output (Stratecon 2019). This excess output would be sold to other countries in the Southern Africa Power Pool. In this alternative the BCR drops from 4.44 to 3.75, which is still an efficient result. The NPV falls from $10 643m to $8 526m and the IRR from 28% to 24%.

The updated economic assessment also assessed whether any other renewable energy and new coal generation options would be more efficient than the BGHES. It was concluded that alternative renewable energy options would need storage capacity to fulfil the same role as the BGHES, and accordingly the BGHES was found as the most efficient option. The only economically efficient baseload alternative is Concentrated Solar Power (CSP), but this is less efficient than the BGHES.

6.3 *DAM ALTERNATIVES*

6.3.1 *Dam Location*

The proposed location of the proposed BGHES was first selected in 1971 and thereafter moved approximately 12 km up river in 1981 at a section located at chainage +47 km from Victoria Falls. This location was thereafter studied through numerous geological investigations and compared with two other potential locations [(1)]. The BJVC (1993) Team established that this was the best site/preferred alternative, as there was no other site that would have such strong advantages in terms of geological, topographical, dam volumes and hydrological conditions (theoretical maximum production at the river section) as the identified site.

(1) In total seventeen project alternatives were assessed, including alternatives relating to dam type and full supply water level among others.

Further to that, the SP Team in 2014 also analysed the optimum location for the development of hydropower potential of the Zambezi River between Victoria Falls and Lake Kariba, that included the proposed BGHES (the same preferred site), as well as Devil's Gorge HPP, located at chainage + 65 km. Again, the preferred alternative was found to be the site located + 47 km from the Falls for the following reasons:

- Moving the dam downstream would reduce the capacity of any future development at Devil's Gorge;
- All the sites downstream, especially after chainage +55 km, are characterised by a widening of the valley. The concrete volumes calculated at the seven potential dam sites (from chainage +59 km to +89km) would require approximately 60 % to 200 % more concrete to the equivalent volume at the preferred Batoka Gorge site;
- Moreover, six of the seven downstream sites would require a saddle dam (another albeit smaller dam wall in another location), increasing the costs and impacts associated with the construction of another albeit smaller dam wall; and
- Moving the dam upstream would result in a loss of total head, unless any future development at Devil's Gorge had its full supply level (FSL) raised.

Other promising sites do exist nearby to the proposed BGHES site (~4 km up and downstream), and whilst it was found that these sites are all comparable in terms of cost of construction, the energy production associated with these alternatives was significantly less (~15 %).

In addition to the proposed BGHES site showing advantages in terms of energy production, this site also benefits from:

- A favourable river shape, having a "Z" turn upstream, which makes it favourable for the waterways intake and tunnel river diversion;
- Previous detailed geological studies have already been carried out for this location; and
- The location guarantees an overall good quality of rock foundations for the envisaged rigid concrete dam.

SP (2014) confirmed therefore that no other alternative location is as promising as the preferred BGHES site (i.e. the site 47 km downstream of Victoria Falls).

The siting of the dam is driven primarily by economic and geotechnical considerations, and with consideration to the greater future development context of the broader Project Area. Siting of the BGHES further upstream would not be preferred from an environmental and social perspective, as the impacts to the upper parts of the Batoka Gorge that fall within the World Heritage Site, and within the Mosi-oa-Tunya and Victoria Falls National Parks would be more significant. Moreover, siting of the dam further upstream would ultimately mean that the opportunity of seasonally adjusting the operating level of the dam to allow for half-day rafting trips on the river would not be realised.

As mentioned above, siting of the dam further downstream would require the development of a significantly larger dam, as the valley widens after chainage +55 km. The construction of a larger dam would require approximately 60% to 200% more concrete, which ultimately means a longer construction period for the BGHES, a requirement for larger quarry footprints, larger water requirements, etc. This would not be favourable from an environmental and social perspective.

6.4 OPTIMUM INSTALLED POWER

The selection of the optimum installed power was, together with the project location described above, the first activity reviewed by SP in the updated feasibility study (of 2018). In general terms, a significant increase of the installed power envisaged in the feasibility study carried out in 1993 of 1,600 MW was favoured, due to the:

- The development of the two countries and their consequent energy needs; and
- The development of the energy market and the interconnection facilities in the region.

Two independent economic analyses were used by SP (2018) to evaluate the optimum installed power, namely:

- A least cost analysis (in terms of unit generation costs); and
- A cost-benefit analysis.

The least cost analysis evaluated the optimum installed power, from an economic point of view, calculating the unit generation costs of the Project varying the installed power (from 1,600 MW to 3,700 MW). The capacity that minimises the unit generation costs is the optimum one.

The cost-benefit analysis also evaluated the optimum installed power calculating the costs and benefits of the project, varying the installed capacity in the same range. The capacity that maximizes the Internal Rate of Return (IRR), calculated through a Discounted Cash Flow Analysis (DCFA), is the optimum one.

Factors that needed to be considered in the design of the optimum installed power include:

- Increasing the plant size, substantially increases the cost of the surface power house (civil works), the EM equipment, waterways and transmission lines;
- Increasing the plant size substantially increases the energy production since it reduces the spilled flows. For example, a plant capacity of 1,600 MW results in a loss of approximately 36 % of total flows compared to a loss of 12 % for a plant capacity of 3,700 MW; and

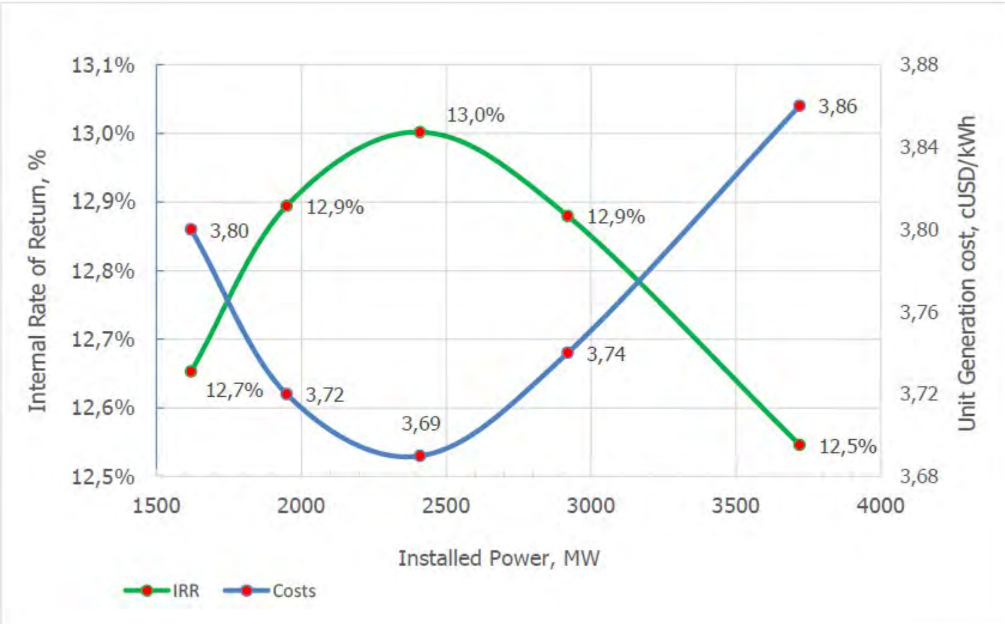
- A higher capacity also provides flexibility to cope with future possible peak production needs.

The results of the Least Cost and Cost Benefit Analysis undertaken by SP (2018), showing the optimum installed power from an economic point of view that results in the lowest unit generation cost and the highest IRR, is provided in *Figure 6.1* below.

The economic analysis indicates that the proposed BGHES should be designed with an installed power of between 2,400 MW and 3,000 MW, since below this capacity energy production is reduced, water losses increase and all the economic parameters (IRR, Unit Generation costs, NPV etc.) are below their peaks (SP, 2018).

From an analysis of *Figure 6.1*, the installed power capacity that maximizes the IRR and minimizes the Unit Generation Cost is **2,400MW** optimum installed capacity.

Figure 6.1 Results of the Least Cost and Cost Benefit Analysis



Source: SP (2018)

6.5 REFINEMENT OF THE PROJECT OPERATING RULES

Initially the Environmental Flow (Eflow) assessment developed a number of operating scenarios in line with *Chapter 2* (Project Description) [(1)], using a range of possible off-peak flow releases provided by Studio Pietrangeli.

(1) These scenarios were chosen to represent the full potential range within which the eventual operating regime chosen by ZRA will fall. They do not themselves represent a proposed operating scenario, but instead were used to assess the potential impact of operating the BGHES on downstream river conditions and inform the development and refinement of environmental and social mitigation measures for consideration in the final design.

In 2018, the Eflow assessment undertaken for the original ESIA was extended to include additional scenarios designed to assist with the refinement of the operating rules for the proposed BGHES. The purpose of the additional assessments was to find a balance between minimising environmental impacts in the downstream river and maximising power output from the BGHES, specifically through the generation of power in periods of peak demand.

During a joint workshop between representatives of the ZRA, ERM, Studio Pietrangeli and Southern Waters, scenarios highlighting particular issues related to hydropower production and impacts on the downstream river ecosystem were constructed and analysed. In an effort to arrive at a scenario (or operating rule) that meets both the environmental and the engineering objectives, the environmental and engineering criteria included in *Table 6.1* were agreed to in order to finalise those scenarios or operating rules for the BGHES.

Table 6.1 Agreed Environmental and Engineering Criteria for deciding on Environmental Flows

Type	Criteria
Environmental criteria	No more than a 1.5 class drop in Overall Ecosystem Condition in the downstream river, i.e., from A/B to no less than a mid-C category. This represents a drop in ecological category from "near natural" to "moderately modified", which is still considered a healthy functioning ecosystem.
	No more than a 25% reduction in abundance for 90% of the fish species.
Engineering criteria	Minimum constraints on power generation in the wet season (when flows are lower than Q20 – i.e. flows that are exceeded at 80% of the time).
	Peak discharges cannot exceed 75% of design peak flows, with Kariba to compensate for this gap.
	No constraints in the wet seasons, unless it is a low flow year in which case ramping up to reduced peak with Kariba compensating.
	Dry seasons Q20 with some minor modifications.

Following agreement on the environmental and engineering criteria, the following four scenarios were designed and evaluated:

- AddPM01:
    - DRY Season (**Sep-Jan**): Two 3 hour peaks a day, at maximum of 1.5 x the off-peak flows when Q (i.e. flow rate) is between Q10 (i.e. flows that are exceeded at 90% of the time) and Q30 (i.e. – flows that are exceeded at 70% of the time); run of river when Q<Q10; peaking ramped up to the maximum; off-peak minimum set at Q10; no sediment flushing.
    - WET Season (**Feb-Aug**): Two 3 hour peaks a day, at maximum of 1.75 x the off-peak flows when Q is < Q10; peaking ramped up to the maximum; off-peak releases set at Q10; no sediment flushing.

- AddPM02:

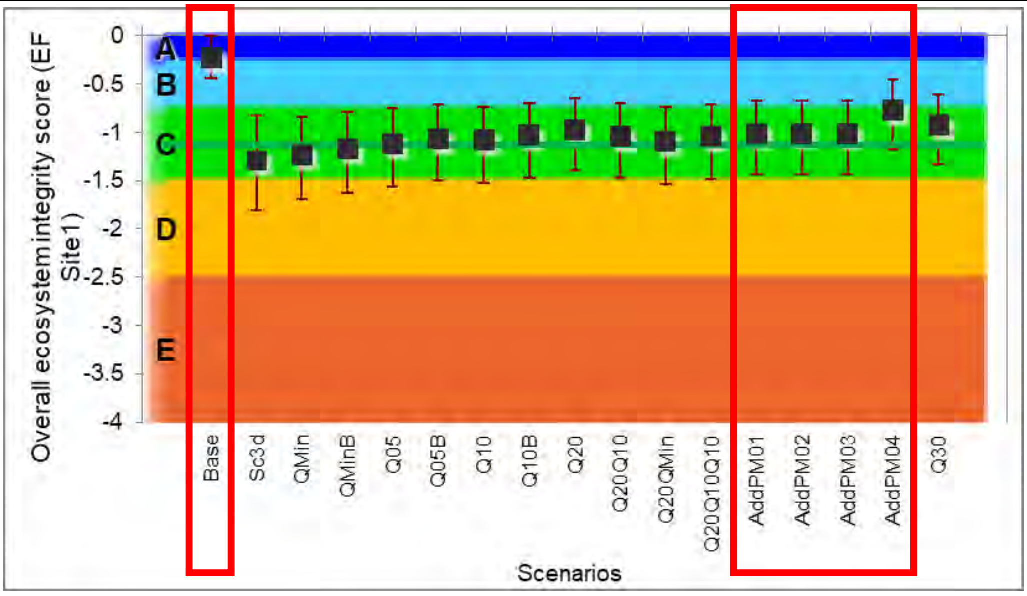
- DRY Season (**Sep-Jan**): Two 3 hour peaks a day with no constraints when Q > Q30; run of river when Q<Q30; peaking ramped up to the maximum; no sediment flushing.
- WET Season (Feb-**Aug**): As for AddPM01.

- AddPM03:
  - DRY Season (**Sep-Jan**): Two 3 hour peaks a day, at maximum of 1.5 x the off-peak flows when Q is between Q10 and Q30; run of river when Q<Q10; peaking ramped up to the maximum; off-peak minimum set at Q20; no sediment flushing.
  - WET Season (**Feb-**Aug): As for AddPM01.

- AddPM04:
  - DRY Season (**Sep-Jan**): Baseline flows; no sediment flushing.
  - WET Season (**Feb-Aug**): QMin with one 6-hour peak a day.

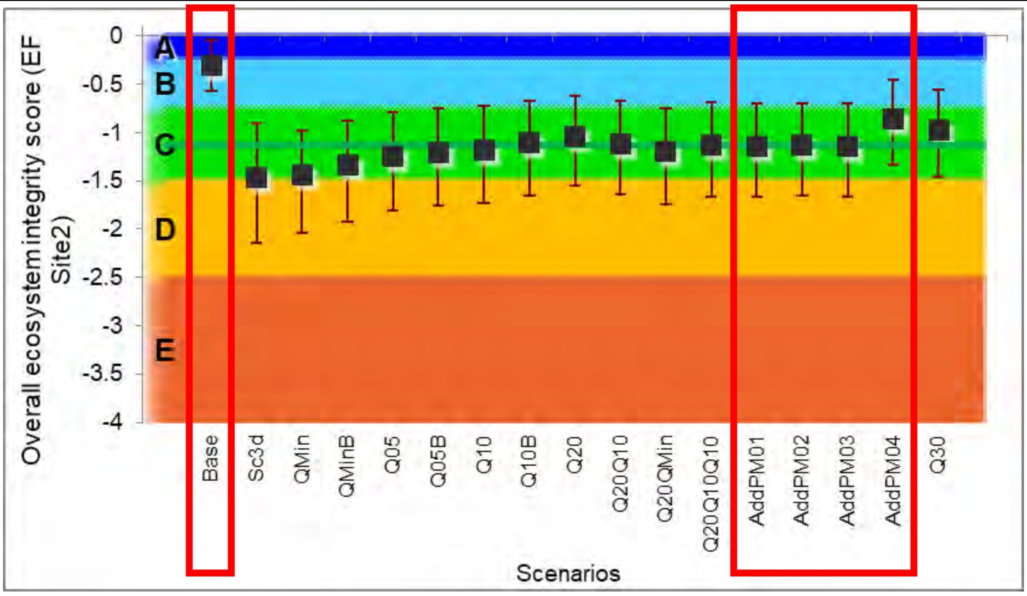
The predicted impacts on the downstream river ecosystem for the sets of scenarios tested as part of this process are presented in *Figure 6.2* and *Figure 6.3*. The predicted impacts associated with the scenarios are based on median changes in abundance/concentration/area of the indicators over a 90-year flow sequence. However, these abundances are expected to vary year-on-year, based on climatic and other conditions, e.g., wet years versus dry years.

Figure 6.2 Overall Ecosystem Integrity Scores for the Scenarios at EF Site 1



Note: The line in category C shows the agreed maximum drop in ecosystem condition in the ecological criteria.
Note: EF Site 1 represents the Zambezi River in the Batoka Gorge downstream of the tailrace of the proposed BGHES to the end of the gorge

Figure 6.3 *Overall Ecosystem Integrity Scores for the Scenarios at EF Site 2*



Note: The line in category C shows the agreed maximum drop in ecosystem condition in the ecological criteria.
Note: EF Site 2 represents the Zambezi River from the end of Batoka Gorge to Lake Kariba.

The results indicate that with respect to the environmental criteria set out in *Table 6.1* that:

- All of the AddPM scenarios (AddPM01, AddPM02, AddPM03 and AddPM04) meet the criterion of no more than a 1.5 class drop in Overall Ecosystem Condition in the downstream river, i.e., from A/B to no less than a mid-C category.
- Only AddPM04 meets the criterion that at least 90% of fish species should be impacted by <25%.

Accordingly, from an environmental perspective the four modelled scenarios are reasonable from an environmental perspective; however, given that AddPM04 meets both environmental criteria (i.e. – no more than a 1.5 class drop in overall ecosystem condition &that at least 90% of fish species should be impacted by <25%), this was identified as the preferred scenario from an environmental perspective.

There is considerable, and intentional, overlap between the scenarios in each of the sets. This is to facilitate comparison between the various scenarios.

It is also important to note that per *Chapter 2*, the ZRA have committed to operate the BGHES under scenario AddPM04, i.e. – only operated as a hydro-peaking scheme during the wet season (Feb-Aug) in accordance with the operating rules established by this scenario.

These scenarios are presented in more detail in the impact assessment relating to downstream river conditions in *Chapter 10*.

6.6 *DAM HEIGHT (FULL SUPPLY LEVEL)*

6.6.1 *Introduction*

Operating a dam at its highest level is economically the most efficient. This fact is demonstrated on numerous occasions in this *Section*, but elaborated further in this section on specific analyses of chosen dam heights. Given the chosen location of the proposed BGHES (as described in *Section 6.3.1*), surveyed data (SP, 2014) from two beacons on each of this sites' banks indicate a valley height of 841.1 masl (P1) and 842 masl (P2). Theoretically, the proposed BGHES Full Supply Level (FSL) could be fixed at or just below these heights to maximize the economic feasibly of the scheme. A FSL at or below these heights would, however result in backwater flooding, resulting in impacts to the Victoria Falls (a World Heritage Site), the Boiling Pot (immediately downstream of the Victoria Falls and itself a tourist attraction), to the 1st and 2nd gorges (essentially the sections of the Zambezi River below the Falls most visible from the Victoria Falls Bridge and the Victoria Falls Hotel), and to the existing Victoria Falls Power Station.

The Victoria Falls Power Station tailraces are controlled by weirs at their downstream ends which are set at 767.69 m amsl and 770.07 m amsl. The relevant powerhouse levels are taken from *Table 12.4* in the 1993 report (reproduced below in *Table 6.2*).

6.6.2 *Full Supply Level of 762 m amsl*

In the 1993 feasibility study (BJVC, 1993) a FSL of the reservoir of 762 m was initially fixed by the average river level at the Victoria Falls power station outlets at Silent Pool to ensure these outlets are not flooded, and to ensure the Victoria Falls and Boiling Pot were not affected.

As the measurements of those points shown in *Table 6.2* differed between the BJVC (1993) and SP (2014) studies by up to 3 m, due mainly to the low visibility of satellites in the steep gorge, SP (2018) will confirm this FSL subject to the measurement and confirmation of water levels, and hence the refinement of the rating curve, particularly at Silent Pool. As such, this FSL has also been *provisionally* selected for the updated feasibility study for the proposed BGHES by SP (2018).

An analysis of the various FSLs is further undertaken as part of the SP (2018) feasibility study, the economic feasibility study undertaken by Stratecon (2015), and in this impact assessment, the results of which are fully presented in *Chapters 10* and *11* of this report.

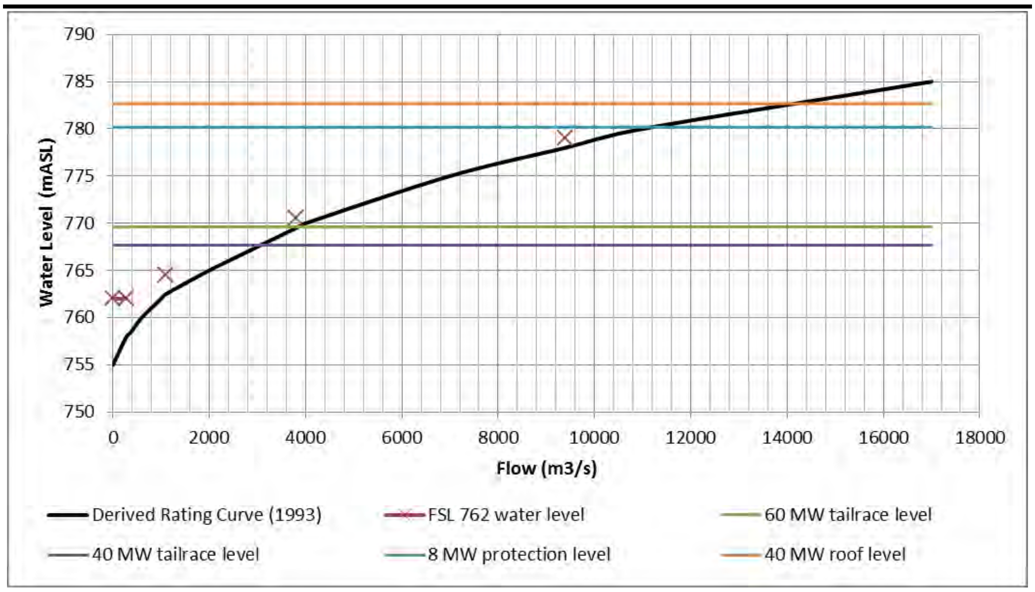
Table 6.2 *Levels at Victoria Falls Power Station (Reproduced from the 1993 Feasibility Study)*

	Feet ASL	Metres ASL
60 MW Station		
Tailrace sill level	2525.00	769.62
40 MW Station		
PS Roof level	2567.75	782.65
Operating Floor level	2538.75	773.81
Tailrace Sill level	2518.66	767.69
8 MW Station		
Ground Floor level	2540.00	774.19
Original Protection level	2554.66	778.66
New Protection level		780.18

Table 12.4 : Levels at Victoria Falls Power Stations

Figure 6.4 below, based upon data extracted from *Section 12* of the 1993 Feasibility Study, summarises the estimated water level conditions at Silent Pool (i.e. the site of the Victoria Falls Power Station) pre and post the BGHES at a FSL of 762 m amsl. The relevant powerhouse levels shown on *Figure 6.4* are taken from *Table 12.4* in the 1993 report (reproduced above in *Table 6.2*).

Figure 6.4 ***Estimated Water Level Conditions at Silent Pool pre and post the BGHES***



It is assumed that conditions at the Power Station remain as described in the report, i.e. that all three units (8 MW, 40 MW and 60 MW) are protected from inundation to the maximum levels shown, but that power generation begins to be compromised when the water level rises above the tailrace levels shown.

Based upon the data shown in *Figure 6.4*, and taking into account the approximations and uncertainties in the calculation methods used:

- Under current conditions, the operation of the power plants begins to be impaired at flows of approximately 3,000 m^3/s (ie when the 40 MW plant tailrace starts to become inundated). This flood has an annual exceedance probability of about 7-8 % (based upon *Figure 8.2* in SP's Draft Options Assessment Report, 2018).

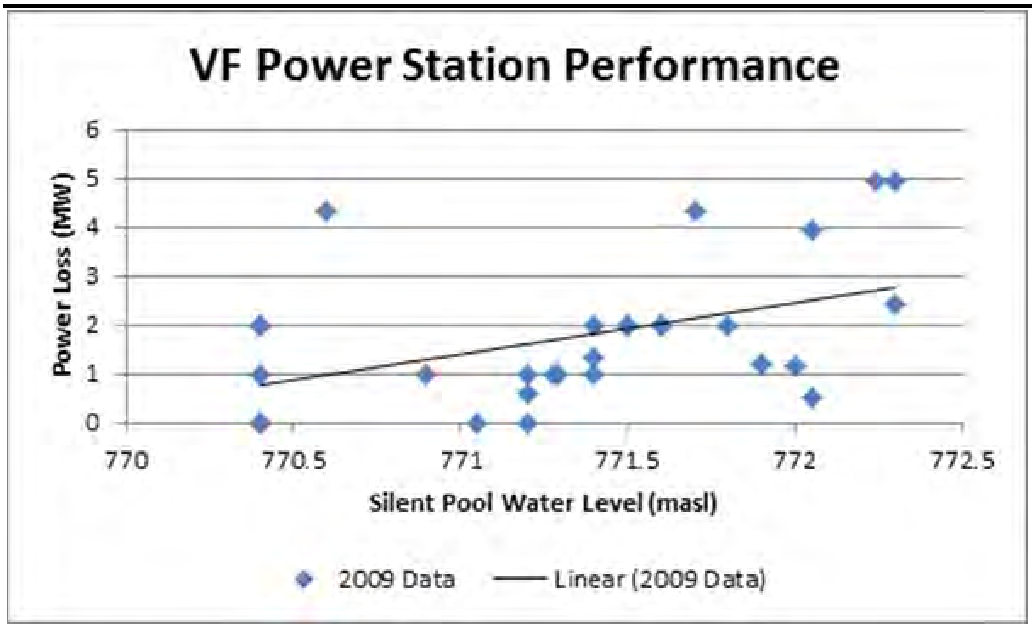
- With the BGHES impoundment in place (@762 m amsl), the flow at which the above situation occurs reduces to around 2,500 m^3/s, which has an annual exceedance probability of around 10-11 %.

- Under current conditions, the flow at which the power station infrastucture would start to become inundated (ie when the flood protection installed at the 8 MW plant is overtopped) is approximately 11,200 m^3/s. This flood has an estimated return period approaching 500 years (based upon data presented in Section 11 of the 1993 feasibility study).

- With the BGHES impoundment in place (@762 m amsl), the flow at which the above situation occurs reduces to around 10,400 m^3/s, which has an estimated return period of around 200 years.

Analysing data from the Victoria Falls Power Station (*Figure 6.5*):

Figure 6.5 Power Losses at the Victoria Falls Power Station against Design Capacity for Different Water Levels at Silent Pool



- It can be deduced that although the lowest tailrace starts to become inundated at around 767.69 m amsl (based upon data provided in 93 Feasibility Study), there doesn't appear to be any significant effect on power production until water levels reach the ~ 770.5 m amsl mark, when the rate of production drops by around 2 MW. The river flow at which this currently occurs is around 4,000 m^3/s, which has an annual exceedance probability of around 4 % (ie the percentage time on average that the flow is exceeded each year). With the 762 m FSL dam in place, the river flow at which this water level is reached reduces to around 3,600 m^3/s, which has an annual exceedance probability of around 5 %. Using this datam and in summary, it is estimated that the effect of the dam will be to, on average, increase the amount of time each year that the rate of power production reduces by 2 MW (or more) by around 90 hours.

Based upon the detailed 1993 hydraulic calculations for Silent Pool, the analysis shows that there is a small incremental effect on water level conditions at the power stations from the 762 FSL dam (due to backwater effects) which will on average increase the percentage of time each year (by around 2-3 %) whereby the power output at the plant is compromised due to water levels rising above the lowest tailrace. It will also reduce the return period of a potentially catastrophic event (whereby the stations become inundated above flood protection levels) from close to a 500 year flood event, to around a 200 year flood event.

Although detailed hydraulic modelling would be required to confirm this (requiring detailed river channel dimensions/survey data through the gorge that are not available), as well as longer term water level measurements at Silent Pool (which has been suggested by SP), if the proposed dam FSL were reduced by 5 m (i.e. to FSL 757 m amsl), this should eliminate any backwater effects from the impoundment at Silent Pool altogether over the full range of flow conditions that have been recorded in the river. That is, there should then be no discernible effect on the power station from the dam, and on Silent Pool.

6.6.3 Reducing the Full Supply Level

The costs and the benefits (energy production) of the BGHES will vary with the FSL. To understand these implications, SP (2018) undertook a DCFA analysis in order to identify the optimum FSL within the selected range. The results are shown in *Table 6.3* below and express the Benefits-Costs as a function of the Full Supply Level.

The result of this analysis shows that, as expected, the higher the dam the better. A FSL of 800 mamsl is possible, leading to maximum power generation, but would result in the complete flooding of the gorge all the way to the foot of Victoria Falls, with consequent severe impacts to the immediate environs of the Falls themselves.

Lowering the FSL from 762 to 757 masl would lead to a loss of benefit of around 140M US$. Statecon (2015), in their economic feasibility study, estimate that a drop in the FSL from 762 m to 757 m would reduce the Benefit Cost Ratio (BCR [1] from 4.71 to 3.98 but the Internal Rate of Return (IRR) would remain unchanged.

As summarised in *Table 6.3* and elaborated further in *Chapter 11*, the BGHES will impact on, in particular, the river rafting industry by the flooding of rapids. Dropping the FSL to 740 m, or preferably to 730 m amsl, would have certain environmental and social advantages as detailed in *Table 6.3*.

Lowering the FSL from 762 to 730 m amsl would, however lead to a loss of benefit of around 630M US$. Statecon (2015), in their economic feasibility study, estimate that a drop in the FSL from 762 m to 740 m and from 762 m to 730 m would reduce the Benefit Cost Ration (BCR) and Internal rates of Return (IRR) for the proposed BGHES from 4.71 and 28 % to 4.08 and 26 % and 3.77 and 25 %, respectively. This loss in benefit also needs to be compared to the loss of revenue from ecotourism (specifically river rafting); this is elaborated further in the Social Impact Assessment (*Chapter 11*). The economic impact of this alternative is not too significant, as the proposed BGHES must be operated in conjunction with the Kariba HPPs, where BGHES (with its relatively small impoundment) will produce maximum power at high flows, with Kariba (given its huge storage volume) will continue producing power at low flows.

A relatively large proportion of the environmental and social impacts associated with the proposed BGHES are as a direct consequence of the reservoir impoundment and the only available mitigation is to alter the operational water levels at the dam (either permanently or seasonally), and in so doing reduce the extent of the upstream effects. An integrated summary of the physical, biological, socio-economic and economic impacts as a direct consequence of reservoir impoundment at various Full Supply Levels is presented in *Table 6.3*.

6.6.4 Seasonal Adjustment of the Operating Level of the Dam (Preferred Option)

As presented in the Project Description (*Chapter 2*), which is used to inform this ESIA, during the course of the ESIA process it was decided through discussions with the ESIA team, Engineering Team (SP) and the ZRA that the operating level of the dam will be seasonally adjusted as follows:

- Reduce the **dry** season (in rafting terms, from August to January) operational level to 730 masl, thereby freeing a reach of river for rafting during this dry (low flow) period (typically when flows are less than 500 m^3/s) that extends all the way from the Falls downstream to around rapids 9 and 10, which is the current limit of half-day rafting trips on the river; and

(1) BCR measures the changes in benefits and costs that would result from an investment. A BCR of 4.71 means that for every $1.00 spent on the project, society would benefit by $ 4.71. A BCR>1 implies that the project would be an economic liability.

- Increase the operating level during the high-flow season to 757 masl under normal flow conditions in the river, and to 762 masl under high flow conditions, defined as the flow above which the Victoria Falls Power Station would normally begin to flood (at approximate flows of 3,000 m^3/s).

The potential benefits of this flexible operational regime would be to maximise power generation during the high flow season whilst facilitating full half-day rafting trips in the river for the majority of the rafting season, and minimising (and potentially avoiding [(1)]) any incremental effects from flooding at the Victoria Falls Power Station.

However, clearly changing the operating level of the dam by some 27 to 32 metres on a regular basis such as this will have consequences for both ecological and aesthetic conditions in the impoundment zone. Moreover, there will be periods during the filling and emptying of the reservoir at the beginning and end of the high flow season, when downstream patterns of flow will be disrupted. Again, this may have consequences for downstream users, and in particular aquatic ecology, and once again, these operating rules will need to be finalised to minimise disruptions and impacts to downstream users.

Where impacts are unavoidable and cannot be mitigated, as a result of direct impoundment or landuse, appropriate compensation to project affected peoples will be required, the exact details of which will be addressed through a further independent study which aims to identify and calculate losses and compensation in accordance with International Good Practice. In addition, the feasibility of an appropriate offset should be investigated to determine if the impact or loss to the Batoka Gorge critical habitat and protected areas, as a result of the impoundment can be compensated.

To Note - ERM has undertaken Livelihood Restoration Plans (LRPs) for only certain BGHES infrastructure. Separate Resettlement Action Plans (RAPs) / LRPs will be commissioned by the ZRA for those Project components that are outside of ERM's current scope, including for (amongst others) displacement (physical and economic) of upstream / downstream water users. These RAPs/ LRPs will be commissioned by the ZRA separately, and will be undertaken in accordance with the regulatory requirements of Zambia and Zimbabwe, and the requirements of IFC PS5 and WB ESS5.

(1) The higher dam operating level would only kick-in at times when the VF power station would normally flood under present conditions. However, the effect of operating the impoundment at the higher level may exacerbate flood levels at the power station and thereby compromise power production further than at present. This effect would therefore need to be examined during detailed design in order to determine a suitable flow threshold for the higher operational level that balanced power gains at the dam versus losses at the power station.

Table 6.3 Analysis of Alternative Full Supply Levels (FSL)

Issue/Effect	Alternative Full Supply Level (FSL)			
	762 masl	**757 masl**	**740 masl**	Reduce the dry season (in rafting terms, from August to January) operational level to **730 masl**
Summary of Physical Effects				
Extent of river potentially affected	47 km (approx.)	46 km (approx.)	44 km (approx.)	43 km (approx.)
Effects at the Boiling Pot	No discernible effect.	No discernible effect.	No discernible effect.	No discernible effect.
Effects on rapids throughout gorges	Inundation of rapids from dam wall to middle of 3rd Gorge, with discernible increase in water levels and reduction in flow velocities extending (but incrementally reducing) as far as 2nd Gorge. (refer to *Figure 6.6*)	Inundation of rapids from dam wall to top of 4th Gorge, with discernible increase in water levels and reduction in flow velocities extending (but incrementally reducing) into 3rd Gorge. (refer to *Figure 6.7*)	Inundation of rapids from dam wall to middle of 5th Gorge, with discernible increase in water levels and reduction in flow velocities extending (but incrementally reducing) into 4th Gorge. (refer to *Figure 6.8*)	Inundation of rapids during low flow season from dam wall to top of Songwe Gorge, with discernible increase in water levels and reduction in flow velocities extending (but incrementally reducing) into 5th Gorge. Effects during flood season as per FSL 762, with transitional periods each year whereby water levels will fluctuate by 30 metres. (refer to *Figure 6.9*)
Area lost to inundation of the Mosi oa Tunya National Park	129 ha directly inundated (~3% total park area) Approx. 17 km of park river frontage effected (~50% of total).	116 ha directly inundated (~3% total park area) Approx. 14 km of park river frontage effected (~41% of total).	83 ha directly inundated (~2% total park area) Approx. 11 km of park river frontage effected (~32% of total).	68 ha directly inundated (~2% total park area) Approx. 10 km of park river frontage effected (~27% of total). Effects during flood season as per FSL 762
Area lost to inundation of the Victoria Falls National Park	163 ha directly inundated (~4% total park area) Approx. 17 km of park river frontage effected (~50% of total).	148 ha directly inundated (~4% total park area) Approx. 14 km of park river frontage effected (~41% of total).	108 ha directly inundated (~3% total park area) Approx. 11 km of park river frontage effected (~32% of total).	87 ha directly inundated (~2% total park area) Approx. 10 km of park river frontage effected (~27% of total). Effects during flood season as per FSL 762
Effects on the Mosi oa Tunya Victoria Falls World Heritage Site (WHS)	283 ha directly inundated (~4% total WHS area)	254 ha directly inundated (~3% total WHS area)	Not calculated, although the reservoir still extends into the WHS.	Not calculated, although the reservoir still extends into the WHS.
Loss of Batoka Gorge, which is a unique and critical habitat	Loss of the Batoka Gorge habitat up to middle of Third Gorge (discounting hydraulic back-flooding during periods of high flows).	Small reduction in the extent of habitat lost, with approximately 3 km of the upper reaches of riparian vegetation preserved.	A large part of the Batoka Gorge is lost, although approximately 6 km of the upper reaches of riparian vegetation preserved.	Habitat loss is reduced at the 730 masl flood height, but the impact of loss of critical habitat has a Major significance.
Effects on river downstream of dam wall	-	-	-	There will be periods during the filling and emptying of the reservoir at the beginning and end of the high flow season when downstream patterns of flow will be disrupted. Depending upon precise timings and rates of change designed, this may have consequences for downstream users/ecology similar to hydropeaking alternative (though less significant). These effects are discussed further in ecological and social terms below.
Biological Impacts				
Effects on Tiger fish populations of the reservoir	Minimal riverine habitat remaining upstream which tiger fish will require for breeding. Tiger fish population may need to be maintained artificially through regular release of fingerlings.	An additional 1km stretch of river may not be sufficient to maintain a population other riverine fish species upon which Tiger fish would need to feed while breeding. Uncertain if this FSL will be adequate to maintain Tiger fish numbers, populations will require careful monitoring and possible artificial population reinforcement.	A 3km stretch of flowing river habitat may be sufficient for tiger fish populations to breed naturally. A small population of riverine fish species will survive as a fragmented population.	Unlikely to be a discernible difference from the 740 masl FSL.
Effects on other fish populations within the reservoir	No important differences are expected as a result of different FSLs, as only an isolated fragment of river habitat would remain, and unlikely to sustain viable populations of fish that are dependent on the flowing river conditions.	Possible increase in shallow-water breeding habitat for Cichlid species and there may be increased fish diversity although populations of other species will be small.	Possible increase in shallow-water breeding habitat for Cichlid species and there may be increased fish diversity although populations of other species will be small.	Low flow is not a breeding period and no benefits to fish populations are expected resulting from this seasonal FSL reduction.
Effects on crocodile and other large fauna	Crocodile and hippo populations within the reservoir are expected to be low and unlikely to show discernible responses to different FSLs.			
Effects on Taita Falcons and other raptors	Impacts to Taita Falcons cannot be assessed as there are gaps in baseline studies and insufficient understanding of the species ecology. There is however concern that insufficient rapids will remain to provide habitat for emerging midges on	As with the 762 masl FSL, impacts to Taita Falcons cannot be assessed as there are gaps in baseline studies and insufficient understanding of the species ecology.	As with the 762 masl FSL, impacts to Taita Falcons cannot be assessed as there are gaps in baseline studies and insufficient understanding of the species ecology.	No expected benefit expected resulting from this seasonal FSL reduction as the riverine habitat will be destroyed once inundated and will not recover and be productive during one season.

Issue/Effect	Alternative Full Supply Level (FSL)			
	762 masl	**757 masl**	**740 masl**	Reduce the dry season (in rafting terms, from August to January) operational level to **730 masl**
	which swifts feed and provide prey for Taita Falcons. The ability of Taita Falcons to switch to an alternative prey base within the Batoka Gorge is unknown. Maximum number of Taita Falcon and other raptor nests may be flooded or become accessible to man and predators and resulting in loss of breeding habitat, but the extent is not known as much of the Batoka Gorge has not been surveyed for this species.	Impacts of a reduced FSL to Taita Falcons may be less, but it is unknown if the remaining impact will allow the continuation of the species in the Project area.	Impacts of a reduced FSL to Taita Falcons may be less, but it is unknown if the remaining impact will allow the continuation of the species in the Project area.	
Social Impacts				
Effects on eco-tourism, rafting etc.	Highest FSL at which the outlets of the Vitoria Falls Power Station would not be affected (except at flows > 3,600 m^3/s – see below). As such, at this level the 1st and 2nd gorges are not impacted (except during very high flows) as are the viewsheds from the Victoria Falls bridge and from the Victoria Falls hotel. At a FSL > 72 masl, the risks of affecting these viewsheds become steadily higher. Impacts to tourism, which is currently contributing US$ 6.9 million per annum (for activities alone). This is made up as follows: • River rafting (which would be lost in its entirety upstream of the dam wall, which contributes US$ 3.3 million per annum). • Hiking and Birding (significantly impacted on, and which contributes US$ 82 thousand per annum). • Scenic flights (significantly impacted on, and which contributes US$ 1.35 million per annum). • Lodges (significantly impacted on, and which contributes US$ 1.4 million per annum). Based on the average expenditure and length of stay, it is estimated that tourists participating in gorge activities spend approximately $74 million per annum. Employment loss of 300-350 employees.	At this level, the risks of flooding of the Victoria Falls Power station outlets are significantly reduced, as are the viewsheds from the bridge and Victoria Falls Hotel. Tourism impacts are expected as follows: • Impacts to river rafting (which contributes US$ 3.3 million per annum). • Hiking and Birding (significantly impacted on, and which contributes US$ 82 thousand per annum). • Scenic flights (significantly impacted on, and which contributes US$ 1.35 million per annum) • Lodges (significantly impacted on, and which contributes US$ 1.4 million per annum).	Dropping the FSL to 740 masl or lower during the rafting (low flow) season will at least allow rafting to continue. However, dropping the FSL to the dry season to accommodate the river rafters, would make hardly any difference to the impact on the income of tourist operators, and as such mitigation would be improved by financial compensation to these operators. Tourism impacts are expected as follows: • It should eliminate any impacts to rapids 1 to 7b (and potentially 8 during the low flow season), which would mean a reasonably long (albeit reduced) reach of river could be rafted from either Victoria Falls or Livingstone outside of the high flow period, usually from late February through to early July (rafting currently stops in April and May). • Hiking and birding to be impacted on. Hiking trips in the gorge generally take place some 20 km downstream from the falls starting around rapid 23. There may be potential to hike sections of the gorge from below the falls up to rapid 8. • Lodges (significantly impacted on, and which contributes US$ 1.4 million per annum).	With a reduction to the FSL to 730 masl during the rafting season, rafting would be available for approximately 136 days per year, between August and December, and would include rafting from rapid 1 to rapid 9/10. Although rafting can still take place, rafting companies operating under these conditions would need to downsize and therefore retrench some employees. The white-water rafting companies not providing alternative activities will be the most impacted.
Economic Impacts (Cost/Benefit)				
Economic Analysis	The NPV is $11,625 million. This is economically efficient and would benefit both Zambia and Zimbabwe. The BCR is 4.71. This means that for every $1.00 spent on the project society would benefit by $4.71. This is a robust result. The IRR is 28%.	The BCR and IRR for this scenario is 3.98 and 28% respectively. The NPV would be $ 11,485 million, a decrease by $ 140 million when compared to an NPV of $ 11,625 million for an FSL of 762m amsl.	Operating the BGHES at less than capacity during the dry season reduces the economic efficiency of the scheme by 3% to 4%. The BCR and IRR for this scenario is 4.08 and 26% respectively. The NPV would be $ 11,025 million, a decrease by $ 600 million when compared to an NPV of $ 11,625 million for an FSL of 762m amsl.	The BCR and IRR for this scenario is 4.44 and 28% respectively. The NPV would be $ 10, 643 million
Impacts to the Victoria falls Power Station (adjacent to Silent Pool)	From data analysed, there does not appear to be any significant effect on power production until	Reducing FSL to 757 masl should eliminate any backwater effects from the impoundment at Silent	No discernible effect.	No discernible effect

Issue/Effect	Alternative Full Supply Level (FSL)			
	762 masl	**757 masl**	**740 masl**	Reduce the dry season (in rafting terms, from August to January) operational level to **730 masl**
	water levels reach around the 770.5 masl mark, when the rate of production drops by around 2 MW. The river flow at which this currently occurs is around 4,000 m^3/s, which has an annual exceedance probability of around 4% (i.e. the percentage time on average that the flow is exceeded each year). With the 762m dam in place, the river flow at which this water level is reached reduces to around 3,600 m3/s, which has an annual exceedance probability of around 5%. In summary, the effect of the dam will be to, on average, increase the amount of time each year that the rate of power production reduces by 2 MW (or more) by around 90 hours. This loss needs to be offset against the gains made in increased power production of the BGHES with a higher FSL. Will also reduce return period of a potentially catastrophic flood event (whereby stations are inundated above flood protection levels) from estimated 500 years, to around 200 years.	Pool altogether over the full range of flow conditions that have been recorded in the river. That is, there should then be no discernible effect on the power station from the dam.		

Figure 6.6 Points of Interest in Relation to Full Supply Level (FSL) 762m Contour

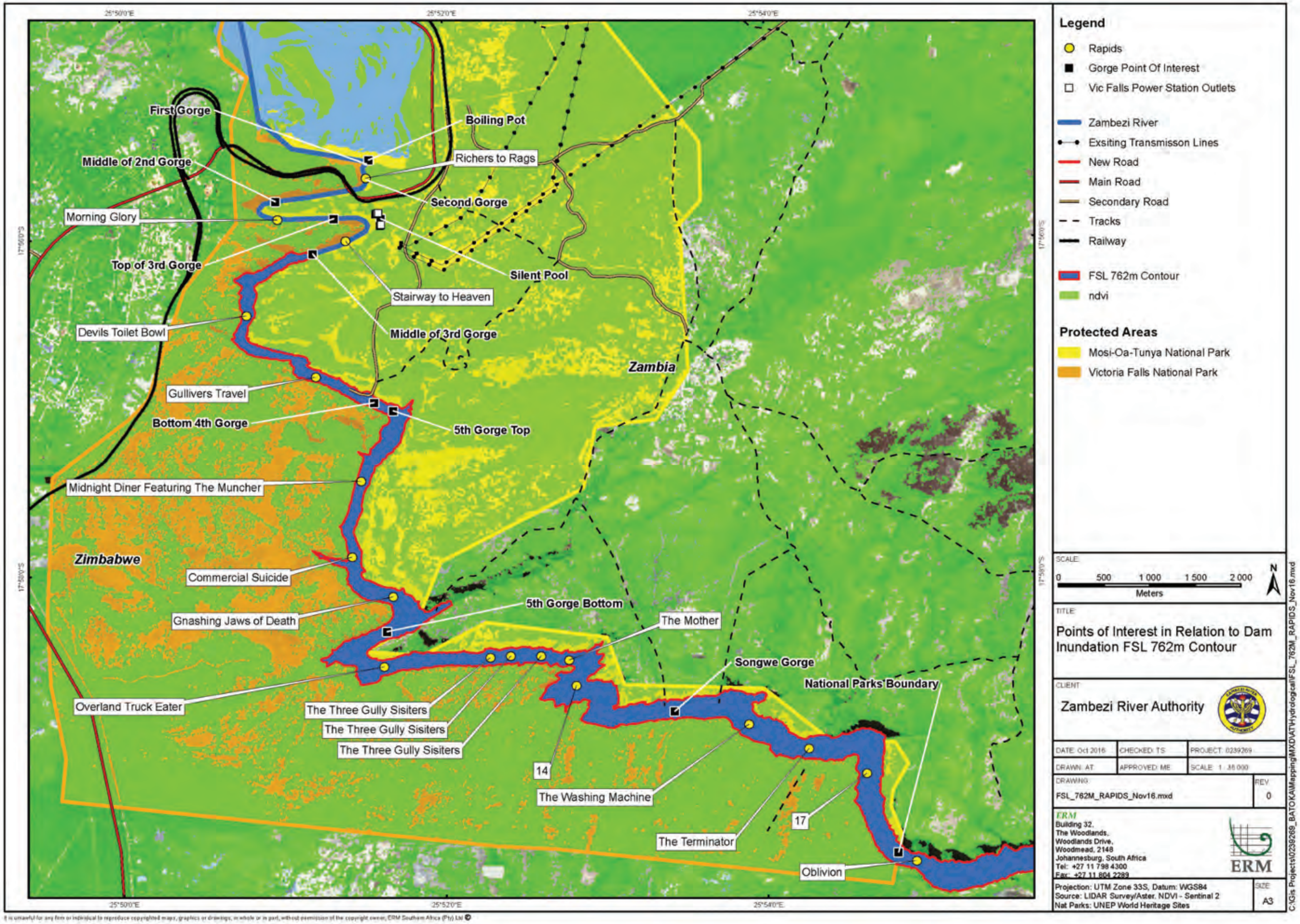


Figure 6.7 Points of Interest in Relation to Full Supply Level (FSL) 757m Contour

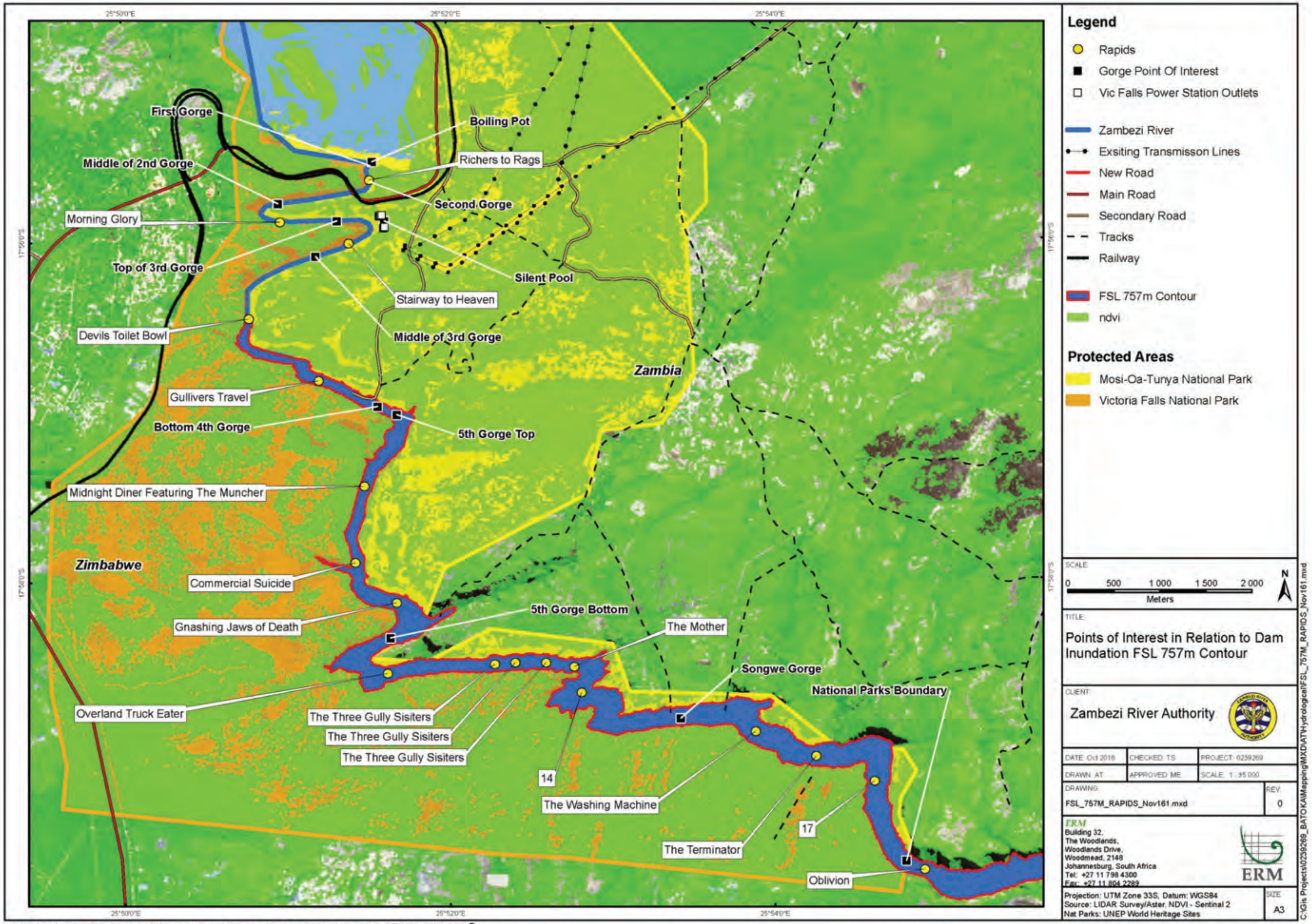


Figure 6.8 Points of Interest in Relation to Full Supply Level (FSL) 740m Contour

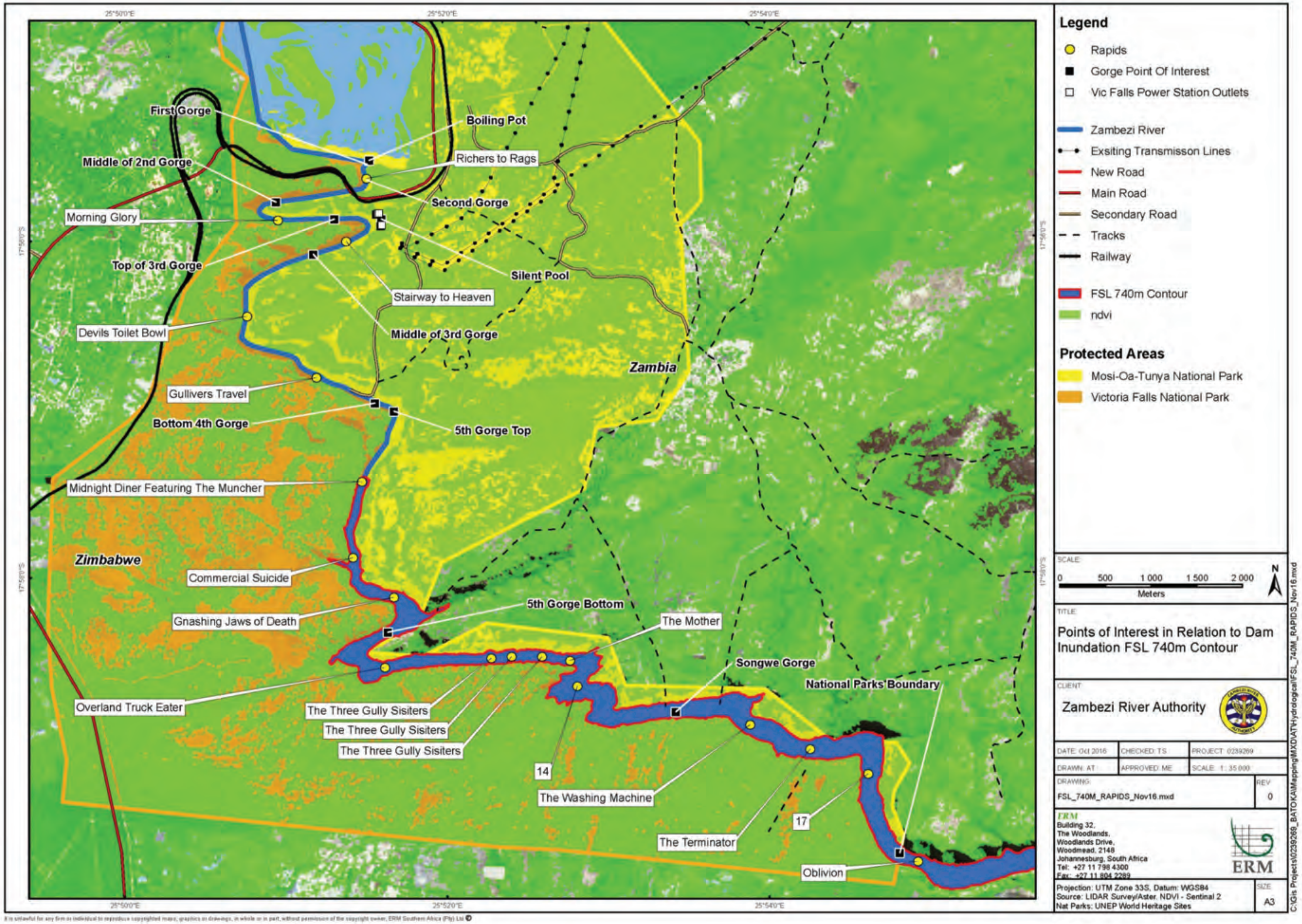


Figure 6.9 Points of Interest in Relation to Full Supply Level (FSL) 730m Contour

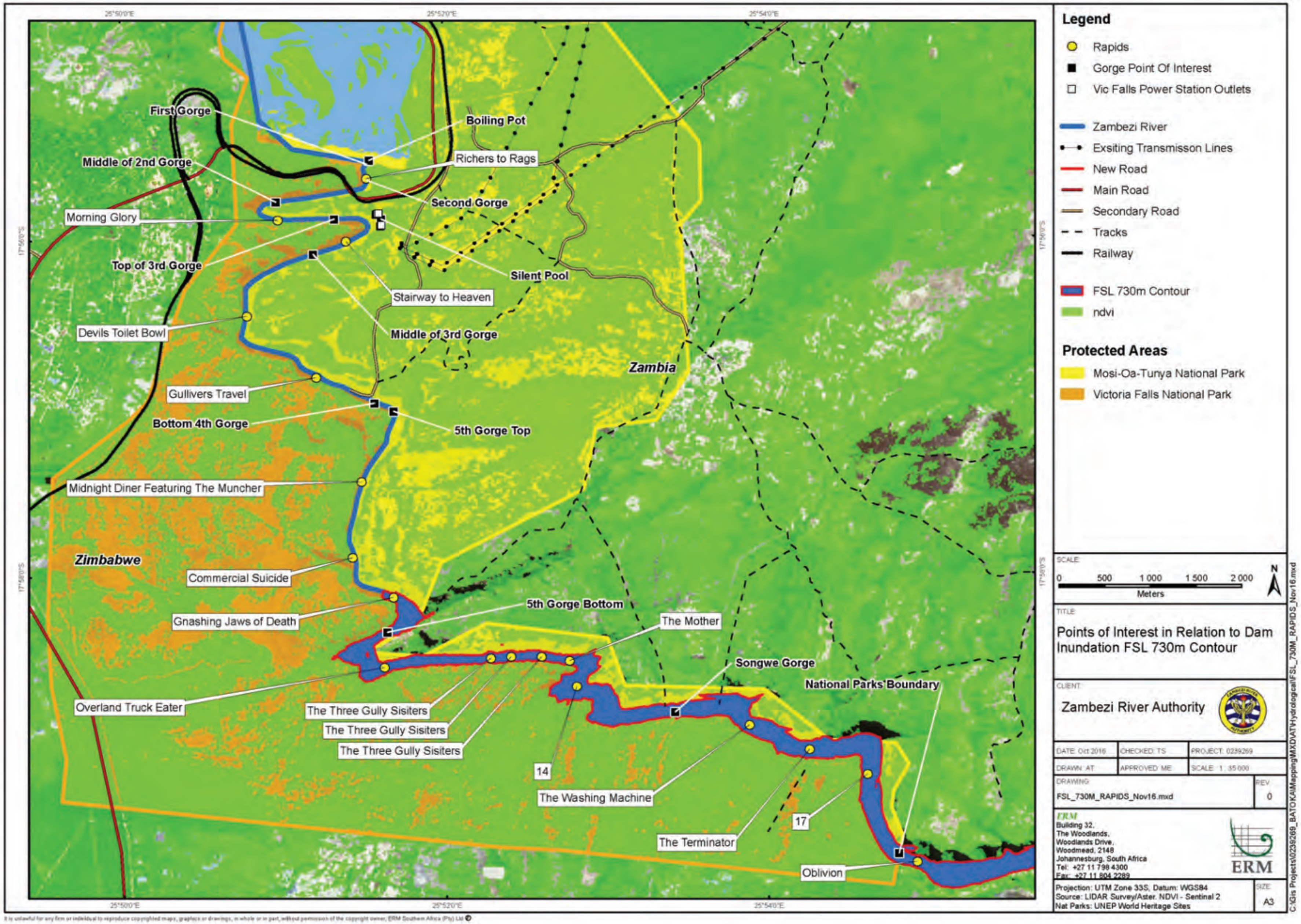
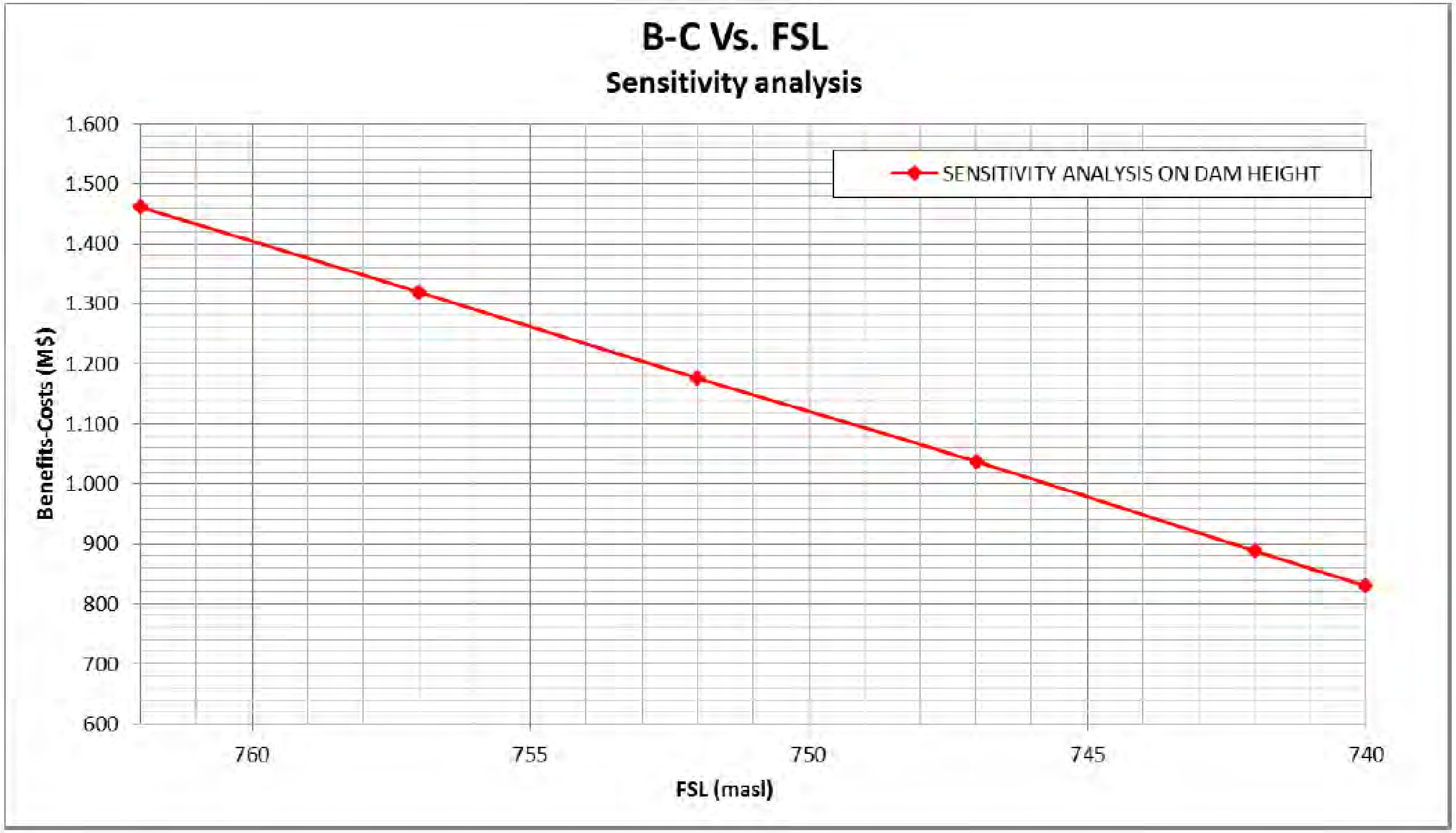


Figure 6.10 Sensitivity Analysis on Dam Height



FSL	(masl)	762	757	752	747	742	740
B-C disc	(M$)	1461	1320	1176	1038	889	830

Source: SP (2018)

6.7 *DAM TYPE*

The SP (2018) report states that previous feasibility studies compared the two following dam alternatives:

- A roller compacted concrete (RCC) gravity dam; and
- An RCC arch-gravity dam (1).

Although the analysis is still ongoing, based on the findings of the studies, further reviewed by SP, and according to preliminary conclusions the best option appears to be a roller compacted concrete (RCC) arch-gravity dam, based on the following technical and economic analysis:

Cost Analysis

The SP (2014) report states that the unit costs of the RCC for a gravity and arch-gravity dam at BGHES are quite similar. While many of the main cost items (equipment, aggregates, transport, placement, etc.) are practically identical, the major differences are the quantity of cement materials and joint preparation with bedding mix. Previous studies indicate the following typical unit prices:

- 65 US$/m^3 BGHES RCC gravity dam; and
- 75 US$/m^3 BGHES RCC arch-gravity dam.

Previous studies indicate that typical medium to large RCC dams cost approximately 55 US$ - 90 US$/m^3 (SP, 2014). Therefore, while there is a 10 US$/m^3 difference between the two prices, SP through other previous projects, has established that both prices are within a reasonable range for recent large RCC dams.

Selection of the Dam Type

The SP Report asserts that both the arch-gravity dam and gravity dam are technically feasible alternatives, considering the quality of the rock foundations. This means that the construction program would not greatly vary. Therefore, SP have focused this comparison on the economic aspects, as follows:

- The total cost of the two alternatives, gravity and arch-gravity, is controlled by several major components such as concrete volumes, excavation volumes, appurtenance structures, foundation treatment, RCC equipment, river diversion, etc.;
- The total cost of several major works (such as RCC equipment, appurtenance structures, river diversion, etc.) is quite constant or varies slightly between the two dam types;
- The total volume, and consequently the total cost, of the RCC is substantially different between the two alternatives. Some other costs

(1) It should be noted that earlier assessments also compared two other alternatives to dam type, namely double curvature arch dam and concrete faced rockfill dam, only the most promising alternatives were assessed in the SP report, 2014.

components would also vary (excavation, foundation treatments, etc.) but substantially less than the RCC; and

- The variation of the total cost of the concrete can be more accurately estimated than the one of the excavation and foundation treatments.

The preliminary estimate of the RCC volumes gave the results indicated in the following table:

Table 6.4 Gravity vs Arch-gravity Dam: Total Cost of RCC

Dam Type	RCC Volumes	RCC Unit Cost	Total RCC Cost
	Mm^3	US$/$m^3$	M US$
Gravity	4.3	65	280
Arch-Gravity	3.2	75	240

The difference in the cost of the RCC is significant, approximately 40 M US$. The variation of the total cost of the excavation and/or foundation treatments between the two alternatives, considering the overall high quality of the foundations, would be quite small.

Therefore, as indicated previously, SP's analysis indicated that based on preliminary conclusions the arch-gravity dam type has been selected as the preferred alternative, as adopted in previous feasibility studies.

6.8 SPILLWAY

Two layout alternatives were looked at by SP (2018). The two alternatives include a separate spillway, i.e. moving the spillway to a saddle on the right abutment, about 2 km from the dam site, and a spillway on the dam crest, with seven gated bays releasing water to a plunge pool at the toe of the dam wall.

A spillway 2 km from the dam site not only shortens the waterways (i.e. replacing the long power tunnels with short penstocks in the dam body) but also ensures the controlled release of flows from the dam downstream so that the water does not overtop and damage or even destroy the dam. Under this option, the spillway section is lower than the other sections of the dam allowing water to flow over its top and down its front face. Another advantage of this alternative is that excavated rock from this spillway may be used as quarry materials in the construction of the dam wall, reducing the need for borrow pits and quarries outside of the inundation area, which serves to minimize the disturbance to areas to within the construction and inundation areas. It is assumed by SP (2018) that at this stage, up to 60 %of the volume of the spillway's excavation could be suitable for RCC aggregates.

In the other layout alternatives, the spillway would not be separate to the dam wall, but would be released to a plunge pool (after energy dissipation) via seven gated bays, each with a sill elevation of 743.5 m amsl.

The costs of a spillway separated from the dam wall are higher, as excavation and support costs for both the approach canal and the downstream canal are additional when compared to the alternative spillway at the dam wall. SP (2018) estimate that the excavation costs in rock for the approach and downstream canals are approximately 12 €/m^3 (13.42 US$/$m^3$), with estimated excavation volumes tentatively estimated in the range of 8 M m^3. Extra costs associated with the spillway away from the dam wall are therefore estimated to be in the region of US$ 107 million. This cost would, however need to be offset against the costs of quarrying for material required for the dam wall under the alternative scenario.

6.9 POWER HOUSES AND WATERWAYS

The following sections illustrate four alternative layouts for the powerhouses examined, namely:

6.9.1 Underground Powerhouses and Waterways (1,600 MW)

This layout include two underground powerhouses, one for each bank, located about 600 m from the intake on the left bank, and 400 m on the right bank. The two powerhouses host 4 turbines that are 200 MW each with a total installed capacity of 1,600 MW. The powerhouses include the main cavern, which totals 130 x 30 x 50 m, and a separate cavern for the transformers. In this layout, there are four identical waterways, two on each side of the river. The average length of the two waterways on the right side of the river is 963 m while for the left side is 712 m. Therefore, the total length of the power waterways is 3,350 m. The power waterway includes an intake, a shaft hosting the gates, a headrace tunnel, a penstock dividing in two manifolds and a tailrace outlet.

6.9.2 Alternative A- Surface Powerhouses and Waterways (1,600 MW)

Two surface powerhouses, specifically on the riverbanks and downstream of the plunge pool, are proposed in this layout. The number of turbines (8) and their size (200 MW each) remain the same as the option above, and the plant size remains the same.

Here the two waterways comprise one line for each river bank. The total length of the two waterways is about 1,930 m, divided in 930 m for the right and about 1,000 m for the left.

6.9.3 Alternative B – Surface Powerhouses and Waterways (2,400 MW)

Here, the layout is similar to Alternative A; however capacity is increased from 1,600 MW to 2,400 MW, which corresponds to the minimum proposed range for the installed power (2,400 -3,000 MW). The size of the turbines is also maintained, while each (of the two) powerhouses has been enlarged hosting two more turbines (i.e. from 4 - 6).

Here there are four waterways, two for each bank. The waterways are identical in the components, but they differ for the length. The average length of the two waterways for the right side is 900 m, while for the left side waterway lengths are about 750 m, resulting in a total length of waterways of approximately 3,300 m.

6.9.4 *Alternative C - Powerhouses at the Dam Toe and Waterways (3,000 MW)*

This final alternative substantially differs from the previous ones. The two powerhouses are located at the downstream toe of the dam, perpendicular to the axis of the Zambezi River. This scheme has a "compact" layout with the dam, waterways and powerhouses close to each other. However, the powerhouses are well separated from the dam, facilitating construction. The two structures are completely independent and the gap between the two will be filled at the end of the construction period. The total capacity of the plant is increased to 3,000 MW, having increased the turbine size up to 375 MW.

In this alternative, there are eight penstocks located in the dam body. Each penstock has a length of 203 m, resulting in a total length of 1,624 m for the entire waterway.

6.9.5 *Advantages of Surface Power Houses and Waterways*

SP therefore selected the most promising alternatives to ensure:

- The *shortest possible construction period*, which substantially improves the financial conditions of the project; and satisfies in the shortest possible time, the energy needs of the two countries; and
- A *significant reduction of uncertainties and risks of delays* during construction.

The time required to build an open-air powerhouse is not comparable to the time needed for an underground powerhouse, mainly because the construction of a large underground powerhouse:

- Can be started only once the access tunnels have been completed;
- Requires a longer construction time as the restricted space available does not allow the use of large cranes and simultaneous activities of several subcontractors;
- Interferes with other underground works such as manifolds and tailrace tunnel lengthens the construction time;
- Includes transformers caverns (and cable shaft, access tunnel, etc.) that are no longer necessary when the transformers are installed in the open-air;
- Has lower production rate of the civil works, that also causes an increase in the unit costs, which are generally 20 % higher than that of a corresponding open air power house;
- Presents a geological risk (special excavation support, etc.) which might cause delays; and
- Presents uncertainties, which might offer contractors' potential grounds for claims and/or delays.

In summary, the merits for the surface powerhouses compared to the underground powerhouses are:

- They have a lower total cost;
- They have lower geologic uncertainties;
- They offer more flexibility in implementation by:
  - Allowing for staggered financing; and
  - They allow for adjustments of the FSL and of the intake level, if necessary.

As such, the preferred alternative is the surface power houses and waterways.

6.10 *NO GO ALTERNATIVE*

As per ESIA good practice, any comparative assessment of project alternatives must include a no-go option. For the purposes of this report the no-go alternative will be that the proposed BGHES is not constructed in its entirety.

The main objectives for constructing the proposed BGHES are as follows:

- **Current Electricity Deficit** – both Zambia and Zimbabwe currently have an electricity deficit where demand exceeds the available supply. This was as a result of the expansions in the mining and manufacturing sectors as well as overall expansions in the economy and population. The current power deficit has resulted in prolonged load shedding and power cuts, which have occasionally affected trade and production.

- **Commercial and Industrial Development** – investment in energy is a prerequisite to achieving commercial and industrial development in Zambia and Zimbabwe. If both countries are to achieve those targets and goals detailed in their Vision 2030 and Vision 2040, and other complimentary plans, Zambia and Zimbabwe will require private sector investment in energy technology that is efficient, sustainable and reliable. The generation of energy through hydropower is a proven technology that is sustainable, and which is actively being promoted at a national level in both Zambia and Zimbabwe. Installed power of the Project would cover 38% and 37% of the total peak demand for Zambia and Zimbabwe in 2030 and 2025 respectively.

- **Power Production Costs** – the proposed BGHES would provide electricity at a cost that would be considerably lower than most of the reasonable alternatives. In Zambia, it is expected to generate the fourth cheapest electricity of the 17 planned power plants in Zambia and in Zimbabwe it will be the lowest cost for electricity production.

- **Macro-economic Benefits** – such benefits include a cumulative contribution of US$ 771 million to the GDPs of the two countries at the end of construction. By 2040 this cumulative contribution is estimated to be $20 237m.

- **Additional Benefits** - additional benefits include savings in generator costs; savings from fewer power outages; alternative fuel savings for individual households; increased income generation for individual households; health benefits for households; and export revenue if the electricity is to be exported.

Moreover, the proposed BGHES will provide opportunities for employment. Direct jobs are anticipated to increase from greater than 1,500 from the 3rd year of construction to 54,000 in 2030. Moreover, indirect jobs are estimated to be 11,900 (2016), 94,000 (2022) and 110,000 (2035).

Accordingly, the proposed BGHES will contribute significantly to local, regional, national and international economic development in both countries. The Project will serve as a central part of the Zambian and Zimbabwean power utility system, helping to promote trade and development in both countries (and neighbouring countries), which is a key objective of Zambia's 2030 and Zimbabwe's 2040 Visions respectively. As such, the "no-go" alternative is not considered reasonable, and will not be considered any further in this report.

6.11 SUMMARY OF ALTERNATIVES CONSIDERED FOR THE PROPOSED BGHES

A summary of the alternatives considered for the proposed BGHES are provided in *Table 6.5* below. Shading in the table presents the most favoured alternative. It is this alternative that has been selected by SP (2015), and this selected alternative was described in *Chapter 2: Project Description*.

Table 6.5 Summary of Alternatives considered for the Proposed BGHES

Dam Location	**Upstream** • Benefits in terms of power production are greatly reduced (energy losses)	**Current Location** • Most favourable geology • Favourable geomorphology • Potential to exploit the entire hydropower potential of the cascade between Victoria Falls and Kariba dam	**Downstream** • Six most downstream projects would require saddle dams • Gorge widens, greatly increasing BGHES dam volumes • Concrete volumes 60% to 200% higher
Optimum Installed power	**1600MW** • Energy production reduced • High loss of 36% of the total flows of the river (spilled flows)	**2400MW** • Lowest Unit Generation Cost • Highest IRR • 23 % spilled flows during the wet season	**3000MW** • Increasing plant size increases cost of powerhouse, EM equipment, waterways and Transmission lines • For an installed plant size of 3,000MW, spills are reduced to 12%.
Refinement of the Project Operating Rules	AddPM01, AddPM02 and AddPM03 only meet the environmental criteria of no more than a 1.5 class drop in Overall Ecosystem Condition in the downstream river.	AddPM04 meets both environmental criteria set out for downstream river conditions (i.e. no more than a 1.5 class drop in overall ecosystem condition &that at least 90% of fish species should be impacted by <25%). This is the preferred scenario from an environmental perspective.	
Powerhouses	**Underground** • High uncertainties/geological risks during construction • Increased construction time	**Above ground** • Lower cost • Lower geological uncertainties • Lesser construction time • Allows for staggered financing • Allows for adjustments in the FSL and of the intake level, if necessary	

Spillway	**Flow over the top of the wall** • Water overtopping the dam wall may damage or even destroy the dam. Appropriate energy dissipaters and a plunge pool are therefore requirements. • Least expensive option requiring less excavation.	**Separate spillway** • Controlled release of flows from the dam downstream of the dam, decreasing the risk of damage to the dam wall during periods of high flows • Excavated rock from this spillway may be used as quarry materials in the construction of the dam wall, reducing the need for borrow pits and quarries outside of the inundation area. • Additional costs associated with excavation and support of the approach and downstream canals (estimated at US$ 107 million).	
FSL	>762 m • Backwaters (especially during high flows) would flood the outlets of the Victoria Falls Power Station • Backwaters would risk flooding all the way to the base of Victoria Falls, leading to visual impacts at the Falls and to the boiling pot, as well as to the viewsheds from the Victoria Falls Bridge and the Victoria Falls hotel.	757m • Allows for changes in the dam's operating rules during periods of high flow (to avoid waters back-flooding into the tailraces of the Victoria Falls Power Station) and into Silent Pool, and during low flows (to allow for rafting in the low flow season to take place).	<762m • Lowering the FSL from 762 m to 740 would lead to a loss in benefit of approx. US$ million 600.
	Note: A full environmental and social analysis of the FSLs is provided in *Chapter 10*.		

6.12 PROJECT TOWNSHIPS

Project Townships will be located on both the North bank of the dam (in Zambia) and on the South bank (in Zimbabwe). Six alternative areas were preliminarily identified, three locations in each of Zimbabwe and Zambia, as potential locations for the project townships.

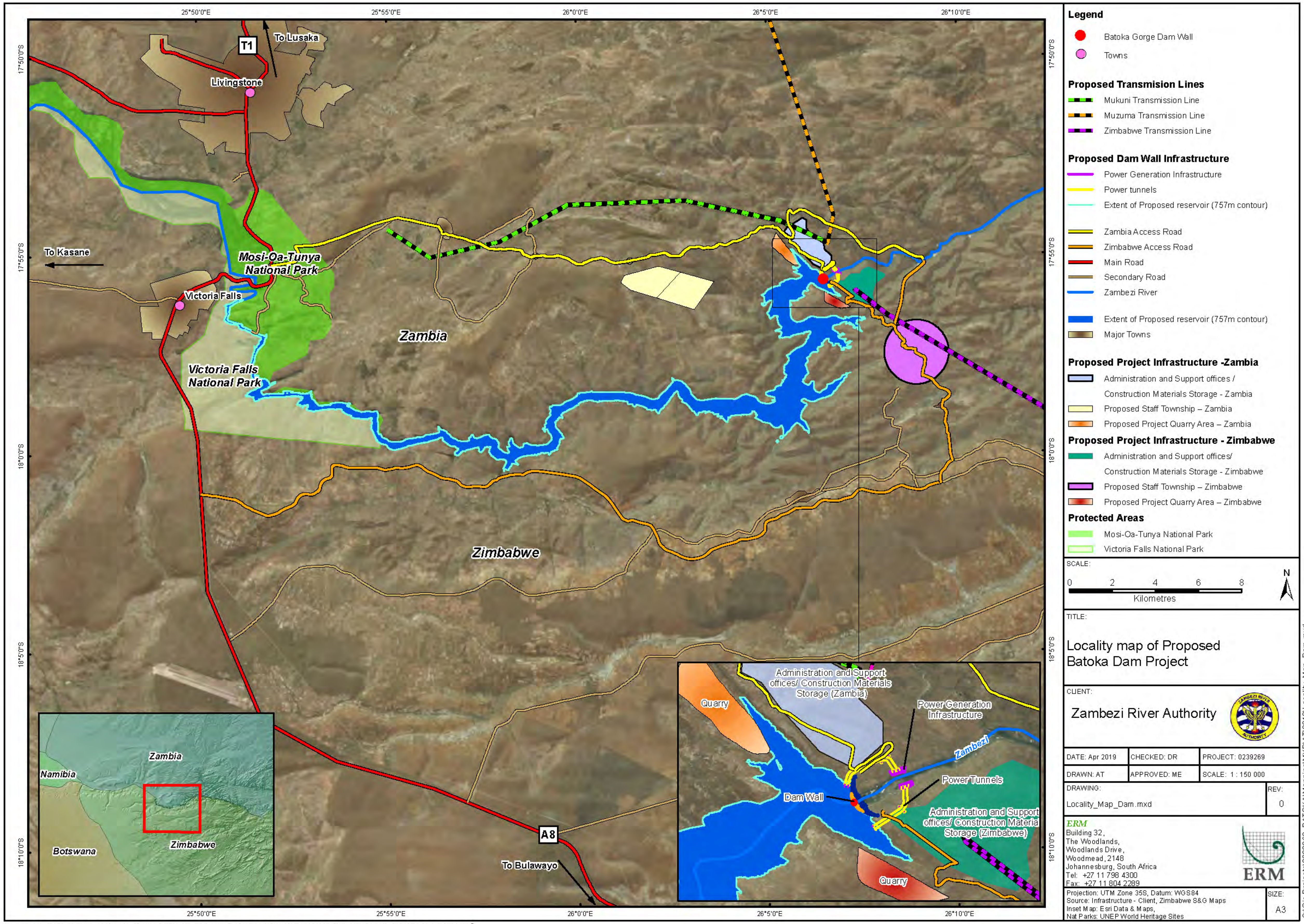
The most suitable locations for the project townships in both Zambia and Zimbabwe are illustrated in *Figure 6.11*.

This selection was made based on the following:

- Reduced physical (and economic) displacement.
- Reduced impact on other important resources such as water for agriculture, and Teak Forest reserves present in this area which the community rely on for sourcing wood for the making of curios (another important livelihood activity), as well as for firewood to meet energy needs and for wood for construction of homes and furniture. The forest areas are also used to source fruits for consumption and income generating purposes and thus access should be maintained.
- The results of the heritage survey revealed that the majority of cultural heritage sites that fall in the proposed project township area are small and already disturbed. As such, they have very limited heritage significance, and give further weight to the development of the camp in this area.
- Surrounding topography and opportunities for expansion of Project Townships, if deemed necessary.

Moreover, the proposed project townships are located in either modified or natural low sensitivity habitats. From a habitat sensitivity perspective, there is therefore no ecological justification for the location of the proposed project townships.

Figure 6.11 Proposed Road Routes and Locations of Project Townships in both Zambia and Zimbabwe



7 PUBLIC PARTICIPATION PROCESS

7.1 INTRODUCTION

As a component of the ESIA for the proposed BGHES, ERM, Black Crystal and Felix Chisha K (independent Zambian consultant) are undertaking a public participation process (PPP).

The PPP has been designed to comply with the regulatory requirements set out in both the Republics of Zimbabwe and Zambia as well as international good practise and the policies of the International Finance Corporation and World Bank Group.

Public participation in an ESIA is not only a statutory requirement, but also a process that is designed to provide stakeholders with an opportunity to evaluate all aspects of the proposed Project, with the objective of improving the Project by maximising its benefits while minimising its adverse effects. Stakeholders represent relevant interests and sectors of society and the various relevant organs of state. Through informed and transparent public participation, effective social and environmental management/mitigation measures can be established and implemented should the Project be authorised.

This *Chapter* presents an overview of the PPP for the ESIA, what engagement activities have been undertaken to date and issues that have been identified. It is concluded by identifying what the next steps in the PPP will be.

It is important to note that parallel resettlement studies are being prepared and a separate PPP will be adopted for these. Issues and comments raised through the resettlement studies, however, will feed into this PPP report.

7.2 APPROACH TO STAKEHOLDER ENGAGEMENT

As detailed above, the PPP has been developed so as to comply with the legislation of both affected countries as well as International Good Practise. The specific requirements with regard to PPP as well as those of the local in-country legislation are set out below:

7.2.1 International Good Practise

Performance Standard 1 of the International Finance Corporation (PS 1) has a particular focus on requirements for stakeholder engagement in a Project. These are described in more detail below in *Box 7.1* below.

Box 7.1 PS 1: Stakeholder Engagement Requirements

IFC PS 1: Assessment and Management of Environmental and Social Risks and Impacts: Stakeholder Engagement

Stakeholder engagement is an on-going process that may involve, in varying degrees, the following elements: stakeholder analysis and planning, disclosure and dissemination of information, consultation and participation, grievance redress mechanism, and on-going reporting to Affected Communities.

Disclosure of relevant Project information

Provide affected communities with access to relevant information on: (i) the purpose, nature, and scale of the Project; (ii) the duration of proposed Project activities; (iii) any risks to and potential impacts on such communities and relevant mitigation measures; (iv) the envisaged stakeholder engagement process; and (v) the grievance redress mechanism.

Informed Consultation and Participation

For Projects with potentially significant adverse impacts on affected communities, conduct an informed consultation and participation process. It should involve deep exchange of views and information, and an organized and iterative consultation, leading to the Project incorporating into their decision-making process the views of the affected communities on matters that affect them directly, such as the proposed mitigation measures, the sharing of development benefits and opportunities, and implementation issues.

The process should be documented, in particular the measures taken to avoid or minimize risks to and adverse impacts on the affected communities. The communities should be informed about how their concerns have been considered.

External Communications

Implement and maintain a procedure for external communications that includes methods to (i) receive and register external communications from the public; (ii) screen and assess the issues raised and determine how to address them; (iii) provide, track, and document responses, if any; and (iv) adjust the management program, as appropriate. In addition, clients are encouraged to make publicly available periodic reports on their environmental and social sustainability.

Grievance redress mechanism for Affected Communities

Establish a grievance redress mechanism to receive and facilitate resolution of affected communities' concerns and grievances about the client's environmental and social performance.

On-going Reporting to Affected Communities

Provide periodic reports to the affected communities that describe progress with implementation of the Project Action Plans on issues that involve on-going risk to or impacts on affected communities and on issues that the consultation process or grievance redress mechanism have identified as a concern to those communities.

IFC Performance Standards require that after completion of an environmental assessment the consultation and disclosure must continue throughout the life cycle (construction and operation phase) of the Project.

In addition, The World Bank Environmental and Social Safeguard 1 (ESS1) prescribes the following stakeholder engagement requirements:

- For all Category A and B Projects, the borrower consults Project-affected groups and local nongovernmental organizations (NGOs) about the Project's environmental aspects and takes their views into account. The borrower initiates such consultations as early as possible. For Category A Projects, the borrower consults these groups at least twice: (a) shortly after environmental screening and before the terms of reference for the EA are finalized; and (b) once a draft EA report is prepared. In addition, the borrower consults with such groups throughout Project implementation as necessary to address EA-related issues that affect them.

- For a Category A Project, the borrower provides for the initial consultation a summary of the proposed Project's objectives, description, and potential impacts; for consultation after the draft EA report is prepared, the borrower provides a summary of the EA's conclusions. In addition, for a Category A Project, the borrower makes the draft EA report available at a public place accessible to Project-affected groups and local NGOs.

7.2.2 *Zimbabwean Legislation*

Statutory Instrument No. 7 of 2007 the Environmental Management (Environmental Impact Assessments and Ecosystems Protection) Regulations provides the requirements for stakeholder engagement in respects of the development of EIAs. Developers are required to consult widely with all stakeholders: "*Before any environmental impact report is furnished to the Director-General, the developer shall carry out wide consultations with stakeholders*". The use of print and electronic media is recognised.

The Director General of the EMA has a right to verify whether full stakeholder participation was undertaken; the Environmental Management Agency will not issue a licence to the developer if they are not satisfied that stakeholder engagement has been undertaken to the manner required: "D*uring a prospectus and environmental impact assessment report review period, the Director-General shall verify whether full stakeholder participation was undertaken when the environmental impact assessment report was prepared*". Statutory Instrument No 7 also provides that "*the Director-General may advertise in the print and electronic media when a prospectus or environmental impacts assessment report is being reviewed*".

7.2.3 *Zambian Legislation*

In Zambia, the Environmental Management Act, 2011 and Statutory Instrument 28 of the 1997 EIA Regulations are the key legislation that provide the requirements for stakeholder engagement in respects of the development of EIAs.

The Environmental Management Act 2011 provides that the public have the right to be informed of the intention of public authorities to make decisions affecting the environment and of available opportunities to participate in such decisions. The legislation obliges the developer to consult with the public: "*the Agency and the appropriate authorities shall establish mechanisms to collect and respond to public comments, concerns and questions relating to the environment including public debates and hearing*".

The 1997 EIA Regulations states that stakeholder engagement needs to involve government agencies, local authorities, non-governmental and community based organisations and interested and affected parties.

"The developer shall, prior to the submission of the EIS to the Council, take all measures necessary to seek the views of the people in the communities which will be affected by the Project. In seeking the views of the community in accordance with sub-regulation, the developer shall:

> *(a) publicise the intended Project, its effects and benefits, in the mass media, in a language understood by the community, for a period not less than fifteen days and subsequently at regular intervals throughout the process; and*
> *(b) after the expiration of the period of fifteen days, referred to in paragraph (a), hold meetings with the affected communities to present information on the Project and to obtain the views of those consulted".*

The Government is responsible for distributing the ESIA for public comment. The public are notified via the media including radio. Public meetings may be called, as advertised in the media. Media notices shall be published three times a week for two consecutive weeks in the national papers at least fifteen days prior to the public hearing. Comments can be received 20 days from the date of the last media notice however, the Government may extend this period up to a period of 15 days. Such hearings can only be scheduled twenty-five days after the last public notification.

7.3 OBJECTIVES OF STAKEHOLDER ENGAGEMENT

The PPP has been designed to achieve the following objectives:

- To ensure that stakeholders are well informed about the proposed Project;
- To provide a broad set of stakeholders sufficient opportunity to engage and provide input and suggestions on the proposed Project;
- To verify that stakeholders issues have been accurately recorded;
- To draw on local knowledge in the process of identifying environmental and social issues associated with the proposed Project, and to involve stakeholders in identifying ways in which these can be addressed; and
- To comply with the legal requirements.

The PPP has been designed in four phases, these are described in more detail below.

7.3.1 *Screening/Key Stakeholder Engagement Phase*

- Introduces the proposed Project and its processes to key stakeholders;
- Obtains the blessing of these key stakeholders to consult with communities at large; and
- Identifies appropriate, effective and desired means of engagement.

7.3.2 Scoping Phase

- Officially initiates and notifies the public of the formal ESIA process;
- Invites prospective stakeholders to register as interested and affected parties (I&APs) as per ESIA requirements;
- Engages with stakeholders to identify issues of concern, suggestions and comments about the proposed Project;
- Makes suggestions for enhanced Project benefits and reasonable alternatives;
- Verifies that issues raised by stakeholders have been accurately recorded through a Draft Scoping Report; and
- Defines the Terms of Reference for the ESIA specialist studies to be undertaken in the impact assessment phase.

7.3.3 Impact Assessment Phase

This phase allows stakeholders to provide informed comment on the findings of the specialist assessments and proposed mitigation measures. It also allows for a further confirmation on issues identified.

7.3.4 Decision Making Phase

This phase of the study will allow for information sharing around the environmental authorisation decision that is taken in line with the legislative requirements.

7.4 STAKEHOLDER IDENTIFICATION

7.4.1 Identification

ERM undertook an initial exercise to identify potential stakeholders on the basis that they:

- Have an interest in the Project;
- Would potentially be impacted by or have an influence on the Project (negatively or positively); or
- Could provide commentary on issues and concerns related to the Project.

Keeping the above three points in mind ERM then undertook the following steps:

- Identification of people/ communities settled in or within 1 km of the Project Area;

- Identification of relevant traditional, local/ district, and provincial authorities in who's derestriction the Project Area falls;
- Identification of relevant government departments/ bodies who may be commenting authorities, or have an interest in the Project and the ESIA;
- Identification of river users, particularly in around Livingstone and Victoria Falls who may be affected by changes to flow regimes of the Zambezi as a result of the Project; and
- Identification of NGOs and other special interest groups that would likely have an interest in a project of this nature, scale and location was developed.

A preliminary database was compiled including the stakeholders identified through the above process. This database has been maintained and updated during the ongoing ESIA process.

One of the key principles informing the PPP is that it should be an inclusive process and that opportunity is afforded for stakeholders to register to participate in the process.

Stakeholders were invited to become part of the process in two ways:

- Through notification activities, which were designed to ensure that the broader public were informed of the process and invited to be involved; and

- Through proactively registering stakeholders identified as potentially interested or affected through the development of a stakeholder database in advance of the notification activities and directly informing these parties of the opportunity to comment and participate.

Media notices were placed in newspapers to notify the general public about the Project and request registration and participation. In Zimbabwe, notices were placed in the *Herald* and *Chronicle* due to wide readership in Harare Province and Matabeleland North Province respectively. In Zambia, a notice was placed in *The Times of Zambia* and *The Post*. Further details of these notices are provided in *Table 7.1* and *Annex C1.*

Proactive registration took place via the distribution of invitation letters and background information documents (BIDs) by email, post or hand delivery to those people identified upfront in the Scoping Phase as stakeholders. Traditional authorities and village headmen were notified directly via preliminary meetings and provided with flyers and posters to encourage the participation of their communities. Notification and registration of public participation materials are appended to this report as *Annex C1.*

Following the completion of the initial round of consultations, the following parties have been registered on the stakeholder database:

7.4.2 *Zimbabwe*

- **Government**: Stakeholders from selected National, Provincial, District and Local Departments as well as relevant Ward Councillors and elected political representatives. Specifically these have included:

  - Civil Aviation Authority of Zimbabwe;
  - Civil Protection Unit;
  - Civil Service Commission;
  - Department of Immigration;
  - Department of Physical Planning;
  - Department of Veterinary Services;
  - District Development Fund;
  - Environmental Management Agency;
  - Hwange District Administrator;
  - Hwange Local Board;
  - Hwange District Council;
  - Meteorological Services Department
  - Ministry of Defence, Security and War Veteran's
  - Ministry of Energy and Power Development
  - Ministry of Environment, Tourism and Hospitality Industry
  - Ministry of Finance and Economic Development
  - Ministry of Health and Child Care
  - Ministry of Higher Education, Science and Technology Development
  - Ministry of Home Affairs and Cultural Heritage
  - Ministry of Industry and Commerce
  - Ministry of Information, Publicity & Broadcasting Services
  - Ministry of Justice, Legal and Parliamentary Affairs
  - Ministry of Local Government, Public Works and National Housing
  - Ministry of Mines and Mining Development
  - Ministry of Primary and Secondary Education
  - Ministry of Public Service, Labour and Social Welfare
  - Ministry of Transport and Infrastructural Development
  - Ministry of Women Affairs, Community, Small and Medium Enterprises
  - National Museums and Monuments of Zimbabwe;
  - Registrar General's Office;
  - Rural Electrification Agency;
  - Social Services Department;
  - Victoria Falls Municipality;
  - ZESA Holdings;
  - Zimbabwe Council of Tourism;
  - Zimbabwe Electricity Transmission and Distribution Company;
  - Zimbabwe Energy Regulatory Authorities;
  - Zimbabwe Forestry Commission;
  - Zimbabwe National AIDS Council;
  - Zimbabwe National Statistics Agency (ZIMSTATS)
  - Zimbabwe Parks and Wildlife Management Authority;

- Zimbabwe Parks and Wildlife Management Authority;
- Zimbabwe Tourism Authority;
- ZIMRA;
- ZINARA;
- ZINWA; and
- ZRP.

- **Traditional Leadership**: areas are governed by Traditional Leaders, Village Heads and Village Headmen:

    - Bishop Matata Sibanda;
    - Chief Hwange;
    - Chief Shana; and
    - Headmen of the affected wards.

- **Tourism Stakeholders:** these include stakeholders having an economic interest in the Project area as a result of tourism activities and include:

    - Adventure Zone;
    - African Paddling Association;
    - African Predator Diving;
    - Azambezi Hotel;
    - Backpackers Lodge;
    - Bonisair;
    - CANSAF;
    - Cheziya Crocodile Ranch;
    - Croc Cage Diving;
    - Dabula Safari;
    - Dingane Tours;
    - Eco Elements;
    - Elephant Hills Hotel;
    - Employers Association of Tourism and Safari Operators;
    - Hotel Association for Matabeland North;
    - Ilala Lodge;
    - Imvelo Safari Lodges;
    - Imvilo Gorges Lodge;
    - Khanando;
    - Kingdom Hotel;
    - Lion Encounter Alert;
    - Rafting Association;
    - Rainbow Hotel;
    - Regional Tourism Organisation of Southern Africa;
    - Shearwater Adventures;
    - Shock Wave Rafting;
    - Spray View Hotel (Cresta);
    - Stanley and Livingstone;
    - The Elephant Camp (Wild Horizons);
    - Victoria Falls Hotel;

- Victoria Falls Publicity Association;
- Victoria Falls Safari Lodge;
- Victoria Falls Wonders Online;
- Wild Horizons; and
- Zambezi Helicopter Company (Shearwater).

- **Community/Development Organisations:** these involve stakeholders involved in community development and social improvement Projects in the area

  - CAMPFIRE Project;
  - Chisuma Clinic;
  - Rose of Charity;
  - Intengwe;
  - Lubancho House;
  - Dhibha Mombe; and
  - Catholic Development Commission / Caritas.

- **Interest Groups:** these are organisations with an environmental or other interest in the Project

  - *Non-Governmental Organisations*
    - Bird Life Zimbabwe;
    - Environment Africa;
    - Green Fund;
    - KAZA (Kavango-Zambezi Transfrontier Conservation Area);
    - The Victoria Falls Wildlife Trust;
    - Victoria Falls Anti-Poaching Unit;
    - Zambezi River Society;
    - Zambezi Society; and
    - Zimbabwe Conservation Task Force.

  - *International Organisations*
    - International Rivers;
    - International Rafting Federation;
    - Man & the Biosphere (MAB);
    - South African Development Community (SADC)
    - UNESCO;
    - UNICEF;
    - United Nationals Development Programme;
    - University of California;
    - WWF;
    - Gayathi Paper; and
    - Department of Environmental Sciences, Unisa.

Other Interest Groups

- Batoka Clan;

- CADEC Hwange;
- EMRAS Ambulance Services;
- Finx;
- Friends of Victoria Falls ;
- Hwange Colliery;
- Hwange Power Station (HPS);
- Hwange Show Society;
- Jafuta Foundation;
- Matetsi ECS;
- Mputalo hunters;
- PSMI Medical Clinic (VF);
- The Chronicle;
- The Falls Private Medical Centre - Health Bridge;
- Tree Society of Zimbabwe;
- University of Zimbabwe's Centre for Applied Social Studies;
- UZ Department of Biological Sciences;
- VFM;
- Victoria Falls Communications Bureau;
- Zimbabwe Power Company (ZPC); and
- Zim Construction.

- **Affected communities:** these entail those both directly and indirectly affected by the proposed Project. On the commencement of the resettlement work, this will be expanded to include affected individuals within communities:

  Directly Affected Villages

  In Jambezi, Nemangana, Kattchecheti, Chidobe, Chikandukubi, Matetsi, Mbhizi, Sidinda and Mashala wards.
  Neighbouring villages and those experiencing indirect benefits

7.4.3 Zambia

- **Government**: Stakeholders from selected National, Provincial, District and Local Departments as well as relevant Ward Councillors and elected political representatives. Specifically these have included:

- Choma District Council;
- Department of National Parks and Wildlife of Zambia
- Department of Water Affairs;
- Energy Department;
- Energy Regulation Board;
- Environment Department;
- Geological Survey Department;
- Human Rights Commission;
- Kazungula District Council;
- Kalomo District Council;

- Legal, Social and Governance;
- Livingstone City Council;
- Livingstone Museum;
- Ministry of Agriculture;
- Ministry of Chiefs and Traditional Affairs;
- Ministry of Community Development and Social Welfare;
- Ministry of Energy;
- Ministry of Finance;
- Ministry of Fisheries and Livestock;
- Ministry of General Education;
- Ministry of Health;
- Ministry of Higher Education;
- Ministry of Housing and Infrastructure Development;
- Ministry of Labour and Social Security;
- Ministry of Lands and Natural Resources;
- Ministry of Local Government;
- Ministry of Mines and Mineral Development;
- Ministry of National Development and Planning;
- Ministry of Tourism and Arts;
- Ministry of Transport and Communication;
- Ministry of Water Development , Sanitation and Environmental Protection;
- Ministry of Works and Supply;
- National AIDS Council;
- National Council for Construction;
- National Heritage Conservation Commission (NHCC)
- National Parks and Department of Maritime and Inland Waterways;
- National Road Fund Agency;
- Planning and Information Department;
- Road Development Agency;
- Road Transport & Safety Agency;
- Southern Water and Sewerage Company Limited;
- The National Water Supply and Sanitation Council;
- Water and Sanitation Association of Zambia (WASAZA);
- Water Authority Board;
- Zambia Environmental Management Agency
- Zambia National Commission for UNESCO;
- Zambia National Museums and Monuments;
- Zambian National Commission for Development Planning;
- Zamtel;
- ZESCO Ltd; and
- Zimba District Council.

- **Traditional Leadership**: areas are governed by Traditional Leaders, Village Heads and Village Headmen:

    - Chief Mukuni;

    - Chief Musokotwane;
    - Chief Sipatunyana;
    - Chief Simwatachela;
    - Chief Singani;
    - Chief Chikanta; and
    - Headmen of the affected wards.

- **Tourism Stakeholders:** these include stakeholders having an economic interest in the Project area as a result of tourism activities and include:

    - Adventure logic;
    - Bundu Adventures Ltd.;
    - Euma Tours;
    - Fawlty Towers;
    - Limbo lodge;
    - Livingstone Business District Association;
    - Livingstone Tourism Association;
    - Maramba River Lodge;
    - Mukwa Travel & Tours Zambia;
    - Munga Eco Lodge;
    - Raft Extreme;
    - Safari Par Excellence;
    - Safari Trek International Group;
    - Savannah Southern Safaris
    - Stanley Exploration & Safari;
    - Tabonina Guesthouse;
    - Taita Falcon Lodge;
    - United Air Charter;
    - Wasawange Lodge & Tours
    - Water Rafters Association; and
    - Zambezi Rafting Company.

- **Community/Development Organisations:** these involve stakeholders involved in community development and social improvement Projects in the area

    - Alliance for Sustainable Agriculture(ASA);
    - Catholic Development Commission / Caritas.
    - Cheshire Homes;
    - Community Based Natural Resources Management Forum;
    - Integrating Climate Change in Water Resource Monitoring in Zambia;
    - Jesuit Centre for Theological Reflection;
    - Livingstone & Kazungula Farmers Association ;
    - MS Zambia;
    - Mukuni Health Centre;
    - Non-Governmental Coordinating Council;
    - Republic of Zambia (Ministry of Agriculture and Livestock (MAL) Policy and Planning Department;

- Southern Medical Centre;
- The Butterfly Tree;
- Water and Sanitation Association of Zambia (WASAZA);
- Wildlife and Environmental Conservation Society of Zambia;
- Zambia Climate Change Network;
- Zambia Community Based Natural Resource Management Forum; and
- Zambia Vulnerability Assessment Committee.

- **Interest Groups:** these are organisations with an environmental or other interest in the Project
    - *Non-Governmental Organisations*
        - Environment Africa.

    - *International Organisations*
        - Care International;
        - International Rafting Federation;
        - International Rivers;
        - OWA;
        - Oxfam;
        - Red Cross;
        - Southern African Development Committee (SADC)
        - UNESCO;
        - World Vision; and
        - WWF.

    - *Other Interest Groups*
        - EAG;
        - AZMEC, WECSZ, ZAMDEX;
        - Copperbelt University;
        - Hearth Earth Art (Permaculture Fundi)
        - Livingstone Chamber;
        - Livingstone General Hospital;
        - Private Sector Development Association;
        - The Livingstone Man;
        - University of California;
        - Zambezi Memories;
        - Zambia Chamber of Small and Medium Business Associations;
        - University of Zambia;
        - The Copperbelt University;
        - University of Lusaka;
        - Information and Communication University; and
        - Mulungushi University.

- **Affected communities:** these entail those both directly and indirectly affected by the proposed Project. On the commencement of the resettlement work, this will be expanded to include affected individuals within communities:

Directly Affected Villages

In Livingstone, Zimba, Kalomo and Choma Districts

Neighbouring villages and those experiencing indirect benefits

A stakeholder database has been compiled and will continue to be updated throughout the PPP. The existing detailed stakeholder database is appended as *Annex C2*.

7.4.4 Analysis

As it is not practical, and not necessary, to engage with all stakeholder groups with the same level of intensity all of the time, analysing and prioritizing stakeholders is important to determine appropriate engagement methods.

To support the analysis of stakeholders and help develop an appropriate approach for engagement, the support/influence matrix was been used to group stakeholders. Support refers to the attitude a stakeholder may have towards a Project, while influence refers to the leverage a stakeholder may have in relation to decisions either taken by, or affecting the Project. In this model, it is assumed that all stakeholders have a level of interest in the Project.

Based on the outcomes of the stakeholder analysis, recommended levels of engagement have been assigned to Project stakeholders. This approach recognises that stakeholder engagement is multi-faceted, and that the approach to engagement is not uniform across stakeholders. In analysing these stakeholders and developing an approach to engagement, consideration has also been given to:

- Level of interest in the Project/operation;
- Anticipated impact of the Project on the stakeholder;
- Vulnerability status of the stakeholder; and
- Relationships with high influence stakeholders, including their ability to influence these stakeholders.

The stakeholder engagement activities undertaken during the ESIA, described below, have been based on the outcome of the stakeholder analysis.

7.5 ACTIVITIES UNDERTAKEN DURING THE SCOPING PHASE

Table 7.1 below provides details of the PPP activities undertaken during the Scoping Phase of the overall ESIA process to date. Where activities have already been completed, annexes of supporting material are indicated.

Table 7.1 Public Participation Activities undertaken to date

Activity	Details	Reference in ESIA
Pre-Scoping/Key Stakeholder Phase		
Site visit for orientation and identification of affected area, stakeholders and logistical considerations	A site visit was undertaken to inform the scope of work for this Project. This was undertaken between 9th and 13th June 2014.	
Meetings with key stakeholders to determine stakeholder engagement approach	Meetings with local authorities and traditional authorities. Introduction of the proposed Project and its processes. They key purpose of these meetings was to refine the stakeholder engagement plan. These meetings took place between 29th July and 8th August 2014.	***Annex C3*** I&AP meeting minutes
Meetings with key stakeholders to expand on approach and assist with logistics for community meetings	Further meetings were held with the traditional authorities in order to set dates and venues for community meetings and ensure that their permission for these meetings was provided. These meetings were undertaken between 17th and 23rd September 2014.	***Annex C3*** I&AP meeting minutes
Scoping Phase		
Identification of stakeholders	Stakeholder database was compiled which includes interested and affected parties from various sectors of society and the regulatory environment including directly and indirectly affected communities in and around the proposed Project area. This was expanded on following the first round of PPP and will continue to be updated throughout the PPP process.	***Annex C2*** Stakeholder database
Distribution of proposed Project announcement letter and Background Information Document (BID)	BID and announcement documentation emailed and posted to pre-registered stakeholders. (Registration period: 1st Oct to 30th October 2014 in Zambia; 18th September 2014 to 19th October 2014 in Zimbabwe)	***Annex C1*** BID, letters, registration and comment sheet, media notices, flyers and site notices
Placing of media notices	Adverts were placed in the *Herald* (18th September 2014 - Zimbabwe) and *Chronicle* (18th September 2014 and 22nd December 2014 - Zimbabwe) and *Times of Zambia* (1st October 2014 - Zambia) and *The Post* (19th December 2014 – Zambia) newspapers. These media notices also advertised the public open days in Harare, Lusaka, Victoria Falls and Livingstone	***Annex C1*** BID, letters, registration and comment sheet, media notices, flyers and site notices
Distribution of site notices and flyers for community meetings	In agreement with the traditional authorities, headmen and village headmen, flyers were distributed via these representatives and site notices printed also for their placement at suitable venues. Community meetings were advertised in this manner. These were distributed on 20th September 2014 in Zimbabwe and on 22nd September 2014 in Zambia (Chief Musokatwane only as Chief Mukuni requested that these external notification	***Annex C1*** BID, letters, registration and comment sheet, media notices, flyers and site notices

Activity	Details	Reference in ESIA
	means not be utilised for his communities as he wanted to notify them directly)	
Stakeholder meetings	A full schedule of PPP engagements is provided in *Table 7.2* below. At the request of stakeholders, an additional meeting in Victoria Falls and Livingstone with technical team members was held on 22nd and 23rd January 2015 respectively. An interpreter was provided for all community meetings.	***Annex C4*** Attendance registers
Obtained comments from stakeholders	Comments, issues of concern and suggestions received from stakeholders were captured in the Comment and Response Report.	***Annex C5*** Comment and Response Report
Draft Scoping Report	A DSR was compiled on the basis of comments received. This included a component detailing the public participation activities undertaken to date.	Not applicable
Announcement of DSR	DSR announcement letter sent to all stakeholders on the database along with a copy of the comments and response report and non-technical summary of the Draft Scoping Report.	***Annex C6*** DSR Public Participation Material
Making DSR available to stakeholders	DSR and/or accompanying/summary documents were placed at the following public places within the proposed Project area: ***Zimbabwe*** Hwange District Council Office District Administrators Office in Hwange Jambezi Clinic Chisuma Clinic Harare Black Crystal Office Provincial Administrators Office Victoria Falls Municipal Office Victoria Falls Environment Africa Office ***Zambia*** Livingstone City Council Livingstone District Office Kazungula District Council Kazungula District Office Lusaka Kaizen Consulting Office District Commissioners offices in Zimba, Kalomo and Choma District Council Offices in Zimba, Kalomo and Choma National Assembly Offices Zimba, Kalomo and Choma Chiefs Palaces (Sipatunyana, Simwatachela & Chikanta)	***Annex C6*** DSR Public Participation Material

Table 7.2 Stakeholder Engagement Undertaken During the Scoping Phase of the Study

Meeting	Venue	Date
Zimbabwe		
Public Open Day, Harare	Harare Royal Golf Club	30th Sep 2014
Authorities Meeting, Bulawayo	Bulawayo Club	1st Oct 2014
Community meeting, Jambezi	Chief Shana's homestead	2nd Oct 2014
Hwange District Council Meeting	Hwange District Council Offices	3rd Oct 2014
Community meeting, Nemangana	Sacred Heart Mission	4th Oct 2014
Victoria Falls Open Day	Victoria Falls Municipal Offices	4th Oct 2014
Community meeting, Kattchecheti	Ndhlovu Business Centre	5th Oct 2014
Community meeting, Chidobe	Chisuma Primary School	6th Oct 2014
Community meeting, Chikandukubi	Mashake Secondary School	6th Oct 2014
Community meeting, Matetsi	Matetsi Police Station	7th Oct 2014
Community meeting, Mbhizi	Milonga Clinic	7th Oct 2014
Community meeting, Sidinda	Lumbora Primary School	8th Oct 2014
Community meeting, Mashala	Mashala Secondary School	8th Oct 2014
Victoria Falls Information Sharing Meeting	Victoria Falls Municipal Offices	22nd Jan 2015
Zambia		
Livingstone Open day	Livingstone Municipal Offices	6th Oct 2014
Lusaka Open Day	Long Acres Lodge	7th Oct 2014
Regulatory authority meeting, Lusaka	Long Acres Lodge	8th Oct 2014
Livingstone Council Meeting	Provincial Conference Room, Livingstone	9th Oct 2014
Kazangula District Council Meeting	Kazungula Council Chambers	10th Oct 2014
Community meeting for Chief Musokotwane villages	Musokotwane Primary School	11th Oct 2014
Community meeting for Chief Mukuni villages	Njando Primary School	13th Oct 2014
Livingstone Information Sharing Meeting	Livingstone Lodge	23rd Jan 2015

7.6 *SCOPING PHASE*

Feedback on the results of the Scoping Phase of the Project so that issues identified to date can be confirmed and expanded on has taken place as detailed in *Table 7.2* above. The report was made available for a 30 day comment period, after which comments received have been included into the Final Scoping Report which was submitted to EMA and ZEMA. In addition the Comments and Response Report has been updated with all comments received and will be circulated to all stakeholders as confirmation of issues identification.

7.6.1 *Final Scoping Report*

The Scoping Report was made available to stakeholders for review and comment in December 2015. The comment period began from 1st December 2015 to the 22nd January 2016. The Scoping Report was accompanied by the following documents:

- Non-Technical Summary of the Scoping Report;
- Comments and Response Report; and
- Grievance redress mechanism.

Public Availability and Accessibility of the Scoping Report

The full Scoping Report was made available via the project website http://www.erm.com/batokahesesia; and/ or could be requested from our local Zimbabwe and Zambia consultants; as well as public places within the project affected districts including:

Zimbabwe

- Hwange District Council Office;
- District Administrators Office in Hwange;
- Jambezi Clinic;
- Chisuma clinic;
- Matebeleland North Provincial Administrators Office;
- Victoria Falls Municipal Offices;
- Environment Africa Office Victoria Falls; and
- Black Crystal's Office in Harare (see address below).

Zambia

- Livingstone City Council;
- Livingstone District Commissioner's Office;
- Kazungula District Council;
- Kazungula District Commissioner's Office;
- Lusaka Kaizen Consulting Office;
- District Commissioners offices in Zimba, Kalomo and Choma;
- District Council Offices in Zimba, Kalomo and Choma;
- National Assembly Offices Zimba, Kalomo and Choma; and
- Chiefs Palaces (Sipatunyana, Simwatachela & Chikanta).

In late 2015, the ESIA process was placed on hold for numerous technical and commercial reasons; however, ongoing discussions have been held between ERM, the ZRA and the World Bank (the funder of the feasibility studies), and the ESIA process for the Project has since recommenced. An interim round of public participation was undertaken by ERM. This is described below in *Section 7.7*.

7.7 INTERIM ENGAGEMENT ACTIVITIES

Given the length of time that has lapsed between the public participation undertaken as part of the Scoping Phase (late 2015), and the recommencement of the ESIA process in late 2018, an interim round of public participation was undertaken with the following objectives:

- To notify stakeholders of the recommencement of the ESIA process and its associated timeline for delivery;
- To inform them of further opportunities for the engagement of Stakeholders;
- To update stakeholders on changes to the Project Team;
- To provide updated contact information for further communication;
- To invite new stakeholders to register as an I&APs for the Project; and
- To allow stakeholders an opportunity to raise questions or comment on the Project and ESIA process.

The activities undertaken in furtherance of the above stated objectives are described below.

7.7.1 Stakeholder Database Update

An exercise was undertaken to verify and update contact details for stakeholders on the existing stakeholder database, which was developed as part of the ESIA in 2015. The database has also been updated with the details of additional communities and leadership identified as part gathering of additional baseline information in the proposed Project area, particularly downstream of the proposed dam wall and in the areas proposed for the sourcing of quarry materials. The updated stakeholder database is provided in *Annex C2*.

7.7.2 Notification of Status of the ESIA Process

Stakeholders on the existing stakeholder database were notified of the status of the ESIA process via email or post on 6 December 2018. A copy of the letter is attached in *Annex C7*, together with proof of distribution.

In addition, a series of meetings were held with District Authorities and Traditional Leaders. These meetings afforded key stakeholders the opportunity to raise concerns and ask questions. ***Table 7.3*** presents a schedule of the meetings, and meeting minutes are provided in *Annex C7*.

Table 7.3 Meetings Undertaken during Interim Stakeholder Engagement

Meeting	Date
Zambia	
Southern Province Secretary	3 December 2018
HRH Chief Mukuni	4 December 2018
Kazungula District Council	4 December 2018
Livingston City Council	5 December 2018

Meeting	Date
Zimba District Council	6 December 2018
Chief Simwatachela	10 December 2018
Chief Sipatunyama	11 December 2018
Zimbabwe	
DA	27 November 2018
AREX	27 November 2018
Hwange District Administration	27 November 2018
Hwange District Council	28 November 2018
Ward Councillors from Chidobe Ward and Mbizha Ward	28 November 2018
Chief Shana	30 November 2018

7.8 SUMMARY OF STAKEHOLDER COMMENTS AND CONCERNS

7.8.1 *Summary of Comments and Concerns Raised During the Scoping Phase*

A summary of comments raised by stakeholders through the public participation process up to and including the Scoping Phase is included in *Table 7.4* below, while a summary of comments pertaining to the Scoping Report is presented in *Table 7.5*. A full list of comments and associated responses are included in the Comment and Response Report (*Annex C5)*.

Table 7.4 Summary of Stakeholder Questions and Concerns

Category	Comments Raised
Biodiversity	• Requirement for an offset for National Park area lost • Need for the relocation of crocodiles in the Gorge • Need for liaison with and engagement between stakeholders to monitor and relocate affected species • Loss of birding tourism • Loss of endemic bird species • Loss of nesting areas for several unique bird species • Loss of unique insect life • Threat to animal life • Impact on bats • Loss of unique aloes and succulents • Impact on unique vegetation found in the Gorge • Movement of wild animals from the Gorge into the communities • Disruption of livelihoods as a result of an increase in human-wildlife conflict • There are elephant corridors in the area and consultation is required with the Zambian Wildlife Authority • Impact on elephant crossing and therefore increase in human-wildlife conflict • Impact on Community Wildlife Project in Chief Mukuni's area • Impact on the Chete and Secula islands which are both rich in wildlife • Zambian transmission line on the bird migratory path between Mozambique and Okavango • Need for appointment of a bird specialist and the study cannot just be undertaken at a desktop level • Spread of water hyacinth

Category	Comments Raised
	• Impact on freshwater biodiversity and downstream ecological processes • Impact on large mammals • Relocation of communities should promote conservation and take into account animal corridors and routes • Need to monitor environmental attributes to guide policy and decisions for similar future Projects
Community development	• Use of local companies as sub-consultants for the Project • Use of local companies for the supply of goods and services • Need for plans to support the youth of the area • Provision of power to those impacted • Employment of local people required • Social benefits for local people is required • Need for a reliable water supply in the communities • Need for transparency with regard to Project benefits • Need for the development of social infrastructure • Need to benefit from the water supply provided by the dam • Need to upgrade roads in the area to improve community access • Need for water and sanitation projects • Need for recreational facilities • Compensation required to the community as a whole in the form of community development projects
Heritage	• Impact on cultural sites • Impact on historical sites and graves • Need for presentation on how cultural heritage will be addressed • Measures to protect the "boiling pot" • Relocation of heritage sites • Engagement of heritage authorities
Dam stability	• Impact downstream if dam failure • Historical concerns raised with regard to dam failure • Suitability of the geology for the dam development
Downstream water impacts	• Impact on downstream water quality and flow • Information required with regard to releases of water from the dam – issues around regularity of these and seasonality • Availability of existing water quality data • Impact on Kariba water levels during construction and operation • Impact on energy generation at Lake Kariba Impact on downstream tourism activities including those located in Binga • Impact on downstream conservancies • Impact on Hwange Colliery water abstraction • Impact on downstream irrigation schemes • Impact on falls in close proximity to the dam? • Full comprehensive assessment required on environmental flows • Will water require treatment prior to release? • Impact on sedimentation downstream
Upstream water impacts	• Impact on Victoria Falls as a result of sedimentation • Impact on Victoria Falls if there is flooding
Impact on surface and groundwater bodies	• Impact on the water table and surface and groundwater bodies as a result
Details about the ESIA Process	• Need for the use of local baseline data collectors

Category	Comments Raised
	• Validity of the environmental authorisation decision and change to baseline conditions during this period • Implications if one country approves the Project and the other does not • Request for a copy of the ESIA • Duration of ESIA • Lack of suitable responses provided at the Scoping Meetings • Current stage of the ESIA • Meaning of "Scoping" • Independence of the ESIA Consultant • Availability of the Final Inception Report • Infrastructure included in the Scope of the ESIA • Design changes may necessitate the need for another round of meetings and repeat of Scoping • The Ministry of Community Development – Mother and Child Health and ZESCO would like to review the terms of reference for the health impact study • The socio-economic study needs to consider impacts on the community as a whole and not just those parties affected by resettlement • A review of the legislation that is deemed relevant is required • Need for the presentation of mitigation measures • Involvement in water flow workshop and use of results
Employment	• Local people to benefit from employment • Training of local people now so they can benefit when Project commences • Monitoring of local employment required • Corruption in employment selection is of concern • Clarity required with regard to criteria for employment • Split of employment opportunities between Zimbabwe and Zambia • After construction it will just be qualified people that are provided with employment
Grievance management	• Clarity required for the process of grievance management
Impact on fishing activities	• Impact on the tiger fishing industry • Loss of fishing livelihood
Impact on river rafting activities	• Compensation required for the loss of livelihood derived from river rafting and other tourism activities • Anticipated impact on the flow of the rapids and resultant impact on the river rafting industry • Loss of jobs and compensation for this • Loss of jobs as a result of reduced river rafting needs to be weighed up against jobs provided by the dam
Improved access	• Social impacts associated with improved access to the area • Cross-border cattle theft and other security issues to increase with improved access • Improved access to the area may improve tourism in the area
Project alternatives	• Solar power versus hydroelectric power to be considered • Alternatives for power distribution and use • Alternatives for the siting of the dam • Record of Project alternatives considered to date • Turbine generated power to be considered as an alternative • Options for power supply for Zambia require consideration • Options of a smaller dam require consideration as Zambia is near to achieving its required power quota

Category	Comments Raised
	• Generation of dam elsewhere in Zambia and export of power to Zimbabwe • Development of the Kafue Stage 2 dam as an alternative • Use of fish friendly turbines • Expansion of Hwange Power Station • Run of river power generation without the development of a dam
Project details	• Clarity required regarding the extent of the dam and size of inundation area • Need for the Hwange powerline alternative • Rationale for the location of the permanent camps, transmission lines and dam site • Need for blasting • Need for a new customs post over the dam • Who to be housed in the permanent villages? • % power contribution offered by the Project in terms of national requirements • Why Batoka Gorge site was selected? • Why is spillway located in Zimbabwe? • Size of spillway and commercial value for the loss of this land • Location of the permanent villages • Who is the construction contractor? • Use of existing roads as a preference • Suggestion for environmentally friendly technologies to be employed in permanent camps • How is the population for the permanent camps derived if there are only 1500 employees? • Fate of township infrastructure? • Number of spillway gates? • Type of surfacing for access roads and which roads to be upgraded • Alignment of access roads • Number of transmission lines • Height of the dam above or below the gorge • Width of powerline servitude • Volume of water in the dam • Will new roads be constructed? • Which communities will be impacted on by the Project? • Different construction phases and what proposed during these. • Duration of construction period • Ownership of the Project • Why power lines proposed to Choma instead of Livingstone? • Lots of activity already underway in Zimbabwe, but not Zambia • Location of Project headquarters? What governance structure to be employed? • Meaning of "impoundment" • Need for a holding dam • Change to design of dam if 3000 MW capacity is desired • Has a pre-feasibility study been undertaken? • Will dam expand in the future? • What could impact on the start date for the Project? • Will there be access between the two countries as part of the development? Have cost calculations included costs for de-commissioning of the dam?

Category	Comments Raised
Impact on existing roads	• Decreased condition of roads as a result of increased construction traffic • Increased traffic resulting in noise and air quality impacts
Resettlement	• Compensation for loss of hunting quotas • Provision of social services and infrastructure for resettled households • Land availability for resettlement • Need to stay in traditional area of jurisdiction • Compensation for loss of biodiversity, fishing and wildlife • Affected people to input into compensation decisions • Types of compensation anticipated • Compensation required for psychological and emotional inconvenience • Resettlement required as a result of the access roads • Compensation for temporary structures • False promises will be made with regard to compensation • Need for compensation to be agreed in writing • Uniformity of compensation • Compensation for economic displacement • Minimise compensation by the avoidance of structures • Identification of host sites and ability to choose where resettled to • Continuation of livelihoods and improvements with resettlement been discussed • Explanation of physical versus economic displacement • Desire for resettlement schemes according to government models • Clarification required regarding the resettlement process • Assistance in the preparation of agricultural land • Suitability of replacement agricultural land and remediation if less productive than previous • If people have to be resettled, will they need to move on their own or have government assistance • If there is a need for resettlement will, whole villages be resettled or just parts thereof? • Will replacement grazing land be provided? • Sufficient and good quality agricultural and grazing land needs to be provided • Will our replacement houses be built before we are resettled? • Will our access to water be maintained if we are resettled? • Need for resettlement on both Zambian and Zimbabwean sides of the dam? • Impact on fields as a result of the transmission line • Why is a RAP being undertaken for the dam and an RPF for the transmission lines? • Lessons should be taken from the Kariba experience for resettlement.
Stakeholder engagement	• How will the implementation and addressing of stakeholder concerns and comments be monitored? • Request for the involvement of the local authority on the Technical Team • Opportunities for people to raise concerns • Why consulting with multiple wards in Zimbabwe? Jambezi is the most affected • Consultation required before any agreements are reached • Lack of respect for traditional leadership as no prior consultation

Category	Comments Raised
	• Why addressing Chiefs in Zambia, but not Zimbabwe? • Consultations required with all chiefs in the Kazangula District • Poor notice period for open day in Livingstone • Request for a further meeting in Livingstone before the Scoping Report is submitted. • Comment received from World Heritage Authorities • Comment received from International Rivers • Need for an engineer to be present to answer stakeholder concerns • Need for translators and interpreters • Need for accurate co-ordinates in the Background Information Document • Need for accurate Districts to be marked on the maps • Meeting format preferred to a public open day • What Community engagement undertaken? • National Parks boundary not denoted clearly on the map. • The local offices of Museums, Wildlife and Tourism and other critical stakeholders need to be invited personally to attend • Need to consult tourism stakeholders • Meeting flawed as names associated with issues have not been recorded • Processing of comments • Need for stakeholders to have view of both Zimbabwe and Zambian concerns and comments • A review of the stakeholder list is required • Consultation with key stakeholders before the ESIA meetings are held • Date of release for reports and comments and response report? • Need to advertise Project internationally
Sustainability of dam	• For how long will BGHES meet the Zimbabwean power requirements • Financial provision for maintenance during operation required • Loss of employment opportunities following the completion of the construction phase • Feasibility of dam in dry season
Health and Safety	• Compensation for work related injuries if employed • Project impact in terms of the spread of HIV/AIDS. There are legislative requirements now for the consideration of this in Zambia • Spread of Ebola if in-migration • Potential risk of malaria due to impoundment • Safety of livestock and poultry • Health impact resulting from stagnant water in dam and hence further need for resettlement • Safety of employees during construction • Potential for rockfall into the gorge and dam as a result • Health impact assessment needs to consider what authorities require and need to mobilise for in order to accommodate the development.
Aesthetic impact	• Loss of geological and aesthetic value of Victoria Falls
Seismic Activity	• Seismic activity with dam filling
Project benefits	• Will reduced load-shedding result from the Project? • Easier extraction of water from the dam
Service provision	• What are the proposals for solid waste management as part of this Project?

Category	Comments Raised
	• The provision of sanitation in the permanent villages is of concern
Odour	• Is there a potential impact of odour due to the presence of stagnant water?
Climate change	• Need to consider climate change in the design, capacity and feasibility of the dam. • Uncertainty regarding use of historical data
Other	• Concern that empty promises are being made by the developer • Mistrust of developer and consultants • Project is a "fait accompli" • Cumulative impact of multiple dams on the Zambezi River • Consideration to be given to the construction of Kazangula Bridge • All chiefdoms should benefit from the Project • Lots of Projects in the past in Mukuni and Musokotwane has been left out of Project benefits • Has the funding of the Project been finalised? • Need to access the engineering and cost details of the Project • Need for the Project in Zimbabwe driving this Project. Not required in Zambia • Risk of the dam overflow • Project previously cancelled by Government. Why now under consideration? • Appointment of the construction contractor – has this been finalised? • The history of Kariba requires consideration in this Project. Lessons can be learnt from the Kariba experience • Ownership of the dam infrastructure • Will noise as a result of the dam impact on schools in the area? Will vibrations result in collapsing structures? • The development of a national park around the dam development is a requirement of the legislation. Is there potential for this? • Will fishing and agricultural activities still be permitted in the Muzuma/Sidinda area? • The Scoping studies undertaken in 1998 have never been disclosed to stakeholders. Who has access to these reports? • Cumulative impact on the river as a result of multiple water abstraction schemes

Table 7.5 Summary of Stakeholder Comments on the Scoping Report

Category	Comments Raised
Responses provided in the CRR	• Responses to the many detailed comments and requests from community members with regards to the community development are extremely vague – a generic 'cut and paste' response is given in each case.
Social impacts	• Social impact limited to downstream water users, between the BGHES site and Kariba dam and no consideration are made about the upstream users.
Downstream impacts	• Impacts of BGHES extend beyond borders i.e. to Kariba Dam and Cabora Bassa as such environmental flows should be extended to these.

Category	Comments Raised
Impacts of nutrients in the flows	• Wastewater effluents have a significant impact on receiving waters. • What will be the impact of wastewater emanating from the sewerage systems in Livingstone and Victoria Falls on the BGHES? • Batoka Gorge Dam will alter this water and nutrient flow.
Climate change	• Has the impact assessment investigated the extent of climate change impacts on BGHES hydropower production?
Fish production	• What is the potential impact of the proposed dam on fish production downstream of BGHES as it affects the large number of communities on the shores of Lake Kariba, Binga and Mlibizi basin that are totally reliant on this fish supply for their livelihoods?
Project unknowns	• There are still far too many unknowns. It is difficult to consider the full impact of something that is not yet determined • No cost impacts of flooding the existing power station in case of excessive rainfall
Avi-fauna	• What are the proposed mitigation measures for the bird species nesting in the gorge? • How will mitigation for birds that are currently nesting in the gorge that will be filled up by the reservoir be carried out?
Solar energy as an alternative	• The analysis of alternative power sources seriously under rates solar power. • Solar has high cost in the short term but greater returns in the long term
Financial analysis	• No evidence of a financial analysis in the scoping report. The analysis should be undertaken to account for the cost of the dam vs the risks of underutilization due to reduced rainfall and the loss of the existing and future tourism income.
Community benefits	• Numbers are given regarding the benefit of employment etc. without the comparison with the loss of employment/revenue that will result from the construction of the BGHES – which gives a biased impression
Tourism	• The report makes assumptions that building a dam in the area will contribute to the tourism economy of the area – this is untrue. Visitors to the area come for the eco-tourism offered not man-made structures. • The tourism income loss will impact the whole town of Livingstone which has very little other industry besides tourism and is directly affected by any fluctuation in tourist level
Public participation in drawing-up mitigation measures	• Suggestions made to give the public an opportunity to suggest potential schemes to mitigate the negative employment and heritage losses of the dam.
Grievance redress mechanism	• Request for grievance procedure for compensation from loss of income for individuals and companies.
Limitations of baseline studies	• Limited baseline information regarding the tourism industry – including employment numbers, contribution to the economy, etc. • Birds, the reliance of the specialist studies to secondary data instead of undertaking primary data collection of their own. • It is not acceptable to spend millions of dollars are spent on specialist engineering studies and then try to meet the requirements for biodiversity, economic and community impact studies and concerns using 'borrowed' data and desktop surveys.
Mapping	• Concerns about maps in the report that are wrong

Category	Comments Raised
Proposed full supply level (fsl) of 957m of the BGHES	• Consideration to reduce the fsl to 710 so that river rafting activities can continue.
Impact on river rafting activities/	• Compensation required for the loss of livelihood derived from river rafting and other tourism activities • Anticipated impact on the flow of the rapids and resultant impact on the river rafting industry • Loss of jobs and compensation for this • Loss of jobs as a result of reduced river rafting needs to be weighed up against jobs provided by the dam • A balance economic impact on river rafting should include a balanced assessment must include data of employment/revenue lost due to the construction of the dam.
Supply chain	• Compilation of a database of available business in Livingstone and Victoria Fall that can form part of the project's supply chain.
Resettlement	• Clearly spell-out the framework for full compensation

7.8.2 *Summary of Comments and Concerns Raised During Interim Engagement*

During Interim Engagement, stakeholders have had the opportunity to ask questions, raise comments and concerns. This has been facilitated through the Project email box, and the stakeholder meetings described in *Section 7.7.* A summary of comments and concerns is provided in ***Table 7.6***

Table 7.6 ***Summary of Stakeholder Comments and Concerns Raised During Interim Engagement***

Category	Issues and Comments Raised
Resettlement	• The Project should ensure meaningful engagement, compensation for economic losses and availability of the resettlement plans to stakeholders. The resettlement process should be transparent.
Tourism	• The Project impacts on tourism must be sufficiently addressed in the ESIA.
Solar and wind energy as alternatives	• The Project should consider alternative energy sources i.e., solar and wind as sustainable methods to address the demand for electricity.
Downstream impacts	• The ESIA should assesses the Project impacts on downstream water flow.
Stakeholder engagement	• Concerns regarding the Project delays, the timing of the next round of stakeholder engagement and lack of meaningful engagement previously.
Community benefits	• The Project is supported if it will create jobs, develop community Projects and reduce load shedding.
Biodiversity	• Concerns regarding the destruction of the greatest white water river on earth and how that influences the local ecosystem and adventure tourism.
Health and Safety	• The Project team should exercise caution when working in certain where landmines may be present.

7.9 *ACTIVITIES PROPOSED AS A WAY FORWARD*

7.9.1 *Impact Assessment and Public Disclosure Phase*

During the impact assessment phase of the Project, the primary aim of the PPP will be to disclose the findings of the specialist studies, impact assessment studies and the share proposed management measures detailed in the ESMPs. A comment period of 30 days on the Draft ESIAs and ESMPs is currently proposed. Stakeholders on the stakeholder database will be notified via email, sms, mail, hand delivery and/or fax of the availability of the Draft ESIAs and ESMPs and engagements that are proposed during this phase.

Table 7.7 below provides details of the public participation activities proposed for the impact assessment phase of the ESIA.

Table 7.7 Public Participation Activities Proposed During the ESIA Phase of the Project

Activity	Details
Notification of the ESIA Feedback Phase and availability of the Draft ESIAs and ESMPs	Registered stakeholders will be notified by mail/email/hand delivery/fax/sms of the availability of the Draft ESIAs and ESMPs for public comment and further stakeholder engagements. The Draft ESIAs and ESMPs and/or accompanying and summary documents will be placed at the following venues for a 30 day period: ***Zimbabwe*** Hwange District Council Office; District Administrators Office in Hwange; Jambezi Clinic; Musana Chisuma Clinic; Harare Black Crystal Office; Provincial Administrators Office; Victoria Falls Municipal Office; and Victoria Falls Environment Africa Office. ***Zambia*** Livingstone City Council; Livingstone District Office; Kazungula District Council; Kazungula District Office; District Commissioners offices in Zimba, Kalomo and Choma; District Council Offices in Zimba, Kalomo and Choma; National Assembly Offices Zimba, Kalomo and Choma; and Chiefs Palaces (Sipatunyana, Singani, Simwatachela & Chikanta). Additional notification measures will include: • Flyers and site notices for community meetings; and • Telephonic follow up for meeting attendance.
Disclosure meetings	The following meetings are proposed for feedback on the findings of the ESIA: **Zimbabwe** • Public meeting/ open house meeting in Victoria Falls; • Community meeting for Chief Shana's villages; • Community meeting for Chief Mvutu's villages; and • Community meeting for Chief Hwange's villages. **Zambia** • Public meeting/ open house meeting in Livingstone;

Activity	Details
	• Community meeting for Chief Musokotwane chiefdom; • Community meeting for Chief Mukuni chiefdom; • Community meeting for Chief Sipatunyana chiefdom; • Community meeting for Chief Simwatchela chiefdom; and • Community meeting for Chief Chikanta chiefdom.
Update Comments and Responses Report	Comments, issues of concern and comments received from stakeholders will be captured in the updated Comment and Response Report. Responses will be provided by EAP, Project engineers and ZRA.
Preparation of the Final ESIA and ESMP	The Draft ESIAs and ESMPs will be updated where applicable on the basis of issues raised during the comments period. The final ESIAs and ESMPs will be submitted to the regulatory authorities to inform the environmental authorisation decision.

7.9.2 *Environmental Authorisation*

The ESIAs and ESMPs will later be submitted to both the EMA and ZEMA for review and consideration. The environmental authorisation decisions taken by the EMA (Zimbabwe) and the ZEMA (Zambia) will be advertised in the media and all registered stakeholders will be informed by email/fax/hand delivery/ mail/sms of the environmental authorisation decision.

7.10 GRIEVANCE REDRESS MECHANISM

As mentioned above, a grievance redress mechanism has been developed for the proposed BGHES. The purpose of it is to outline ZRA's approach to accepting, resolving and monitoring grievances from those affected by it, and its contractors', activities in relation to the Project. Stakeholders can submit grievances in writing, telephonically or presented verbally to ZRA's Grievance Manager using the following details:

Zambezi River Authority (ZRA),
Contact Person: Eng. Christopher Chisense, Project Director – BGHES

Zambezi River Authority
P. O. Box 30233, Lusaka, Zambia.
Telephone: +260 (211) 227 229
Fax: +260 211 227 498
Email: chisense@zaraho.org.zm

A detailed grievance redress mechanism was appended in the Scoping Report. The grievance redress mechanism has been updated and is attached to this ESIA as *Annex E*.

7.11 CONCLUSION

A comprehensive PPP has been undertaken to date and the following can be concluded in this regard:

- A significant number of issues have been identified through this process and have been recorded and responded to in the Comments and Response Report. These issues have guided the scope of specialist investigations and ultimately the Environmental and Social Impact Assessment.

- Initial key stakeholder discussions proved effective in terms of convening and facilitating the community meetings. The correct notification channels for the community meetings were followed and should continue to be used throughout the Project.

- Concerns have been raised by stakeholders in the Livingstone and Victoria Falls areas with regard to the format of the public meetings and level of information provided there. These concerns were addressed through a second round of information sharing meetings.

- Concerns have also been raised with regard to the notice period provided for stakeholder engagements. As requested, all notice periods will now be a minimum of 21 days.

- An extensive stakeholder database has been compiled for both countries, which can now be used for direct communication with these parties for the remainder of the Project. Mechanisms for the greater involvement of international stakeholders, as requested by the local consultants, are currently being identified.

- Stakeholders on the existing database have been notified of the recommencement of the ESIA, and the stakeholder database has been updated.

- The Stakeholder Engagement Plan for the remainder of the Project has been updated to reflect the content of this chapter. It is presented in *Annex B*.

8 DESCRIPTION OF THE BIOPHYSICAL ENVIRONMENT

8.1 AREAS OF INTEREST

The area of influence for the biophysical environment can be defined as an area likely to be disturbed by the Project activities during the pre-construction, construction and operation phases. Below is the description of the areas of influence as they relate to the Project.

> **Please Note**:
>
> Rather than providing a description of the receiving environment specific to the Project components specifically associated with this ESIA, this *Chapter* presents a description of the biophysical attributes of the area in which the overall BGHES is proposed and its surroundings. The description of the baseline environment is essential in that it represents the conditions before the construction of the proposed Project. The description of the baseline biophysical environment provides a description of the current or *status quo* environment against which biophysical impacts of the proposed Project (refer to *Chapter 10*) are assessed and future changes monitored. The biophysical impact assessment presented in *Chapter 10* is however specific to the following Project components:
>
> - Dam wall and impoundment, including a spillway;
> - Surface power houses, one on each side of the river; and
> - Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching areas).

The **Areas of Immediate Influence (AoII)** also referred to as the Project Site(s):

These include areas within the anticipated project footprint and corridors for the dam wall, area of inundation, construction and permanent camps, spillway, powerhouses, access roads and transmission lines.

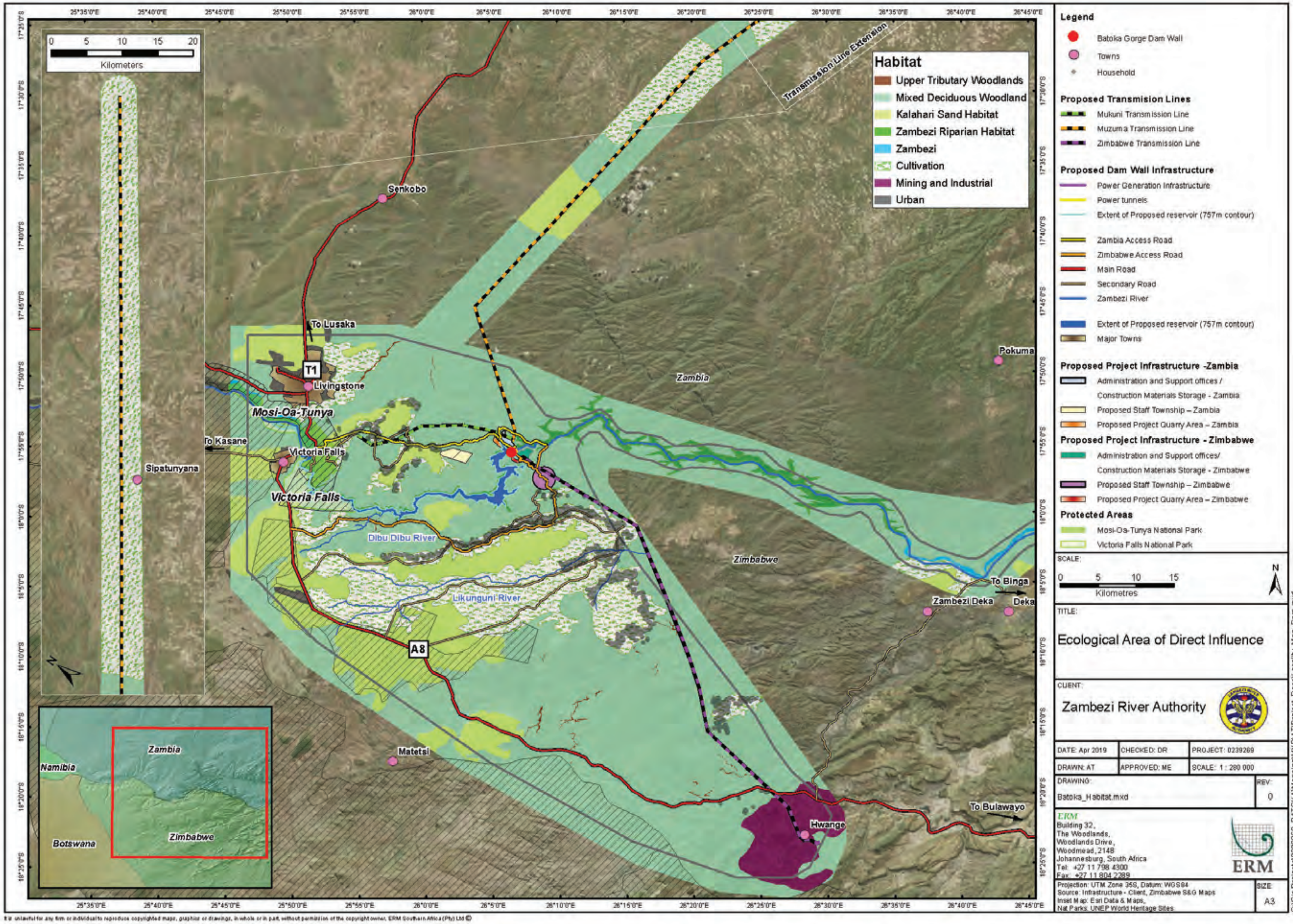
The **Area of Direct Influence (ADI)** also referred to as the Project Area/ Project Affected Area(s):

It includes areas immediately adjacent to the fixed engineering buffers and corridors (*i.e.*, Project footprint) as mentioned above that will be subjected directly to impacts associated with the proposed infrastructure development and operation.

The ADI also includes the reach of the river downstream of the Batoka impoundment as far as Lake Kariba that may be affected by the operation of the hydropower dam. It should be noted that any downstream consequences beyond Lake Kariba have not been assessed for the present ESIA study since any changes in the operation of Kariba Dam as a result of the conjunctive operation of the proposed BGHES have not been included.

From an ecological perspective the ADI includes the length of the river from the Victoria Falls to below the end of the Batoka Gorge, as well as the habitats on either side of the proposed reservoir plus the areas proposed for the construction camps, town development, roads and transmission lines. The ADI includes the transmission line that proceeds northeast from Livingstone town to the vicinity of Choma, for a length of approximately 160km. This ADI is illustrated in *Figure 8.1*.

Figure 8.1 Ecological Area of Direct Influence (ADI)



8.2 *PHYSICAL ENVIRONMENT*

8.2.1 *Data Sources*

The following sections describe the physical context for the BGHES, including the river basin physiography, climatic conditions, surface water conditions (flows and water quality), geology, soils and river morphology.

The data presented herein complement and where possible update those presented in the earlier 1993 and 1998 feasibility study reports, which included:

- Historical flows in the Zambezi River and associated hydrological and hydraulic analyses, including flow-duration curves, flood frequency calculations, stage-discharge relationships etc.;
- Climate data for the project area, including rainfall and evaporation statistics;
- Water abstraction data in the project area;
- Water quality/limnology survey data in the vicinity of the dam (1997/98);
- Various geo-physical survey data in the vicinity of the dam, including morphological and sediment transport characteristics.

In addition to updating the hydrological time series data (and associated analyses) to the present day using data supplied by ZRA, the main supplements to this dataset for the present study were as follows:

- Water quality data for the Zambezi River collected by ZRA on monthly basis from 2010 to date, in addition to a 2-year detailed programme of hydrometric, water quality and sediment monitoring carried out along the course of the Zambezi for the study *Pollution Monitoring and Management on the Zambezi River* (ZRA, August 2005);

- A detailed basin-level characterisation of water resources, including present and expected future water availability and utilization data, as described in two studies in particular: *Integrated Water Resources Management Strategy and Implementation Plan for the Zambezi River Basin* (ZRA, April 2008); and *The Zambezi River Basin: A Multi-Sector Investment Opportunities Analysis* (World Bank, June 2010);

- Meteorological data necessary to compute surface heat exchange and surface wind stress (air and dew-point temperatures, windspeed and direction, solar radiation) collected from various web-based sources for the region.

- Various biological and geo-morphological survey data for the Zambezi River in the river reach between the dam and Lake Kariba obtained from a field survey conducted in September 2014.

The Approach and Methodologies used in this baseline assessment are presented in *Annex G*.

8.2.2 *Physiography*

The Zambezi River Basin is located in southern Africa and drains an area of almost 1.4 million square kilometres extending across eight countries: Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe (*Table 8-3*). It covers almost all of the territory of Malawi, over 70 percent of Zambia and almost half of Zimbabwe and is the fourth-largest river basin in Africa.

The river rises at an elevation of over 1,500 metres above sea level in the high plateau between Zambia and the DRC, and flows for a distance of some 2,700 km to where it enters the Indian Ocean about 250 km north of Beira in Mozambique. Over this distance it receives inflows from 13 major sub-basins (*Table 8-3*) which contribute to a total mean annual runoff of around 130 cubic kilometres at the Zambezi Delta (*Table 8-1*) [(1)].

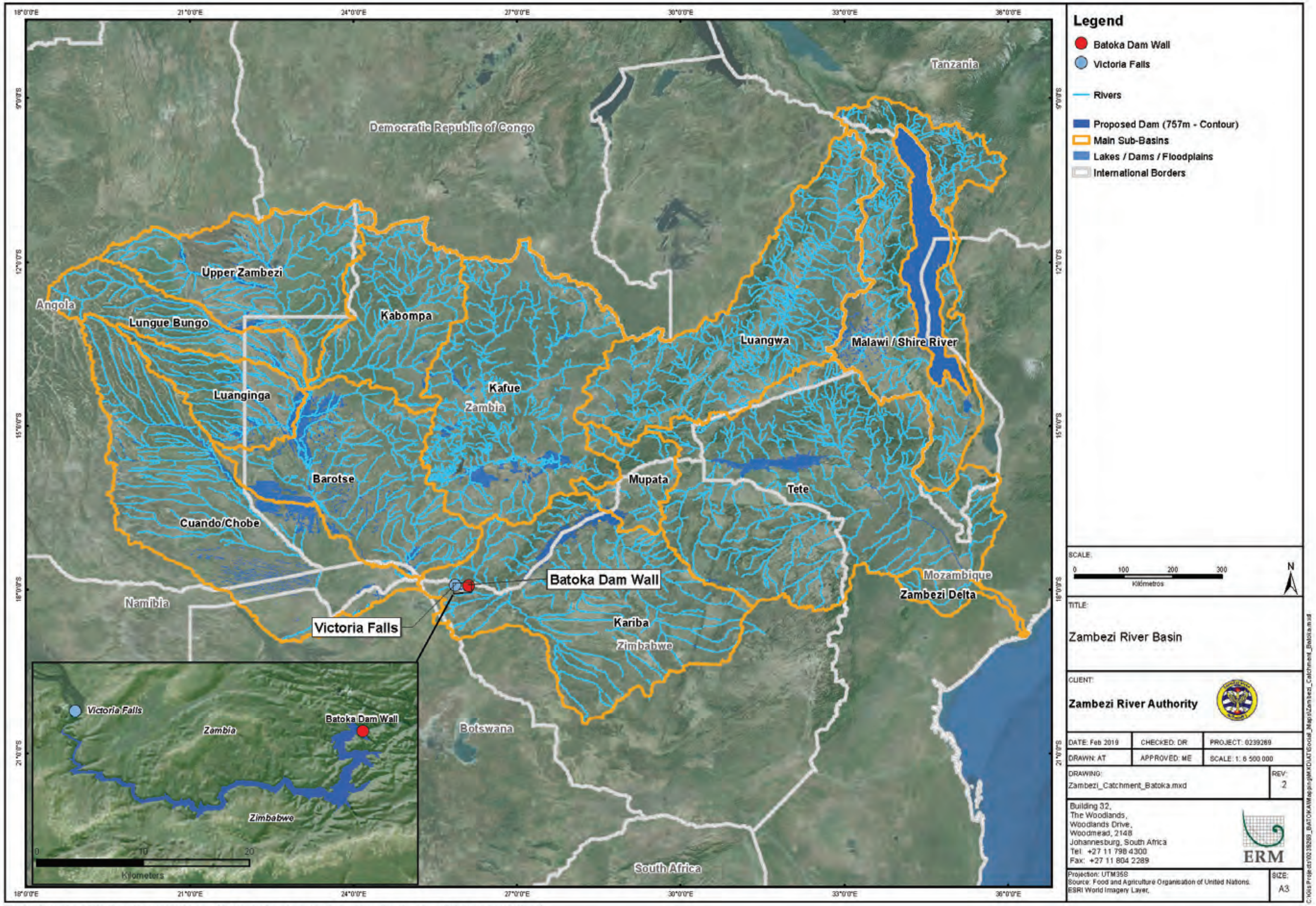
Table 8-1 ***Runoff from the Zambezi River Basin***

Sub-basin	Area (km^2)		Mean annual runoff (km^3)	
	Incremental	Total	Incremental	Total
Kabompo	78,683	78,683	8.61	–
Upper Zambezi	91,317	91,317	23.40	–
Lungúe Bungo	44,368	44,368	3.59	–
Luanginga	35,893	35,893	2.19	–
Barotse	115,753	366,014	–0.56	37.22
Cuando/Chobe	148,994	148,994	0.00	–
Kafue	155,805	155,805	11.74	11.74
Kariba	172,527	687,535	6.49	43.71
Mupata	23,483	1,026,438	1.68	73.46
Luangwa	159,615	159,615	16.33	16.32
Shire River – Lake Malawi/Niassa/Nyasa	149,159	149,159	15.71	–
Tete	200,894	1,227,332	37.64	111.10
Zambezi Delta	**18,680**	**1,395,171**	**3.58**	**130.39**

Source: The Zambezi River Basin: A Multi-Sector Investment Opportunities Analysis, World Bank, 2010

(1) This estimate is presented by the World Bank (2010). Beilfuss (2012) presents a lower estimated annual runoff volume of around 110 km3 based upon a significantly lower estimate for the Tete sub-basin runoff.

Figure 8.2 Zambezi River Basin



From a physiographical perspective, the basin can be divided into three sub-sections as follows:

- The *Upper Catchment*, comprising the Northern Highlands and Central Plains that form part of the North Kalahari Basin, a vast and largely featureless plateau;

- The *Middle Catchment* below Victoria Falls, where the river gradient steepens sharply and flows through the Gwembe Rift valley, a south-westerly extension of the East African rift system; and

- The *Lower Catchment*, where after Lake Cahora Bassa the river gradient levels out again as it crosses the coastal plain before reaching the Indian Ocean.

The Project site lies within the Middle Catchment, approximately 50 km downstream of Victoria Falls and within a series of steep gorges that extend almost to Lake Kariba, a vast lake covering some 5000 km^2 that was formed by the construction of the Kariba Dam in the 1950s. The Batoka site lies upstream of Lake Kariba and also of the confluence with the Gwayi River, which rises on the Limpopo/Zambezi watershed near Bulawayo and flows north-westwards to enter the Zambezi just upstream of the lake (*Table 8-3*).

The river flows at the Project site are governed by the physiological characteristics of the Upper Catchment, and in particular those of the Barotse Plain. This is a low lying floodplain on the main Zambezi channel some 200 km long and 80 km wide (at its northern end at Lukulu) that floods annually and effectively becomes a large lake traversed by numerous subsidiary channels and oxbows. The storage within the Barotse Plain during major floods has been estimated to be around half of the mean annual river discharge at Victoria Falls (Sharma and Nyumbu, 1985), and as such it exerts a marked regulating effect on downstream discharges in the Zambezi. Further downstream the Zambezi merges with the Kwando/Chobe river system, which includes the Chobe Swamps that cover an area of some 3,000 km^2. However, the combined evaporative losses in the sub-basin's floodplains and swamps are such that effectively the Kwando/Chobe system does not significantly contribute any runoff to the Zambezi River above Victoria Falls (Batoka HES Feasibility Study, BJVC, 1993).

8.2.3 Climate

The climate of the Zambezi River Basin is typically sub-tropical, i.e. influenced by the annual movement of the Inter-tropical Convergence Zone (ITCZ), with a general seasonal pattern as follows:

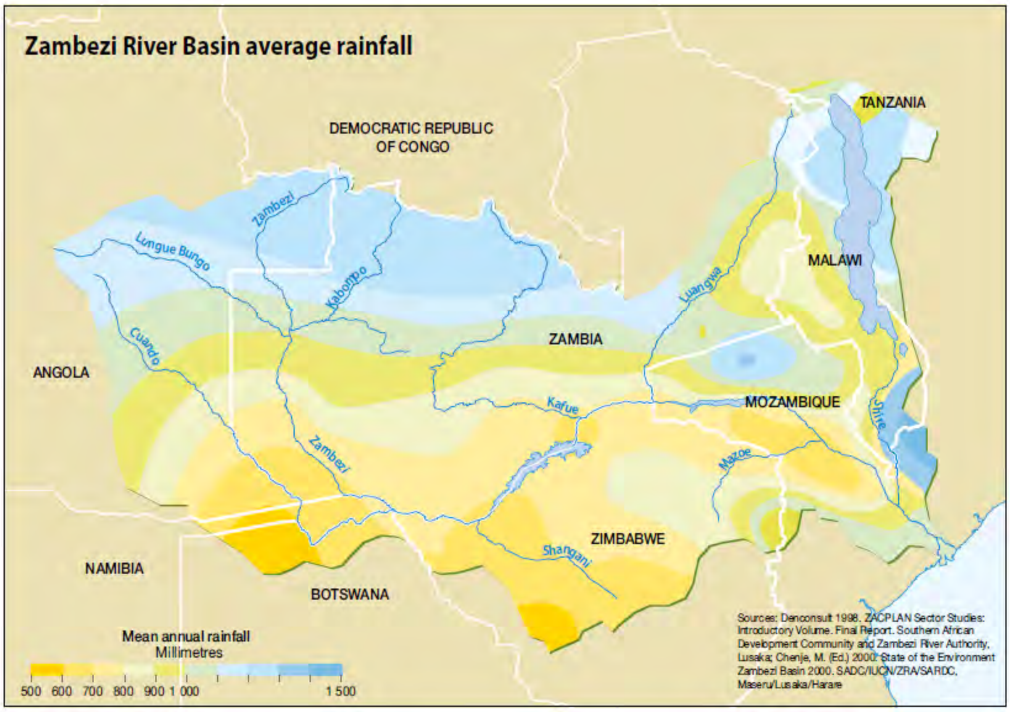
- A hot season from late August through the beginning of the main rains;
- A main rainy season, lasting from October/November through to March/April;

- A post rainy (transitional) season in April/May; and
- A cool season from June through to early August.

The main rainfall season (or austral summer) is generally longer in the north, where it lasts for up to six months, than in the southern-most extremities of the basin, where it can be as short as four months. The cool season (or austral winter) is generally characterised by dry weather across the basin, although some rainfall can occur in southern and eastern areas where an influx of cool maritime air brings periods of occasional drizzly rain (known as the *Guti* in Zimbabwe, and *Chiperone* in Malawi).

In terms of rainfall amounts, in general terms rainfall is higher in the northern parts of the basin, i.e. the upper highland reaches and the areas around Lake Malawi/Niassa/Nyasa, where it reaches up to 1,400-1500 mm per year, and lowest in the southern parts of the basin, e.g. within Zimbabwe, where it can fall to 500 mm per year (*Figure 8.3*). In the upper catchment above Victoria Falls there is a general gradation of mean annual rainfall from 1,500 mm in the north to 700 mm in the south near the Chobe Swamps. Average rainfall intensities are typically of the order of 35 mm per hour due to the predominance of convective storms, and can reach as high as 70 mm per hour for short periods in severe storm conditions (Batoka HES Feasibility Study, BJVC, 1993).

Figure 8.3 Zambezi River Basin Average Rainfall

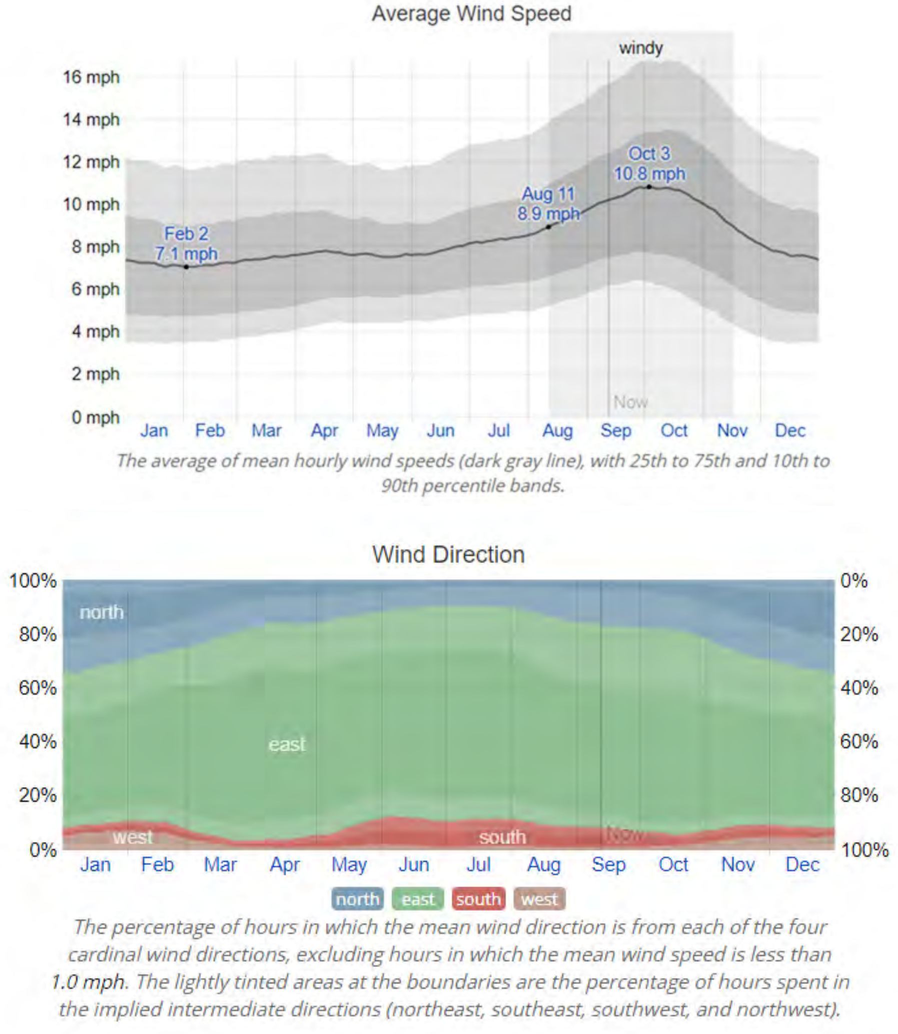


Source: Zambezi River Basin: Atlas of the Changing Environment (SARDC, 2012)

Average temperatures in the basin vary mainly with elevation, but also to a lesser extent with latitude. During the cool season mean temperatures can fall to 13^{0}C in the higher elevation areas in the south of the basin, and overnight ground-frosts can occur. Mean daily temperatures during the warmest months can reach 31^{0}C in the lower reaches of the Zambezi valley, and around 23^{0}C in the higher elevation areas. Correspondingly, mean annual evaporation is highest in a belt running east-west across the basin, varying from about 200 mm per month in the October to March period, and 125 mm per month in the cooler months of June and July.

Regarding wind, the average hourly wind speed in the Study Area varies throughout the year, with the windier months being August to October (*Figure 8.4*). The predominant wind direction throughout the year is from the East (*Figure 8.4*).

Figure 8.4 ***Average Wind Speed and Direction*** (1)



The potential effects of global climate change on the Zambezi River Basin are discussed in *Annex H*.

(1) https://weatherspark.com/y/91732/Average-Weather-in-Livingstone-Zambia-Year-Round

8.2.4 *Baseline Greenhouse Gas (GHG) Emissions*

Introduction

The baseline for greenhouse gas (GHG) emissions prior to the development of the BGHES (i.e. – prior to the construction phase) is defined as zero for the purposes the ESIA, as it is understood that the BGHES will provide additional capacity to meet energy demand rather than displacing existing grid capacity. Construction and operational activities will lead to incremental increases in GHG emissions, primarily due to the consumption of fuel and land use changes.

For context, the annual national emissions of Zimbabwe were 59.9 million tonnes of carbon dioxide equivalent ($MtCO_2e$) in 2010, whilst annual national emissions of Zambia were 396.4 million tonnes of carbon dioxide equivalent ($MtCO_2e$) in 2010. These figures represented 0.12% and 0.78% of global emissions in 2010 (global emissions amounted to 50,911 million tonnes of carbon dioxide equivalent ($MtCO_2e$) [(1)].

National GHG Inventories for Zimbabwe and Zambia

Zimbabwe submitted its Third National Communication Update Report (NC3) to the UN Framework Convention on Climate Change in 2017 [(2)]. NC3 includes information on Zimbabwe's greenhouse gas inventory for the year 2006, measures to reduce emissions (mitigation) and adaptation to climate change.

Zambia submitted its Second National Communication Update Report to the UN Framework Convention on Climate Change in 2014 [(3)]. NC2 summarises the national GHG inventory for the year 2000.

Given that the National Communication reports for Zimbabwe and Zambia only include GHG emissions data up to 2006 and 2000 (respectively), UNFCCC (United Nation Framework Convention on Climate Change) 2010 data has been used in this ESIA [(4)] to contextualise annual emissions from the BGHES, and to determine whether expected GHG emissions are deemed to be 'significant' (refer to *Chapter 10*).

Table 8-2 summarises Zimbabwe and Zambia's emissions from 1990 to 2012, compared with total global emissions. Zimbabwe and Zambia had an estimated 72.1 and 320 million tCO_2e (respectively) in 2012, excluding the emissions from land use, land use change and forestry. The countries were

(1) Source: Country information from UNFCCC (UNFCCC, 2010), data on current emissions and their share of global emissions including LULUCF from JRC/PBL (2012) (EDGAR 4.2 FT2010): http://edgar.jrc.ec.europa.eu/overview.php https://edgar.jrc.ec.europa.eu/overview.php?v=GHGts1990-2012
(2) Source https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/national-communications-and-biennial-update-reports-non-annex-i-parties/national-communication-submissions-from-non-annex-i-parties
(3) Source: https://unfccc.int/process-and-meetings/transparency-and-reporting/reporting-and-review-under-the-convention/national-communications-and-biennial-update-reports-non-annex-i-parties/national-communication-submissions-from-non-annex-i-parties
(4) Country information from UNFCCC (UNFCCC, 2010), data on current emissions and their share of global emissions including LULUCF from JRC/PBL (2012) (EDGAR 4.2 FT2010): http://edgar.jrc.ec.europa.eu/overview.php https://edgar.jrc.ec.europa.eu/overview.php?v=GHGts1990-2012

therefore responsible for 0.13% and 0.59% (respectively) of global emissions in 2012 and are considered to be low emitters. However, between 1990 and 2012, national emissions grew by 105% in Zimbabwe and 53% in Zambia, whilst global emissions increased by 41% over the same period.

The data available are not sufficiently detailed to show the sector emissions specifically associated with energy for Zimbabwe and Zambia.

Table 8-2 World, Zimbabwe and Zambia GHG Emissions (1)

		1990	2000	2010	2011	2012
World	Total Mt CO_2e, excluding LULUCF	38,232.0	40,563.0	50,911.0	53,197.0	53,937.0
Zimbabwe	Total Mt CO_2e, excluding LULUCF	35.1	51.4	71.0	71.6	72.1
	Relative to 1990 base %	-	46.5	102.3	1.309	105.3
Zambia	Total Mt CO_2e, excluding LULUCF	209.6	290.8	319.8	320.0	320.3
	Relative to 1990 base %	-	38.7	52.5	52.6	52.8

8.2.5 Hydrology (Runoff)

Average flows

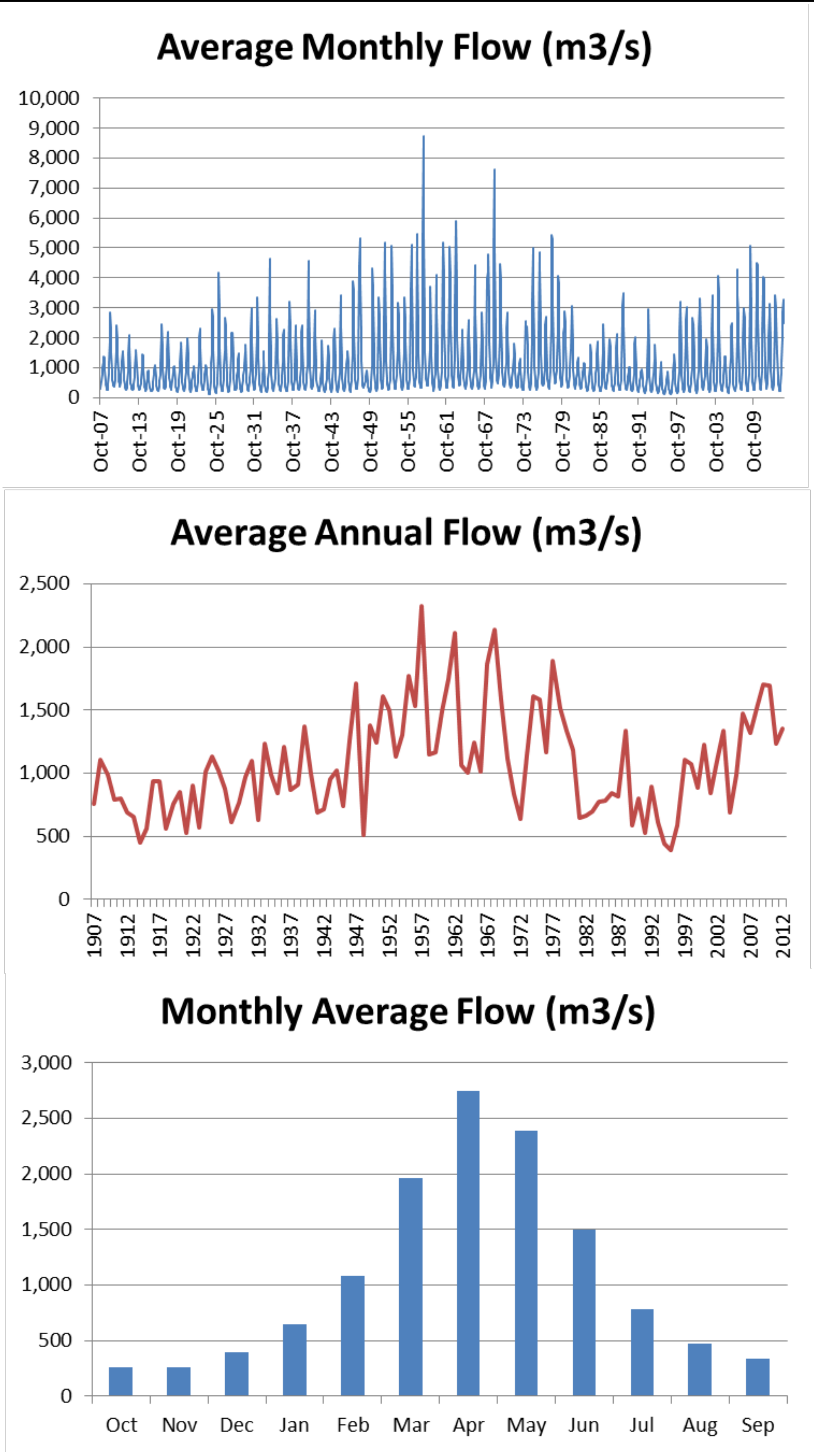
General hydrological conditions in the basin were described in the previous sections. For the Project site in particular, there is a long historical river flow record at Livingstone/Victoria Falls (2) that spans the following period:

- Monthly average flow data from 1908 to 1924; and
- Daily average flow data from 1925 to 2014.

The consolidated historical flow data are shown in *Figure 8.5*. The location of the river gauging station itself has been moved on occasion during this period; however, the consistency of the derived flow record has been analysed in detail and verified as suitable for use by both the earlier *Batoka HES Feasibility Study* (BJVC, 1993), and more recently by the *Batoka Gorge HES Draft Options Assessment Report* (SP, July 2014).

(1) Source: https://edgar.jrc.ec.europa.eu/overview.php?v=GHGts1990-2012&sort=asc1
(2) Whilst the gauging record is not located at the site of the BGHES, the incremental catchment area and flow contribution between the two locations is relatively insignificant in comparison to the flow in the main river such that it is considered to be sufficiently representative of flows at the site.

Figure 8.5 Zambezi River Flows at Victoria Falls (1907-2014)



Source: data supplied by Zambezi River Authority (ZRA) in September 2014.

As shown in *Figure 8.5*, the peak river discharge at Victoria Falls generally occurs in mid-April, and almost invariably the minimum flow occurs within the first or second week of November. There has also been a marked long-term variation in river flows between years over the last century, with periods of prolonged drought occurring from 1907 to the early 1920s, and again from around 1980 to the late 1990s (as evident in the plots shown in *Figure 8.6*). In both cases the average yearly flow fell to around 700 to 750 m^3/s for a period of 15 to 20 years, as compared to the long-term average of around 1,070 m^3/s.

Figure 8.6 ***Average Yearly Flow Statistics at Victoria Falls***

Source: data supplied by Zambezi River Authority (ZRA) in September 2014.

Analysis suggests that these drought periods are linked to inter-annual rainfall patterns in the upper catchment, whereby a series of low rainfall years can significantly reduce the runoff efficiency [(1)] in several subsequent years (and conversely a series of wet years can contribute to higher runoff efficiency and elevated flows in subsequent years, e.g. in the period after 1947, and again after 2000) (Beilfuss, 2012).

Flood flows

The maximum recorded daily discharge at Victoria Falls of 9,331 m^3/s occurred between 5 and 9 March 1958. Based upon the design flood analysis presented in the earlier 1993 Feasibility Report (see Table 11.4.10) this flood had an estimated return period of around 100 years [(2)].

Further analysis of the flow records (BJVC, 1993) indicates that the majority of flood peaks arrive within a two to three week period either side of mid-April,

(1) The proportion of rainfall that occurs as runoff.

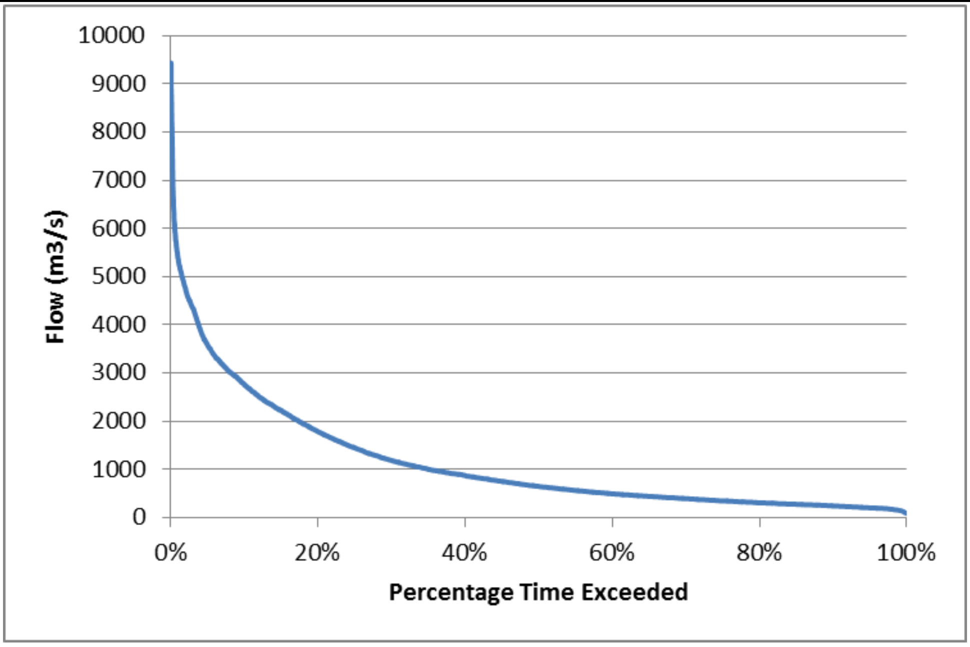
(2) This analysis will be updated with results of the ongoing engineering design studies, once available.

and that generally the higher the flood peak, the earlier its occurrence. This is attributed to the effect of the Barotse Plains, which act as a reservoir whereby under high flood conditions the storage has much less of a dampening effect on the flood hydrograph.

Low flows

The lowest daily average flow on record at Victoria Falls of 92 m^3/s occurred over a two day period from 12 to 13 November 1996, and the lowest monthly average flow of 100 m^3/s occurred in October 1924 (by comparison, the monthly average in November 1996 was 118 m^3/s, which is the third lowest on record). The overall flow duration analysis for the daily flow series at Victoria Falls is shown in *Figure 8.7*.

Figure 8.7 Flow Duration Analysis at Victoria Falls (1907 to 2014)



Source: data supplied by Zambezi River Authority (ZRA) in September 2014.

Abstractions

Basin-Wide Abstractions

The Upper Catchment of the Zambezi above Victoria Falls is predominantly rural and the largest abstractions from the river and its tributaries are for irrigated agriculture. The estimated surface water abstractions from the various sub-basins are shown in *Table 8-3*, although these figures do not include water use by recession-based agriculture in wetland areas such as the Barotse Plain (1). The total estimated direct abstractions in the Upper Catchment (around 86

(1) The estimated abstraction figures in the 2010 report (both existing and planned future) are considered to be a reasonable representation of the present day situation given the overall scale and approximate nature of the estimation processes used to derive them, and the relatively modest development of irrigated agriculture in the last few years.

million m³ per year) represent approximately 0.3 % of the annual average runoff at Victoria Falls.

Table 8-3 Annual Abstractions for Irrigation in Upper Catchment (World Bank, 2010)

Sub-basin	Abstractions (1000 m^3/year)	Percentage total for Zambezi basin
Cuando/Chobe	10,139	<1%
Barotse	3,491	<1%
Luanginga	14,203	<1%
Lungue Bungo	15,674	<1%
Upper Zambezi	37,623	1%
Kabompo	4,817	<1%
Upper Catchment total	85,947	3%
Zambezi River Basin total	3,234,836	100%

Source: The Zambezi River Basin: A Multi-Sector Investment Opportunities Analysis, World Bank, 2010

Table 8-4 indicates the potential future development of irrigated agriculture in the upper basin, both in the short to medium term (where projects or programmes were already identified in the 2010 study) and in the long-term if the sub-basins are developed to their full agricultural potential. Taking into account the capacity of existing water regulation systems, it was estimated that the former would require the development of an additional 55 million m^3 per year of regulation in the catchment (a small percentage of which may have occurred since 2010), and the latter some 480 million m^3 per year. This represents approximately 0.2 % and 1.4 % respectively of the annual average runoff at Victoria Falls.

Table 8-4 Projected Irrigation Development in Upper Catchment (World Bank, 2010)

Sub-basin	Irrigated Area (ha/year) [1]		
	Current	Current + identified [2]	Upper limit potential [3]
Cuando/Chobe	765	1,215	19,215
Barotse	340	12,753	30,466
Luanginga	1,000	6,000	18,500
Lungue Bungo	1,250	1,875	14,375
Upper Zambezi	3,250	8,250	20,750
Kambompo	595	11,314	28,328
Upper Catchment total	*7,200*	*41,407*	*131,614*
Zambezi River Basin total	*259,039*	*773,680*	*2,795,800*

[1] Total cropped area per year (includes multi-season cropping).
[2] Includes irrigation projects and programmes identified but not yet constructed.
[3] Estimate of total area suitable for irrigated development.

Source: The Zambezi River Basin: A Multi-Sector Investment Opportunities Analysis, World Bank, 2010.

Aside from potential large-scale water transfers (see below), other direct water abstractions in the basin are relatively insignificant in volumetric terms in comparison to agriculture. The aforementioned 2010 study estimates that net industrial surface water use across the entire Zambezi River Basin is less than 25 million m^3 per year (ie a tiny fraction of the estimated 130 km^3 per year of runoff at the Zambezi Delta) and potable water supply from surface water sources was estimated to be around 175 million m^3 per year in large urban areas, and 24 million m^3 per year in rural areas. Moreover, only a very small proportion of these abstractions are from the largely rural Upper Catchment.

In addition to the above, several large-scale water diversion schemes have been mooted in the Zambezi River Basin over the years, some of which are located within the vicinity of the Project site. These include the Chobe-Zambezi Water Transfer Scheme in Botswana, that proposes to abstract water from the river in the Kazungula area (upstream of Victoria Falls) and convey it via the Dikgatlhong reservoir to be used for commercial agriculture and industrial/potable supply in the greater Gaborone area as part of the North-South Carrier (NSC) Water Project. Botswana currently has rights to abstract some 495 million m^3 per year of water from the river (approximately 1.5 % of the present runoff at Victoria Falls) under this scheme, and is currently in the process of constructing the first stage that will involve supplying approximately 350 million m^3 of water per year for irrigated agriculture (including rice farming) in the Pandamatenga area.

There are also plans to supply Bulawayo under the Matabeleland Zambezi Water Project via an offtake situated close to the Deka River confluence (a short way downstream of the Batoka site), which would convey water via a pipeline to a dam near the Gwayi-Shangani confluence. However, this project has been in gestation and discussion for a number of years and would seem very unlikely to be constructed in the near future, if at all.

<u>Abstractions in the Project Vicinity</u>

Annex G contains a full list of water abstractions in the project area on both sides of the border, and *Figure 8.8* shows the main abstractions that lie between the dam site and the upper headwaters of Lake Kariba that may be directly affected by the project. These include the following (with licensed amounts shown in brackets):

- ZESA (Hwange) power station (2 Mm^3/day)
- Hwange Colliery Company (320,841 m^3/day)
- Sundowner lodge (3 m^3/day)
- Olive Beadle Fishing (205,000 m^3/day)
- Breamland Lodge (1 m^3/day)
- Msuma Fishing Resort (40 m^3/day)

Additional non-consumptive water uses, e.g. fisheries, rafting etc., are discussed in the socio-economic baseline section.

8.2.6 *Water Quality*

Water quality conditions in the Project area are characterised by the recent monitoring data presented in *Annex F* and summarised in *Figure 8.9*, and also by the earlier water quality data collected during field campaigns in 1998 and 2004, as presented in *Annex F*.

Figure 8.8 Overview of Zambezi River Abstractions in Project Area

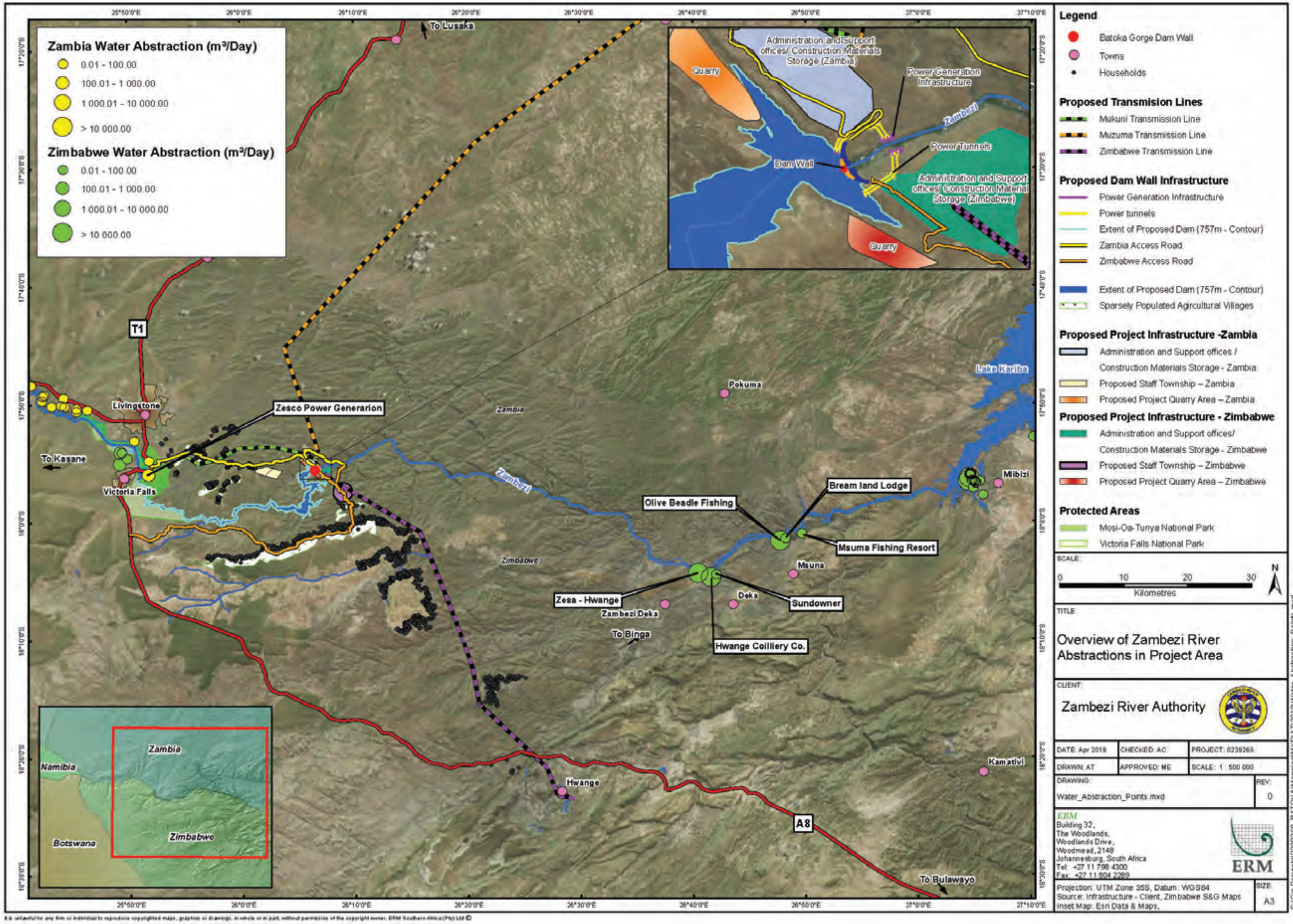
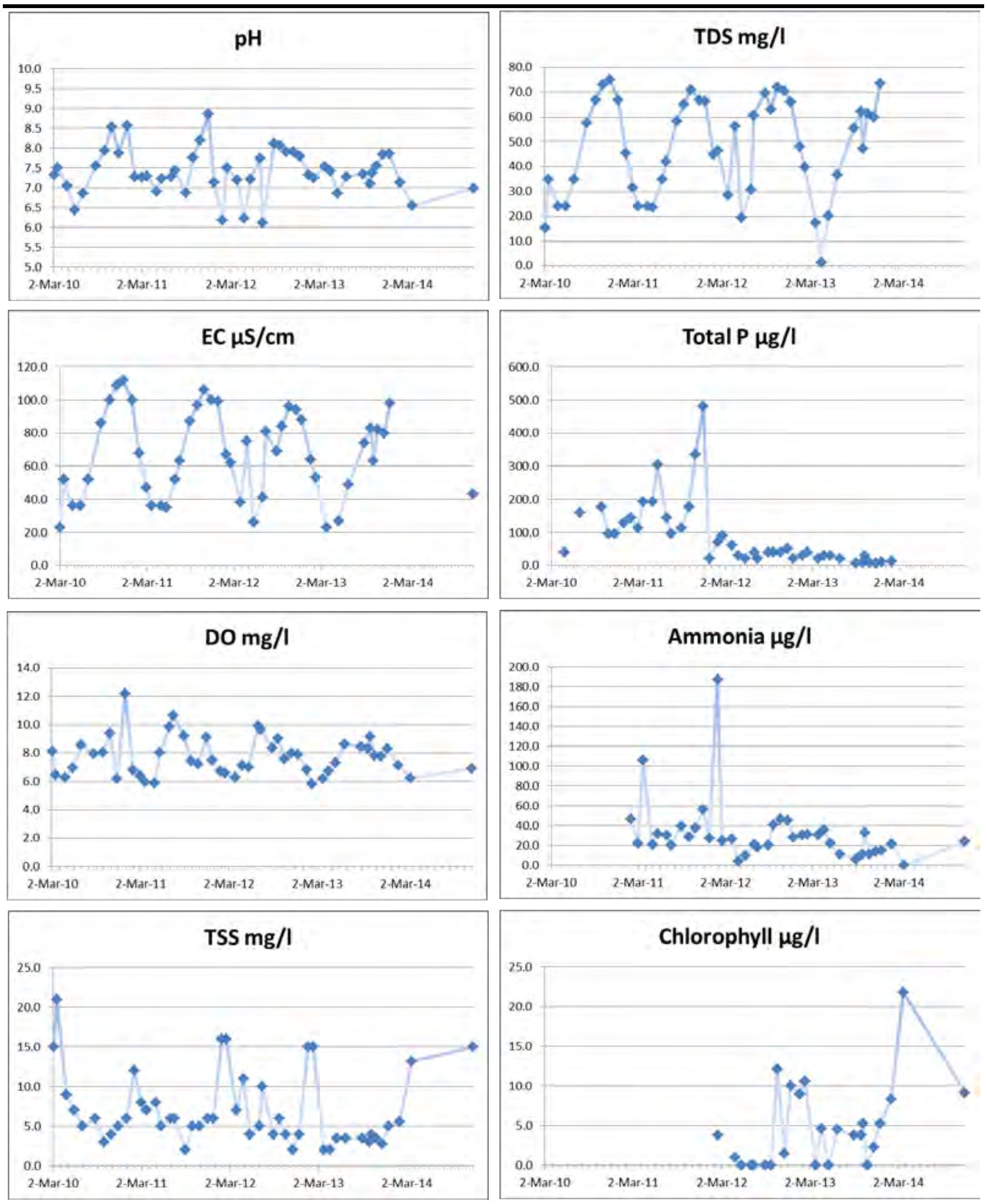


Figure 8.9 Water Quality Monitoring Data for Zambezi River at Big Tree (u/s Falls)



Source: ZRA monitoring data provided January 2015.

One of the main observations in all of the water quality datasets (including the most recent) is that there has been no significant change in the chemical constitution of the water above Victoria Falls in recent decades, and that water quality conditions at that point are generally indicative of a largely unpolluted, undeveloped catchment. This would be anticipated given the limited industrial development that has occurred in the upper catchment over this period.

In particular, conductivity values appear to be consistently low between surveys, indicative of low levels of inorganic pollution as would be expected from a largely rural catchment area, and dissolved oxygen values are consistently fairly high (and well above the ZRA threshold for healthy aquatic biota of 5.0 mg/l). One exception to this situation is the presence of occasional high lead concentrations detected in some of the earlier surveys, including both upstream and downstream of the Falls [(1)]. These have been previously attributed to a combination of spillage from the outboard engines of pleasure craft upstream of the Falls, and also the untreated disposal of waste oils from industrial centres in Livingstone and Victoria Falls (ZRA, 1998).

In terms of organic pollution, there is a noticeable increase in phosphorus, nitrate and BOD levels in the earlier survey data from upstream of the Falls to the Batoka site, and similarly a marked increase microbiological contamination. This has been largely attributed to the inflow of poorly treated or untreated sewage effluent from the population centres at Victoria Falls and Livingstone (ZRA, 1998). Water quality conditions downstream of the Falls are unlikely to have changed from this time as the over-loaded and poorly functioning waste stabilisation pond systems remain to this day. Given the population increases in all three centres the volume of untreated sewage entering the river is likely to have increased [(2)].

Sediment Transport

There are very few direct sediment discharge measurements available for the Zambezi River above Victoria Falls, although most studies conclude that from the limited data (principally collected during the 1950s and 1960s) and general observations over a long period of time that sediment transport rates in the river are very low, and unlikely to exceed more than a few hundred parts per million even at high flood flows (ZRA, 1993). This is consistent with more recent studies of sedimentation rates in Lake Kariba (Kunz, 2011) that estimate (based *inter alia* upon core sampling) an average sediment accumulation rate in the reservoir of 3.7 million tonnes per year. Assuming a total annual inflow to the lake of approximately 60 km^3 per year, and assuming that the sediment inflows are predominantly from the Zambezi River, this equates to an average sediment concentration in the influent river of approximately 60 parts per million, i.e. in line with the earlier estimates.

The main reason for this relatively low sediment transport rate is that tributaries of the Upper Catchment have relatively low gradients and drain extensive areas covered by permeable Kalahari sands, and consequently have gently rising and falling hydrographs that do not pick up much sediment. Also, average flow velocities in the Barotse Plain and Chobe Swamps are extremely low outside of the main channel such that the majority of sediment carried in the flow effectively precipitates on the floodplain before it reaches Victoria Falls. Moreover, the channel downstream of the Chobe Swamp cuts through hard basaltic formations where erosion is minimal. Similarly, erosion rates at the Victoria Falls themselves have been estimated to be of the order of 1,000 m^3 of rock material per year (ZRA, 1993), which is relatively insignificant in comparison to the volume of the proposed reservoir at Batoka.

(1) As compared to the ZRA Guideline Value of 0.2 µg/l for lead for Aquatic Biota.

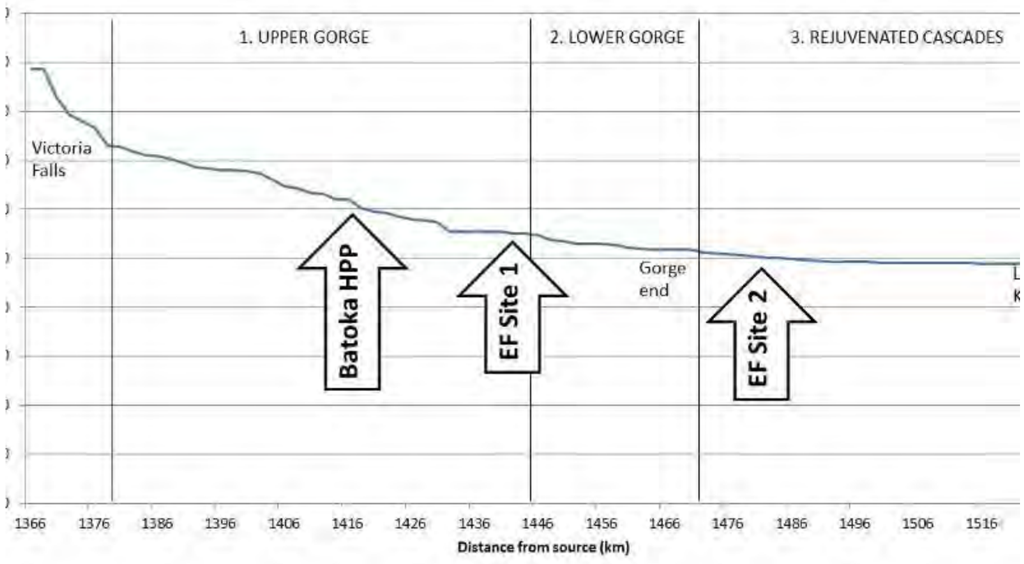
(2) The most recent data are collected upstream of the Falls only and so the comparison cannot be made.

8.2.7 *Geology, Soils and Geomorphology*

The project is located within a large area of plateau basalt some 170 million years old, which investigations at the dam site have shown to be 500 m thick (ZRA, 1993). The basalts form a flat plateau with low flat-topped hills incised by the steep sided gorges of the Zambezi and its tributaries. The lava pile is underlain by Jurassic and Triassic sediments of the Karoo group. Both basalts and sediments fill a north-east trending, 70 to 80 km wide trough, which is intersected by the Deka Fault that crosses the Zambezi River some 75 km downstream of the Project site. Immediately adjacent to the gorge shallow, basaltic soils are prevalent whereas moving further away the plateau basalts are covered by deeper layers of younger, wind transported (aeolian) sandy sediments and alluvium (Kalahari sands).

The unique 'zig-zag' series of gorges that wind for a distance of approximately 100 km below the Victoria Falls (collectively referred to as the Batoka Gorge) result from the presence of two systems of joints within the bedrock basalt, along which more rapid erosion takes place such that earlier positions of the Falls are marked by each linear stretch of the river downstream (ZRA, 1993). Below the Falls, the gradient steepens and the river flows over a series of cascades and rapids through the gorge (*Figure 8.10*). After the gorge, the valley widens and the river consists of wide/deep pools that flow around vegetated islands before the impoundment of Lake Kariba backs the water up.

Figure 8.10 ***Longitudinal Profile of the Project Area with Geomorphological Zones (Rowntree et al., 2000)***



Source: Batoka HES Environmental Flow Assessment, Southern Waters, November 2014

The project area downstream of the Falls can be divided into three geomorphological zones based on slope, valley width and confinement, the presence and diversity of morphological units, and tributary inflows as these bring in both flow events and sediment loads to the gorge area. These are described in *Table 8-5*.

Table 8-5 Descriptions of Zones in the Study Area (Rowntree et al., 2000)

Zone Name and Description	Slope	Maximum channel width (m)	Zone length (km)
Upper Gorge - no tributary inputs: Moderate to steep gradient, confined channel (gorge) with limited lateral development of alluvial features. Morphological units include bedrock fall, cascades and pool-rapid. There are few sandy alluvial deposits but no riparian plants establish there. A narrow riparian area consists of trees in patches along the channel but no reeds at the channel edge.	0.0021	180	100
Lower Gorge - some tributary inputs: Moderate gradient with a wider yet still confined channel (gorge) with limited lateral development of alluvial features. Morphological units include bedrock fall, cascades and pool-rapid. Alluvial sand deposits provide some habitat for riparian trees and there are likely to be some marginal graminoids present [(1)]. The riparian area is narrow.	0.0016	250	24
Rejuvenated cascades - widened river valley: Moderate gradient, still within a confined channel, but wider and less steeply sloping banks. Limited lateral development of alluvial features. Morphological units include cascades, pool-rapid, gravel bars, sand bars and vegetated islands. The riparian area remains narrow and consists of a fringing zone of marginal graminoids (reeds) and a narrow band of riparian trees along the channel.	0.0010	550	24

Source: Batoka HES Environmental Flow Assessment, Southern Waters, November 2014

The BGHES site is situated in the Upper Gorge zone, which is characterised by a confined channel (maximum width 180 m) with a moderate to steep gradient and limited development of lateral alluvial features (*Figure 8.11*). The reaches of this zone comprise combinations of bedrock falls, cascades and pool-rapid morphological units. There are few sandy alluvial deposits since there are few tributary inputs. Due to this, there are very few marginal graminoids present. The riparian area is narrow and patchy and comprises riparian trees along the channel situated at elevations above the median flood stage. This zone is approximately 100 km in length.

(1) The precise extent to which marginal graminoids were present in this zone could not be determined accurately due to the limitations of the available satellite imagery for this area.

Figure 8.11 BGHES Site in Upper Gorge Zone

The river channel through the Lower Gorge is similar to that of the Upper Gorge in being a confined channel with a moderate to steep gradient and with limited lateral alluvial features. It differs in being wider (maximum width 250 m) and with an increase in the frequency of alluvial sandy deposits due to the presence of a number of tributary junctions. The reaches of this zone comprise combinations of bedrock falls, cascades and pool-rapid morphological units.

Alluvial sandy deposits provide some habitat for riparian trees and it is likely that there are a greater abundance of marginal graminoids here. The overall extent of the riparian area remains narrow and patchy with the majority of species being found at elevations higher than the median flood stage. This zone is shorter and occurs over a distance of 24 km ending where the gorge ends and the valley widens.

The Rejuvenated Cascades zone comprises a widened river valley (*Figure 8.12*). The river flows within a confined channel over a moderate gradient but with wider and less sloping banks. This zone, like the two upstream, is also characterised by limited development of alluvial features and combinations of cascades and pool-rapids morphological units. It differs with the presence of gravel bars, sand bars and vegetated islands that provide a greater variety of riparian habitats for reeds, shrubs and trees. Marginal graminoids comprise a far greater proportion of the riparian area when compared to the gorge upstream.

Figure 8.12 Rejuvenated Cascades Zone (downstream of Batoka Gorge)

8.2.8 *Seismicity*

The preliminary data on seismicity of the project area has been extracted from Studio Pietrangeli (SP)'s report, entitled Phase III feasibility: Seismic hazard assessment of June 2015.

In terms of regional tectonics, the African plate, on which Batoka is situated, includes southern Africa and the East African Rift System (EARS), which ends in the Indian Ocean. Plate boundaries in both the continental and oceanic lithosphere (including the African wide-plate boundary) are hundreds and thousands of kilometres wide. In fact, plate boundaries cover roughly 15% of Earth's total surface area (Gordon and Stein, 1992). The African plate is considered one of the most tectonically stable areas in the world.

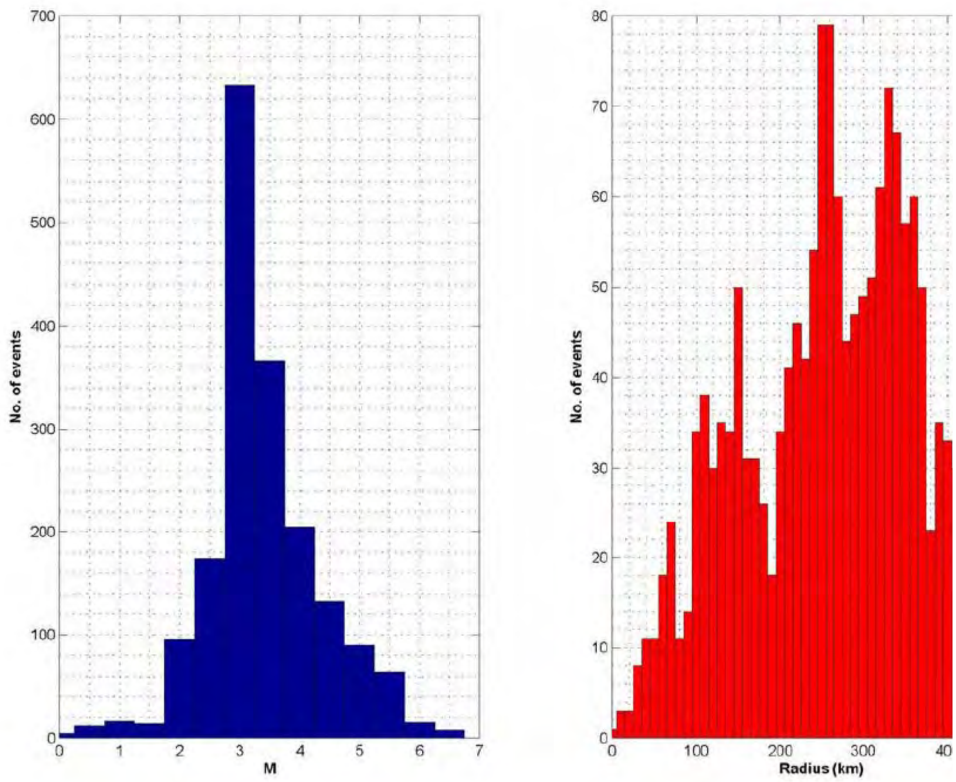
The African wide-plate boundary is characterised by belt-like zones of seismicity surrounding relatively aseismic blocks. The seismicity in Southern Africa appears to portray the same spatial style and supports the notion that the wide-plate boundary extends into South Africa. The rift between the Nubia (west section) and the Somalia (east section) plate, south of 20° S off the coast of Mozambique, is along the southwest Indian Ridge (Lemaux et al., 2002). These two plates are extending in at a slow rate and are commonly known as the East African Rift System (EARS). Seismicity is observed in the EARS as far as the southern part of Mozambique.

Regional seismicity was examined by SP (2015), who analysed data for a total of approximately 7, 700 events within a radius of 500km from the proposed project site, including information related to magnitude, date, latitude, longitude, depth and station name. This data included both a pre-instrumentally recorded seismicity data set derived from Brandt *et al.* (2005), and instrumentally recorded seismic events database selected from:

- The updated database compiled for the Global Seismic Hazard Assessment Project (Giardini, 1999);
- The catalogue provided by the Council for Geosciences, Pretoria;
- The International Seismological Centre in the UK (ISC, On-line Bulletin (www.isc.ac.uk); and
- The United States Geological Survey (USGS) database.

Data on these events is provided in summary form in *Figure 8.13*.

Figure 8.13 Number of events of different magnitude and distance from site



Source: SP (2015): Seismic Hazard Assessment report

In terms of reservoir triggered seismicity (RTS)[1], the Kariba Dam has triggered a seismic event of a maximum of 6.2, one of only four RTS cases worldwide above 6.0 (Gupta, 2002; www.zaraho.org.zm).

The Kariba Dam wall lies about 360 km downstream of Batoka, and its reservoir, Lake Kariba, is the world's largest manmade lake by volume. The

([1]) RTS is defined as, "seismic events manifested during and after impounding, due to interaction of the added weight of the storage water and the pore pressure diffusion, with the critically stressed causative faults."

lake is about 280 km long and up to 40 km wide. It covers an area greater than 5′500 km^2 and it stores a volume of about 185′000 Mm^3 (at the maximum retaining level of 487.8 m amsl).

Impounding started in December 1958 and the lake was full for the first time in August 1963. The seismicity increased steadily after the water depth had reached about 30 m. However, in September 1963 a jump in energy release occurred with six shocks having magnitudes exceeding 5.0 on the Richter scale. The main event of magnitude 6.2 caused damage to the dam structure and some property damage in nearby settlements.

The seismicity induced by Lake Kariba, although more sporadic now than during the first 10 to 15 years after impounding, does not show a clearly defined decrease in intensity particularly for events within magnitudes greater than 4.0.

8.2.9 Groundwater

The basalt bed-rock encountered throughout the project area is virtually impervious, and its permeability is controlled by the nature and frequency of discontinuities that occur in the rock mass. Due to the rarity of these features, the rock mass is therefore considered to be a more or less impervious medium with hardly any groundwater movement, and characterised by perched aquifer conditions (ZRA, 1993). A detailed map of village borehole supplies in the project area is being developed for the socio-economic baseline. Most of these are located within the Kalahari sands and alluvium formations.

8.3 TERRESTRIAL ECOLOGY

This *Section* describes the protected areas associated with the EAoI, habitats therein and their floral composition, and the wildlife component of the fauna. The approach and methodologies used in this baseline assessment are presented in *Annex G*.

Data presented here complements the 1993 and 1998 vegetation and faunal studies conducted for earlier ESIAs done for the development of the proposed BGHES. The following summaries of those studies are provided in bullet point format:

Vegetation Studies (1993 – Document EA4)

- Descriptions of vegetation units in the reservoir area and immediate catchment area are provided.
- Vegetation impacts are described for the same reservoir and immediate catchment areas.
- Mitigation measures include the following:
  - A formal botanical survey should be conducted with an emphasis on riparian habitats. Efforts will be needed to save rare and endemic species threatened by the Project.

- Botanical survey and protection measures are needed for hotspots within the immediate catchment area.
- Monitoring of vegetation change

Vegetation Studies (1998)

- Habitats were mapped from Landsat images for both sides of the Zambezi River but covering a limited area from Victoria Falls to just below the proposed BGHES dam wall.
- Ten habitat / vegetation units were recognised based on an ordination of results from vegetation sample plots.
- An inventory of 248 plant species identified in sample plots was presented.
- An assessment of the endemism, commonness and conservation status of the vegetation was presented.
- An unstructured Environmental Impact Assessment for the vegetation was presented and mitigation measures presented which include:
  - A search be conducted for threatened and Red-listed species and transplanting of specimens threatened by the reservoir.
  - Monitoring of the of fire and human impacts on the vegetation.
  - Trees that are destroyed through construction activities are to be made available to local communities.
  - Schemes need to be developed in conjunction with District Councils that encourage sustainable utilisation of woodlands.
  - Wood carvers and vendors of ornamental plants need to be registered and a permitting system implemented to control their activities.

Wildlife Studies (1993 – Document EA5)

- Results of censes of large mammals are presented for the Zimbabwean and Zambian sides of the project area, but low densities of large fauna are described for the Gorge area.
- A rich assemblage of raptors is described with an emphasis on the presence of Taita Falcons. The importance of the habitat for Rock Pratincole is presented. Presence of forest bird species e.g. African Broadbill) are expected in the riparian vegetation of the gorge.
- The Impact Assessment discusses impacts within the gorge area to raptors and Rock Pratincole. Impacts discussed for the surrounding areas include loss of habitat, the expected influx of people and severing of elephant movement corridors.
- Mitigation measures include:
  - Formation of a formal conservation biology project to compile detailed inventories, estimate the abundance of rare and endemic species, track the elephant movements and develop better mitigation measures.
  - Detailed monitoring of Taita Falcon populations and possibilities for captive breeding programmes.

    - Siting of staff villages and construction camps to avoid elephant migratory corridors.

Wildlife Studies (1998)

- An aircraft based aerial census of wildlife populations was conducted, and a helicopter-based census of raptors within the Batoka Gorge were conducted.
- An inventory of 91 mammals known or expected to occur in the vicinity of the proposed project and 200 bird species was provided.
- Descriptions of birdlife associated with the Batoka Gorge is focussed on the presence of Taita Falcons, Rock Pratincoles and general raptors.
- Brief descriptions of reptile and amphibian communities are provided, with additional data on the known crocodile breeding behaviour within the gorge. A list of 94 herpetofaunal species potentially occurring there is presented.
- There is a brief comment on the known terrestrial invertebrate communities.
- Martienssen's Free-tailed Bat, Lion, Elephant, Springhare and Taita Falcons are listed as threatened species potentially occurring in the project area, and lists of CITES-listed species are provided.
- Impacts resulting from camp, road and dam wall construction, filling of the reservoir, operational phase of the reservoir and impacts to the World Heritage Site are assessed.
- Mitigation measures are presented which include:
    - Requirements for the location of a staff township to minimise the loss of natural habitat.
    - Requirements for measures to prevent illegal hunting by construction workers, and strict enforcement of wildlife laws in the general area of the project.
    - The document states that little can be done to mitigate the expected impacts on birds, but proposes that the possibility for creating artificial falcon nesting sites should be explored.
    - There is speculation on the need to impose controls on tourist and fishing boat activities if impacts as a result of boats are observed on raptor breeding sites.

8.3.2 Protected Areas

A large number of protected areas occur within the vicinity of the proposed BGHES, which lies adjacent to the protected areas of Zambezi National Park, Victoria Falls National Park, Deka and Matetsi Safari Areas, Fuller Forest in Zimbabwe (*Figure 8.14*), and the Mosi-oa-Tunya Park in Zambia. In Zimbabwe there is some seasonal movement of wildlife from these protected areas and the adjacent Hwange Communal Land.

The IBAT database lists 34 protected areas within a 50 km radius of the defined Ecological AoI (*Table 8-6*).

Table 8-6 Protected Areas Identified by the IBAT in the Vicinity of the BGHES

Protected Area Name	Country	IUCN Mgmt Category	Relevance
Mosi-oa-Tunya - Victoria Falls World Heritage Site (natural or mixed)	Zambia & Zimbabwe	Not Applicable	Considered critical habitat
Mosi-Oa-Tunya National Park	Zambia	II	Considered critical habitat
Victoria Falls National Park (and Ramsar site)	Zimbabwe	III	Considered critical habitat
Kazuma Pan National Park	Zimbabwe	II	Not affected
Zambezi National Park	Zimbabwe	II	Incorporated above
Hwange National Park	Zimbabwe	II	Not affected
Kasane Extension FR	Botswana	II	Not affected
Kazuma FR	Botswana	II	Not affected
Bovu FR	Zambia	(IV)	Not affected
Malanda FR	Zambia	(IV)	Not affected
Dambwa FR	Zambia	(IV)	Not affected
Simonga FR	Zambia	(IV)	Not affected
FR No.97 Name Unknown	Zambia	(IV)	Not affected
FR No.98 Name Unknown	Zambia	(IV)	Not affected
Lake Kariba Recreational Park	Zimbabwe	V	Stakeholders engaged
Deka Safari Hunting Area	Zimbabwe	VI	Not affected
Matetsi Safari Hunting Area	Zimbabwe	VI	Not affected
Kazuma State Forest	Zimbabwe	(IV or V)	Not affected
Fuller State Forest	Zimbabwe	(IV or V)	Stakeholders engaged
Kavira State Forest	Zimbabwe	(IV or V)	Not affected
Sikumi State Forest	Zimbabwe	(IV or V)	Not affected
Chidobe WMA	Zimbabwe	(IV or V)	Stakeholders engaged
Kachecheti WMA	Zimbabwe	(IV or V)	Stakeholders engaged
Jambezi WMA	Zimbabwe	(IV or V)	Stakeholders engaged
Nekatambe WMA	Zimbabwe	(IV or V)	Not affected
Nemananga WMA	Zimbabwe	(IV or V)	Stakeholders engaged
Saba-Lubanda WMA	Zimbabwe	(IV or V)	Not affected
Sidinda WMA	Zimbabwe	(IV or V)	Stakeholders engaged
Simangani WMA	Zimbabwe	(IV or V)	Not affected
Tinde WMA	Zimbabwe	(IV or V)	Not affected
Unknown 16 WMA	Zimbabwe	(IV or V)	Not affected
Lubu WMA	Zimbabwe	(IV or V)	Not affected
Sianzyundu WMA	Zimbabwe	(IV or V)	Not affected

Key
Acronyms: FR - Forest Reserve; WMA – Wildlife Management Area
IUCN Management Categories: Ia - Strict Nature Reserve; Ib - Wilderness Area; II - National Park III - Natural Monument or Feature; IV - Habitat/Species Management Area; V - Protected Landscape/ Seascape; VI - Protected area with sustainable use of natural resources

8.3.3 World Heritage Site

The Victoria Falls/Mosi-oa-Tunya area was declared a UNESCO World Heritage Site in 1989 in terms of the World Heritage Convention (*Figure 8.16*). [1] The World Heritage Site is the subject of a Joint Integrated Management Plan (JIMP) established to assist in the protection and preservation of this World Heritage Property. [2] The JIMP establishes three zones, namely: (1) high ecologically sensitive; (2) medium ecologically sensitive and (3) low ecologically sensitive. The purposes of these zones and acceptable activities are presented in *Table 8-7*.

Table 8-7 Sensitivity Zones of the Victoria Falls/Mosi-oa-Tunya UNESCO World Heritage Site

Zones	Purpose	Utilisation
Zone I High ecologically sensitive	To provide for the protection and sustainable utilisation of the core features and processes of the WHS.	**Permitted:** Research, management, law enforcement, traditional rites, existing abstraction and a variety of foot and boat based tourism activities **Prohibited facilities:** No further infrastructural developments
Zone II Medium ecologically sensitive	To permit habitat recovery and reduce utilisation pressure on the core features of the WHS.	**Permitted:** Research, management, law enforcement, traditional rites and a variety of vehicle and foot based tourism activities **Prohibited facilities:** No further permanent structures
Zone III Low ecologically sensitive	To provide for medium and large scale development and other activities compatible with conservation principles and objectives of the WHS.	Not specified

The proposed reservoir will impact Zone I High Ecologically Sensitive zone (*Figure 8.17*) through converting the natural river habitat into a modified pelagic habitat. Impacts will lead to a reduced species diversity through loss of riparian vegetation with associated tree-nesting raptors and fauna, and alteration of fish and aquatic macro-invertebrate species. Any species whose populations are supported by aquatic ecology will be impacted, such as African Finfoot, Rock Pratincole, Fish Eagle, waders and kingfishers. Taita falcon is an iconic species of the World Heritage Site that is expected to be impacted through a knock-on effect to its prey species such as swifts that feed on emerging midges. There are however baseline gaps and insufficient ecological knowledge of this falcon to effectively assess this impact.

(1) A recent update to guidance notes (February 2019) to the IFC Performance Standard 6 (GN55) states that some areas will not be acceptable for financing, with the possible exception of projects specifically designed to contribute to the conservation of the area. Such areas include UNESCO Natural and Mixed World Heritage Sites. Such sites therefore need to be addressed as having the highest level of sensitivity.
(2) Victoria Falls/Mosi-oa-Tunya revised Joint Integrated Management Plan 2012 – 2017, prepared by Joint Technical Committee in conjunction with the Zambia and Zimbabwe National Commissions for UNESCO.

8.3.4 *Other Protected Areas*

A recent initiative by the Zimbabwean Ministry of Environment, Water and Climate seeks to create a biodiversity corridor linking the Hwange/Matetsi/ Victoria Falls wildlife areas across to Binga and the Sebungwe region. This is known as the Hwange Sanyati Biodiversity Corridor (HSBC) [(1)]. In addition to protection of the remaining wild animals, the HSBC project intends to re-introduce certain species and increase the variety of wildlife that is available for safari hunting.

The Project falls within the international Kavango-Zambezi Transfrontier Conservation Area (KAZA TFCA) as shown in *Figure 8.15*. This regional initiative seeks to adopt common approaches to conservation across the international boundaries of Angola, Botswana, Namibia (Caprivi), Zambia and Zimbabwe. It is therefore important that any major developments such as the BGHES take into account the conservation initiatives in the region.

In the Hwange Communal Land, Sidinda Ward lies south and east of the BGHES site area, along the Matetsi and Deka Rivers. It is categorised as wildlife estate under the Communal Areas Management Programme for Indigenous Resources (CAMPFIRE) whereby wildlife that would otherwise be regarded as threat to livelihoods, is turned into a source of revenue through controlled hunting and tourism. In addition to the income from trophy fees, the income generated from safari operators' fees is mainly split between the Hwange District Council and the local community, with a small amount generated from the Campfire Association administration (C. Jonga, pers comm.).

Also operating under the Campfire concept, the Imvelo Gorges Lodge is a joint venture photographic tourism project between Matupula Safaris (a private safari company) and the local communities of Chisuma Village (under Ward 2) in Hwange District. The communities earn an income from the Lodge in the form of an annual lease fee and a levy for each guest.

8.3.5 *Internationally Recognised Areas*

The IBAT database identifies two key biodiversity areas (KBAs) within the vicinity of the BGHES, namely the Batoka Gorge and the Hwange National Park. Both of these KBAs are based on Important Bird and Biodiversity Area (IBA) recognised by Birdlife International.

The Batoka Gorge IBA covers approximately 12,000 ha and is recognised as a haven for cliff-nesting birds, and for the Taita Falcon (*Falco fasciinucha*) in particular. In the 1990s, it was estimated that Batoka Gorge hosted up to 10 pairs of this small falcon. In addition, there is a population of Peregrine falcons (*Falco peregrinus*), another 34 species of raptors (including owls), and breeding Black

(1) Ministry of Environment, Water and Climate, Government of Zimbabwe, December 2013. Hwange Sanyati Biodiversity Corridor (HSBC) Report: Environment and Social Management Framework. Available at :http://awsassets.panda.org/downloads/hsbc_esmf_20_december__2013.pdf

Storks (*Ciconia nigra*). A large and important breeding population of Rock Pratincole (*Glareola nuchalis*) is present.

The Batoka Gorge IBA will be impacted by construction of the BGHES and through inundation by the reservoir, which will result in extensive loss of riparian vegetation, which provides nesting habitat in tall trees for many nesting raptors, such as the Crowned Eagle (*Stephanoaetus coronatus*) and Pel's Fishing Owl (*Scotopelia peli*). The natural riverine habitat will be modified to a deep-water pelagic habitat, resulting in complete alteration of the aquatic ecosystem (fish and macro-invertebrates). Raptors and other birds that depend on food chains underpinned by aquatic ecology will be adversely affected, with possible loss of some of those bird populations. Affected bird species are likely to include Taita Falcons, Black Stork, Rock Pratincole, African Finfoot, African Fish Eagle, various waders and kingfishers. Many bat roosts are expected to be flooded. There is currently no effective mitigation to address these impacts, and the feasibility of offsetting will need to be investigated as explained in *Chapter 10*, but is beyond the current scope of this ESIA.

The Hwange National Park IBA is unlikely to be affected by the Project and is not discussed further.

Figure 8.14 Protected Areas Adjacent to the Proposed BGHES (Zambia and Zimbabwe)

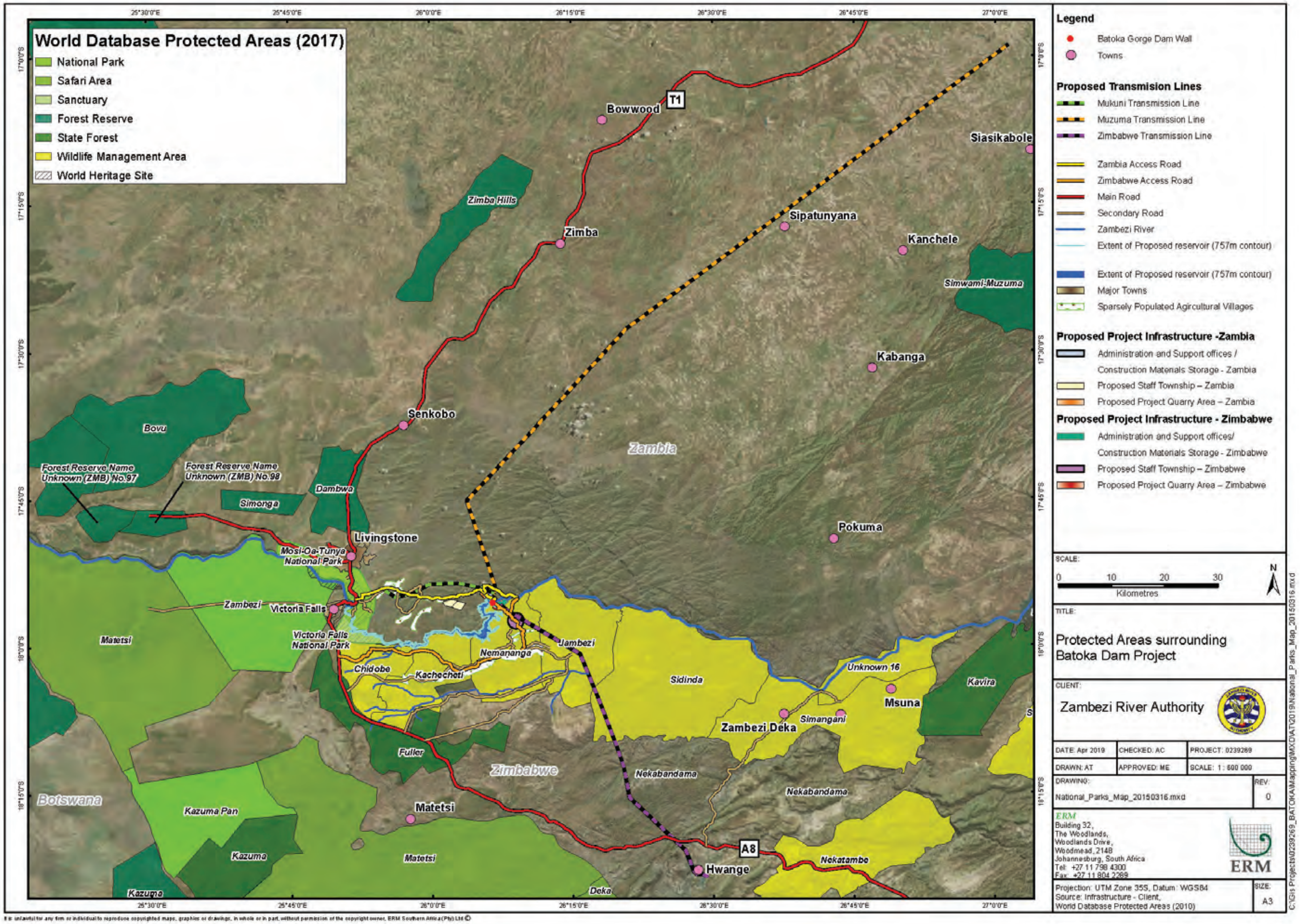


Figure 8.15 The Kavango-Zambezi Transfrontier Conservation Area (formerly known as the Four Corners)

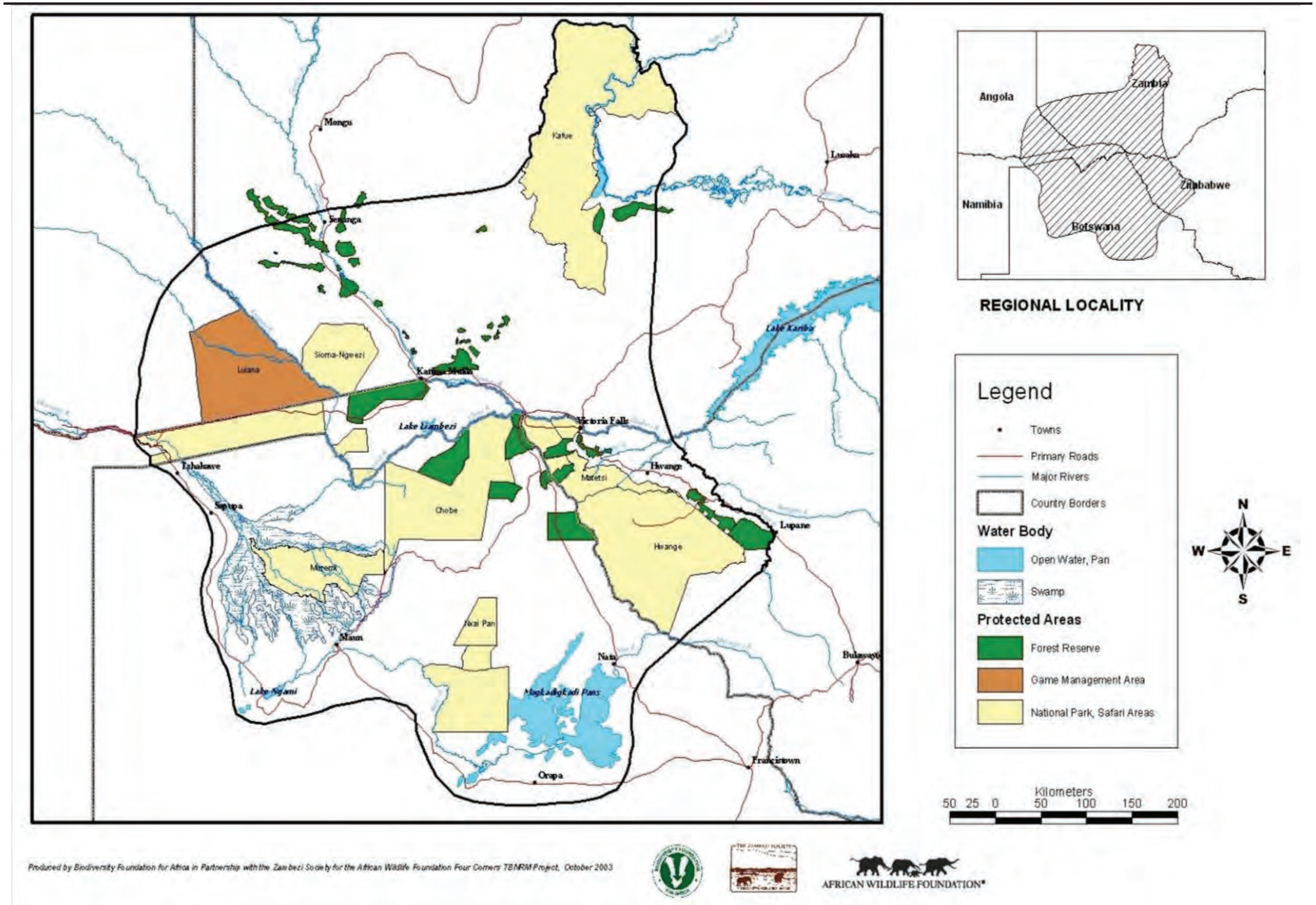


Figure 8.16 Victoria Falls/Mosi-oa-Tunya World Heritage Site

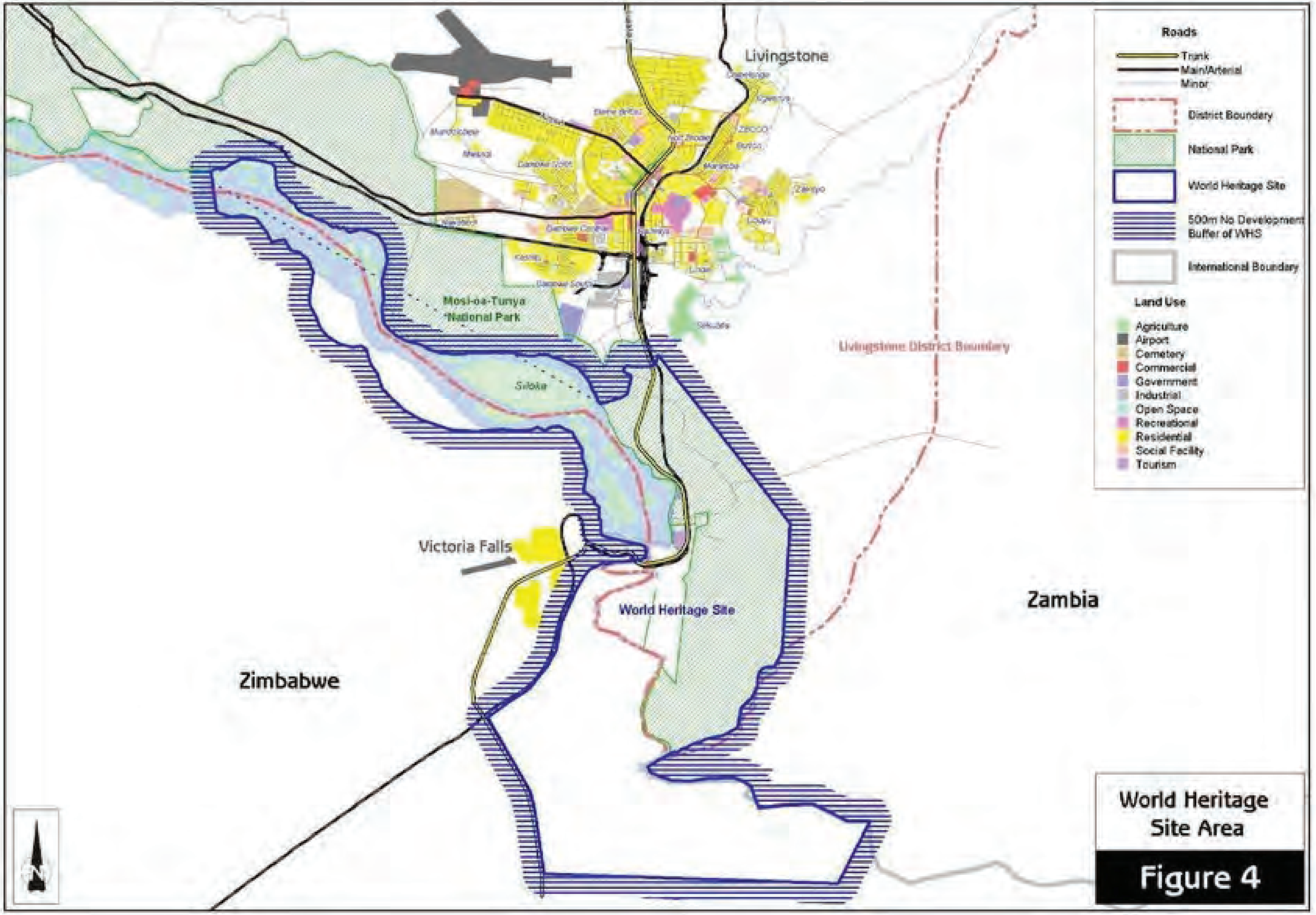
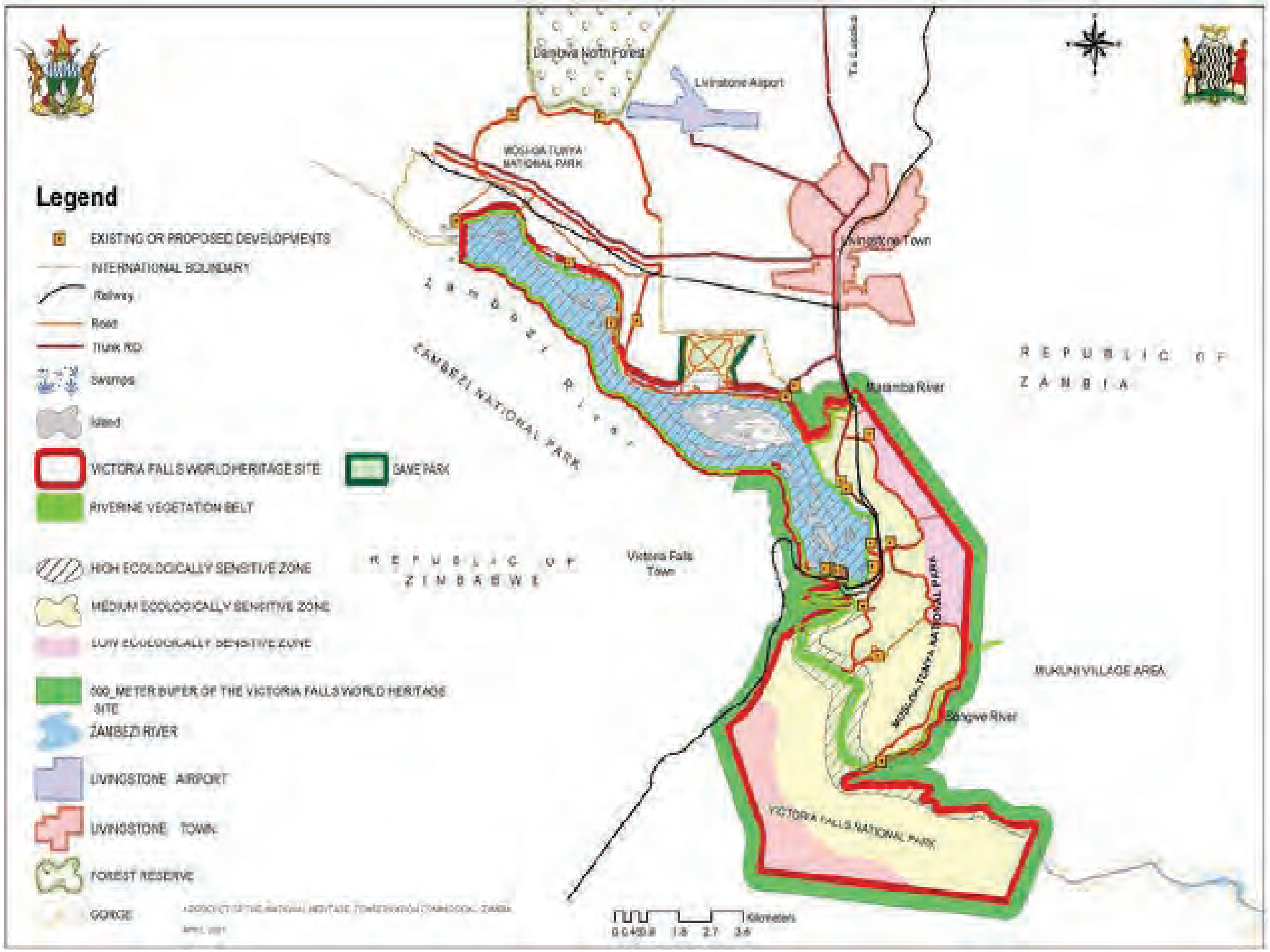


Figure 8.17 Victoria Falls/Mosi-oa-Tunya World Heritage Site Ecological Sensitivity



8.3.6 *Floral Communities*

A habitat assessment was conducted for the 1998 ESIA report for the proposed BGHES. The vegetation units used in that analysis have been extended (with mapping based on Google Earth imagery dated in 2013 and 2014) to include the proposed transmission line routes from BGHES to Hwange town, and to Livingstone in Zambia, and north-eastwards for the proposed transmission line between the Livingstone substation and Muzuma in Choma. This habitat delineation was ground-truthed during a vegetation survey in September 2014. Based on results of the ground-truthing, a habitat map covering the entire Ecological AoI (*Figure 8.18*) was compiled. Where possible, anomalies that were apparent on the satellite imagery were checked on the ground. Biomass estimates in the 1998 report were compared with data from similar sites. The earlier ESIA reports (1993 and 1998) provide comprehensive descriptions of the vegetation types and checklists of plants in the immediate area of the proposed dam.

Overview of Habitats present within the Ecological Area of Influence

Habitat is defined as an ecological area in which particular organisms (plants, animals) live. From a phytosociological classification, there might be several vegetation types, each dominated by a different species e.g. *Kirkia acuminata* or *Colophospermum mopane,* but from an ecological perspective, these are both woodland habitats. The 1998 vegetation types were defined in detail for a small area immediately around the BGHES dam site. This report has an increased area of influence and the earlier vegetation types were interpolated and revised into the new habitat types. These new types are broader and more simplified for ease of mapping from satellite imagery.

Table 8-8 ***Comparison of the 1998 Vegetation Types and against Habitat Types in this Report****

Vegetation types 1998 Report	Habitat types described in this report (2014)	Extent within AoI	Percentage of AoI
• *Kirkia acuminata – Colophospermum mopane* woodland • *Colophospermum mopane* woodland • *Terminalia stuhlmannii* woodland • *Commiphora-Sterculia africana* woodland	Basalt Soil Habitats: Mixed Deciduous Woodland	265 771 ha	64.6 %
Mixed side gorges vegetation / Zambezi riparian vegetation	Riparian Habitat (Batoka Gorge and side gorges)	10 992 ha	2.7 %
Upper tributaries woodlands	Upper Tributary Woodlands	593 ha	0.1 %
Baikiaea plurijuga woodland	Kalahari Sand Habitat	54 782 ha	13.3 %
Cultivation	Cultivation	56 457 ha	13.7 %
Urban	Urban	6 307 ha	1.5 %
-	Mining and Industrial	12 442 ha	3.0 %

* Please note that the AoI covers areas in both Zambia and Zimbabwe.

The four vegetation types from the 1998 report: *Kirkia acuminata – Colophospermum mopane* woodland, *C. mopane* woodland, *Terminalia stuhlmannii* woodland and *Commiphora-Sterculia* woodland are now considered as sub types of the Basalt Soil habitats.

The other vegetation types in the 1998 report are directly comparable with the habitats defined in this report.

Baseline data was collected in 2019 for proposed quarry sites on both Zambian and Zimbabwean sides of the Batoka Gorge. Table 8-9 presents the list of species identified. This species composition has confirmed that the habitats within the proposed quarry locations conform to the broader habitat description for the *Kirkia acuminata – Colophospermum mopane* mixed woodland.

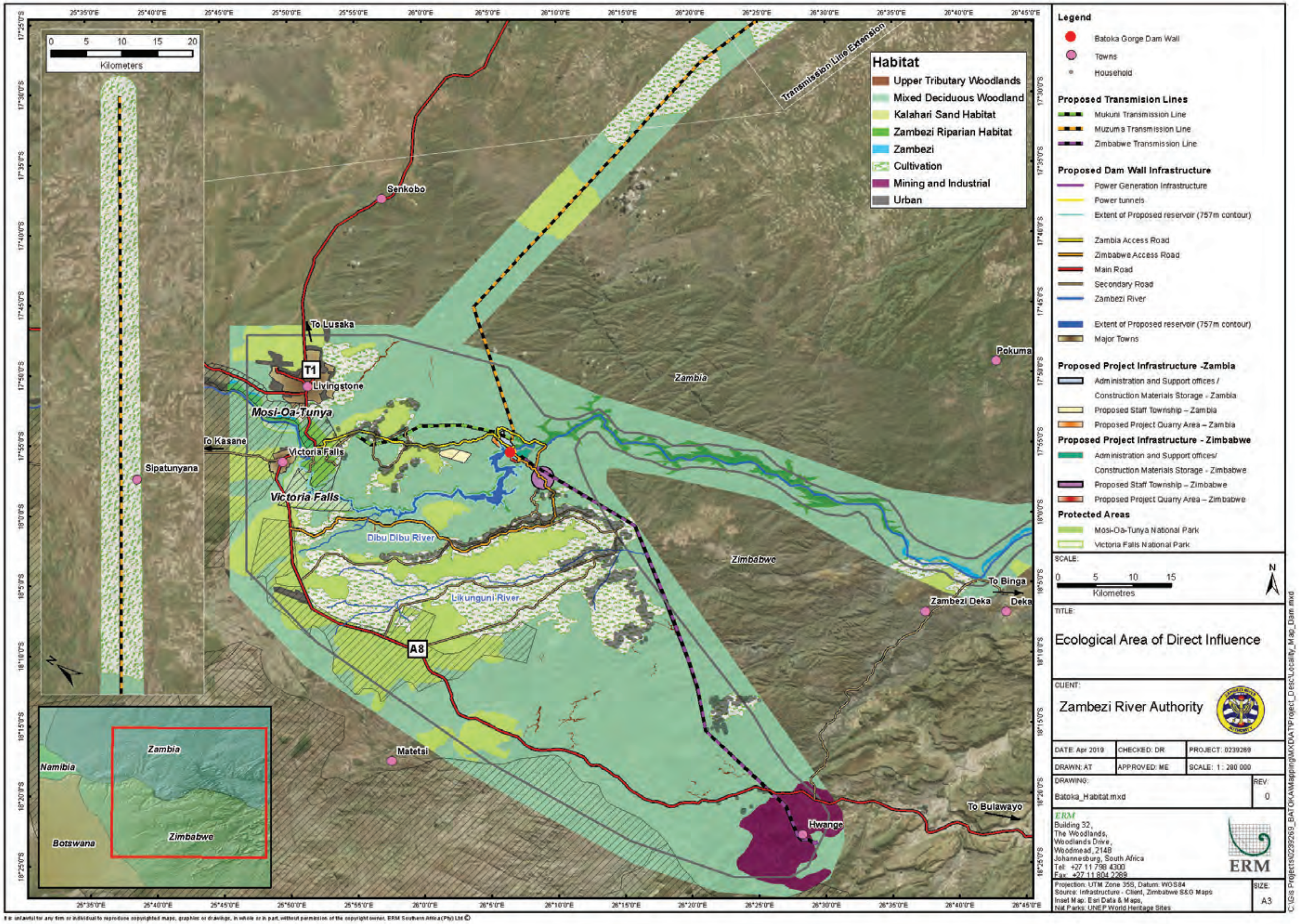
Table 8-9 Plant Species Identified within the Proposed Quarry Locations

Species Name	English Common Name	Zambia	Zimbabwe	Uses / Characteristics
Acacia nigrescens	Knob-thorn Acacia	x	x	Firewood, good browse for livestock
Albizia sp.	-	x	x	Pods may be toxic
Albuca sp.	Herbaceous - Bulbous plant		x	Bulbs may be toxic
Bauhinia thonningii	Monkey Bread		x	Pods used as cattle fodder, various medicinal uses from plant
Colophospermum mopane *	Mopane	x	x	Food plant for edible caterpillars
Combretum apiculatum	Red Bushwillow	x	x	Leaves used for stomach disorders, and browsed by livestock
Combretum zeyheri	Large-fruited Bushwillow	x		Termite-proof timber, roots used for baskets
Commiphora sp.	Corkwood	x	x	Resin has value, good for truncheons
Grewia flava	Raisin bush	x	x	Dried fruit is edible
Gyrocarpus americana *	Propeller Tree		x	Bark and roots used medicinally
Kirkia acuminata *	White Seringa	x	x	Water can be extracted from thickened roots
Lannea discolor	Dikbas	x		Fruit is edible, bark and roots used medicinally
Pseudolachnostylis maprouneifolia	Kubu Berry	x	x	Smoke from roots used medicinally
Sclerocarya birrea	Marula	x	x	Edible fruit, beverage produced from fruit
Sterculia quinqueloba *	Star Chestnut	x	x	Roasted seeds are edible, many medicinal uses
Strychnos sp.	Monkey Orange	x	x	Fruit is marginally edible
Terminalia randii *	Thorny Cluster-leaf	x	x	Gum can be used as emulsifying agent
Terminalia stuhlmannii *	Zigzag cluster-leaf		x	No documented uses found.

Species Name	English Common Name	Zambia	Zimbabwe	Uses / Characteristics
Xerophyta sp.	Herbaceous - Baboon's Tail	x	x	Drought-tolerant plant
Ximenia americana	Sour Plum	x		Fruit is edible but very sour
* denotes species listed in the ESIA as characteristic of the Mixed deciduous Woodland				

Habitats within the proposed quarry sites retain a high level of ecological functionality and show minimal evidence of disturbance. Habitats within both of the proposed quarry sites therefore qualify as natural habitats. There is no evidence of highly threatened species, and no reason to expect critical habitats to occur.

Figure 8.18 Habitat Map for the Ecological Area of Influence for the Proposed BGHES



Basalt Soil Habitats supporting Mixed Deciduous Woodland

The basalt soils cover much of the south and central parts of the project area, on both the Zambian and Zimbabwean sides (64.6%) and support an extensive Mixed Deciduous Woodland habitat (*Figure 8.18* and *Figure 8.19*). This habitat type can be divided into several sub-types based on local-level topographic factors that lead to the formation of ridge, slope and valley conditions, which follow a fairly regular catenary pattern (Childes, 1989b). These sub-type habitats could not be mapped based on the available satellite imagery and the broad scale at which the vegetation has been mapped for this study.

Figure 8.19 ***Undulating Terrain on Basaltic Lava Flows Covered in Mixed Deciduous Woodland***

Sub types:
a) The basalt hilltops and plateaux are characterised by exposed rocks and small boulders and support a *Kirkia – Sterculia – Commiphora* open deciduous woodland with emergent tree reaching 12 m height and short, sparse annual grasses. This gives way to a mixed *Combretum-Commiphora-Colophospermum mopane* open deciduous woodland of 3-5 m height on the slopes, graduating into open *C. mopane* woodland with taller perennial grasses on the lower slopes and at the base of the drainage lines where the soils are deeper clays (*Figure 8.20*). This is the zone of greatest productivity and therefore an important source of forage for wild and domestic herbivores. Fire is a common occurrence in the late dry season where the grass layer is burnt off to provide a "green bite" for livestock. The nutrient and moisture holding capacity of the soils in the lower part of the catena makes these areas suitable for agriculture. Straight-boled hardwood trees e.g. *C. mopane, Terminalia stuhlmannii, T.randii* are selectively cut for construction of houses and fencing.

Figure 8.20 Examples of Mixed Deciduous Woodland on a Rocky Basalt Substrate

	
Kirkia-Sterculia-Commiphora subtype of Mixed Deciduous Woodland on basalt plateaux	Exposed basalt along the Matetsi River with riparian woodland and Mixed Deciduous Woodland behind

In Zambia, the area of *T.stuhlmannii* woodland (Ts) described in the 1998 vegetation description has been cleared for cultivation, although small patches of this vegetation can still be found along the road to Taita Lodge.

b) The scree slopes and steep sides of the Batoka Gorge contain a variation of this broad habitat, with sparsely scattered *Sterculia quinqueloba, Commiphora* species, *Gyrocarpus americana* trees (*Figure 8.21* and *Table 8-10*) and more xeric plants and succulents such as *Aloe chabaudii, Euphorbia griseola* and *Sansevieria pearsonii* growing in the hot dry exposed sites (*Figure 8.22*). *Euphorbia fortissima* occurs in several sites along the gorge, and is listed as a Vulnerable Species in the IUCN Red List and has range restricted to Batoka Gorge and isolated sites near Hwange. In the south facing shaded and moister sites small deciduous ferns and forbs occur, for example the rare *Selaginella imbricata.* Although no *Scadoxus multiflorus* were found during this field work, this attractive flowering plant is found within the spray zone of the Rain Forest and may therefore occur in similar moist zones along the gorge, particularly where small springs and aquifers seep out from the rocks. The endemic forb, *Jamesbrittenia zambesiaca*, was not found although this plant is probably only more visible and identifiable in the rainy season.

Table 8-10 Characteristic Plant Species for the Mixed Deciduous Woodland

Species Name	English Name (and Form)	Local Names
Aloe chabaudii	Dwala Aloe (succulent)	-
Colophospermum mopane	Mopane (tree / shrub)	Iphane (Ndebele) Mupane / Musharu (Shona) Chanye / Mpane (Nyanja)
Combretum apiculatum	Red Bushwillow (shrub)	Bonda / Tsingidzi (Shona), Umbhondo (Ndebele)
Commiphora species	Corkwood	-
Euphorbia griseola	Tree succulent	-
Gyrocarpus americana	Propeller Tree (tree)	Mundari (Shona)
Jamesbrittenia zambesiaca	Small herb	-
Kirkia acuminata	White Seringa (tree)	Mubvumira (Shona), Umvumile (Ndebele) Mzumba (Nyanja)

Species Name	English Name (and Form)	Local Names
Sansevieria pearsonii	Spiky mother-in-law's tongue (herbaceous succulent)	-
Scadoxus multiflorus	Blood lily (bulbous herb)	Mumhandwe (Shona), Umdumbekhulu (Ndebele)
Selaginella imbricata	Resurrection Plant (rock-dwelling herb)	-
Sterculia quinqueloba	Large-leaved Star-chestnut (large tree)	Kukubuyu (Shona), Umkukubuyu (Ndebele) Mgoza / Msambamfu (Nyanja)
Terminalia randii	Spiny Cluster-leaf (small tree)	Ivikane-elincinyane (Ndebele) Musosahwai (Shona)
Terminalia stuhlmannii	Zigzag Cluster-leaf (tree)	Ivikane (Ndebele) Gonondo / Njoyi (Nyanja)

Figure 8.21 Scree slope of the Batoka Gorge showing Bands of Alternating Columnar and Amygdaloidal Basalt with White Streaks showing Seasonal Springs, and a Narrow Strip of Evergreen Riparian Woodland

Figure 8.22 Succulent Plant Species occurring within the Batoka Gorge Scree Habitat

Aloe chabaudii *Euphorbia fortissima*

Kalahari Sand Habitats

Kalahari Sand habitats occur widely in the AoI, but more widespread on the Zimbabwean side than on the Zambian side of the border. The deep sands on the top of the Kalahari Sand ridges support deep rooting *Baikiaea* deciduous/semi-evergreen woodland of 10-12 m height with a relatively closed canopy (*Figure 8.23*). There has been extensive logging of timber (*Baikiaea plurijuga, Pterocarpus angolensis, Guibourtia coleosperma, Brachystegia spiciformis*) on the Zimbabwean side and many of the remaining *Baikiaea* trees are multi stemmed, indicating this past disturbance. Cutting of trees still continues but now appears to target poles for houses and collection of firewood, rather than timber concession logging. There is a distinct shrub layer, which varies in density and species composition according to the degree of canopy cover. Grasses in the denser parts of the woodland are *Panicum maximum* and *Digitaria milanjeana*, both good forage species in the wet season. Where the level of disturbance has been greater, the more weedy, lower forage value grasses and forbs are found. These woodlands form important and one of the few remaining refuges for wildlife in the Project area, providing shade and cover in the dry season and forage in the wet season.

Figure 8.23 ***Baikiaea Woodland on Kalahari Sands during the Dry Season showing an Understorey of Shrubs***

Large areas on the periphery of these woodlands have been extensively modified through cultivation and this is clearly evident from the habitat map (*Figure 8.18*). However the low nutrient value and low moisture holding capacity of the upper layers of these soils means that only dry land (rain-fed) crops can be grown and only produce viable yields for the first three to four years. Thereafter, the nutrient resources that were bound up in the trees, their roots and humic layer become depleted. Consequently, new patches of woodland are cleared each year and the old fields are left as fallow and grazing areas for livestock, although the sparse grass layer does not provide much forage value. Depending on the depth of tree stump removal and level of cultivation, the fallow lands can revert to a layer of 1-2 m high shrubs (*Baphia massaiensis* and *Bauhinia petersiana* are common species) in five to six years, but their nutrient levels take much longer to recover (*Figure 8.24*).

Figure 8.24 Examples of Rotational Cropping Practiced in the Baikiaea Woodland Habitat

Baikiaea woodland recently cleared for agriculture, remnant *Baikiaea* in background	*Baikiaea* woodland left fallow after being cultivated with *Schinziophyton rautanenii* trees in background

In Zambia, where the *Baikiaea* woodland has been cleared, the *Schinziophyton rautanenii* trees have been deliberately retained (*Figure 8.24*) as the edible nuts from these trees provide a source of food and oil for the local villagers (C. Mateke, pers. comm.). *Guibourtia coleosperma* trees are also retained as their fruit is used to make a beverage and large specimens of these trees, together with *Faidherbia albida* can be found near the villages, where they may have been planted as part of an agro-forestry programme.

In Zimbabwean side of the Ecological AoI, there are two distinct drainage lines or dambos within the Kalahari Sands: the Lukunguni and the DibuDibu streams. These drainage lines carry an accumulation of humic clay and silt particles from the upper ridges and form vital strips of nutrient and moisture, especially in the dry season. Water filters down from the sand ridges and comes close to the surface along these lines, eventually draining into perennial streams and rivers. These vleis are focal points for cultivation and grazing as well as a source of water for the communities. This is clearly evident on the satellite imagery where the cultivated areas and settlements are found on the periphery of the sand ridges. The vleis are open grassland with perennial species and in the drier zones, lined with *Terminalia sericea*, merging into *Acacia tortilis, Combretum imberbe* and *Philenoptera violacea* open woodland.

Moving down the catena off the sandy ridges towards the basalts, the sands become shallower and patches of carstone and pipe sandstone become apparent (*Figure 8.25*). The soils are shallow and gravelly and the *Baikiaea* trees give way to shallow rooting species such as *Combretum apiculatum, C.celastroides and Pteleopsis myrtifolia. Kirkia acuminata* and *Colophospermum mopane* (*Table 8-11*) begin to appear.

Figure 8.25 Open Combretum Woodland on Shallow Soils Down the Catena on a Kalahari Sand Ridge

A crescent pattern of vegetation on the Zambian side, near Mukuni village, is an example of this exposure of pipe sandstone, and a possible indication of ancient lava flows.

Table 8-11 Characteristic Plant Species for the Baikiaea (Kalahari Sand) Woodland Habitats

Species Name	English Name (and Form)	Local Names
Acacia tortilis	Umbrella Thorn (tree)	Ingoka / Umsasane (Ndebele) Mzunga / Nyoswa (Nyanja)
Baikiaea plurijuga	Zimbabwe / Zambia Teak (tree)	Mukusi (Lunda)
Baphia massaiensis	Sand Camwood (shrub)	Mvunganyati (Nyanja)
Bauhinia petersiana	Large White Bauhinia (shrub)	Mupondo /Mun'ando (Shona) Katondotondo / Mpondo (Nya.)
Brachystegia spiciformis	Msasa (tree)	Igonde (Ndebele) Msasa / Mutatsa (Shona) Mputi (Nyanja)
Colophospermum mopane	Mopane (tree / shrub)	Iphane (Ndebele) Mupane / Musharu (Shona) Chanye / Mpane (Nyanja)
Combretum apiculatum	Red Bushwillow (shrub)	Bonda / Tsingidzi (Shona), Umbhondo (Ndebele)
Combretum celastroides	Zambezi Jessebush (shrub)	Umlalanyathi (Ndebele) Lusaka (Nyanja)
Combretum imberbe	Leadwood (tree)	Monzo / Mutsviri (Shona) Umtshwili (Ndebele) Chilusa /Nyonja (Nyanja)

Species Name	English Name (and Form)	Local Names
Faidherbia albida	Ana-tree / Apple-ring (large tree)	Musangu / Musenga (Shona), Umpumbu (Ndebele) Nsangusangu / Mtubetube (Nya.)
Guibourtia coleosperma	Large False Mopane	Umtshibi (Ndebele / Lunda)
Kirkia acuminata	White Seringa (tree)	Mubvumira (Shona) Umvumile (Ndebele) Mzumba (Nyanja)
Philenoptera violacea	Apple Leaf / Rain Tree (large tree)	Mumerafodya (Shona) Ichithamuzi (Ndebele) Chimpakasa (Nyanja)
Pteleopsis myrtifolia	Two-winged stink-bushwillow (small tree)	Musunganyemba (Shona), Umsunganyama (Ndebele) Mfundanzovu (Nyanja)
Pterocarpus angolensis	Bloodwood (large tree)	Mukwa (Shona) Umvagazi (Ndebele) Mlombwa / Mlombe (Nyanja)
Schinziophyton rautanenii	Manketti nut (tree)	Mungongoma (Shona) Umgoma (Ndebele)
Terminalia sericea	Silver Cluster Leaf (small tree)	Mangwe (Shona) Umangwe (Ndebele) Gonondo (Nyanja)

Alluvial Soils: Riparian Woodlands, and Mixed Upper Tributary Woodlands

Riparian Woodlands, Sandbanks and Aquatic Habitats

A narrow strip of semi-evergreen riparian woodland habitat occurs along the river terraces on both sides of the Batoka Gorge above the high water mark. This vegetation varies from a single tree wide to 50m wide belt where there is deeper alluvium. The trees are comparatively tall (12-15m) with an understory of thicket and lianes. There is little grass cover in the shaded areas, although in the more exposed sites, the perennial grass *Danthoniopsis petiolata* is found. Dominant tree species are *Diospyros mespiliformis, Acacia nigrescens, Ficus ingens, Philenoptera violacea* and *Garcinia livingstoneii* (*Figure 8.26* and *Table 8-12*). A shrub with a restricted range (Golding 2002), *Rhus lucens*, was found along the track to the river just above the dam wall site on the Zimbabwe side. There are likely to be epiphytic plants associated with the larger trees, especially in the cool, moist places where the spray rises from the rapids and there is seepage from the gorge sides. This evergreen woodland habitat provides vital shade and sources of food for insects, birds and other animals in what is otherwise a harsh dry environment. It is the site of greatest biodiversity and is also pristine, with very minor levels of human disturbance occurring only at the white water rafting exit points.

Patches of sand have accumulated on quiet backwaters where a few sedges (*Cyperus sp., Fimbristylis sp.*) and semi-aquatic plants occur together with *Sesbania sesban, Mimosa pigra* for example. This vegetation is seasonally flooded and scoured out during high flows and therefore considered temporary.

Figure 8.26 Examples of Riparian Habitats

Evergreen riparian woodland along the Zambezi River and in the side gorges

Riparian sand bank habitat along the Matetsi River near the Zambezi River confluence

Aquatic plants, such as *Vallisineria spiralis, Potamogeton thunbergii, P. octandrus* and *Naja horribilis,* occur in slow-flow pools. Given the strength of flows through the gorge and depth of the river channel, both in stark contrast to the slow/no flow and relatively shallow water depth preferred by aquatic macrophytes, these species do not form an important component of the gorge vegetation. Lateral alluvial sand bars occur along the lower parts of the gorge and downstream of the Batoka Gorge. In the gorge the vegetation on these sand banks was sparse and tended to be patchy but consisted of the small trees *Mimosa pigra, Sesbania sesban, Garcinia livingstonei, Ficus capreifolia* and some grasses. Downstream of the gorge the Common Reed *Phragmites australis* and Cape Willow *Salix mucronata* were more common on lateral sand bars and around the vegetated islands.

Table 8-12 Characteristic Plant Species for the Riparian Woodlands and Sandbanks and Aquatic Habitats

Species Name	English Name (and Form)	Local Names
Acacia nigrescens	Knob Thorn (tree)	Chinanga (Shona) Isinanga / Katopa (Ndebele) Mkunku / Nyamamponombwe (Ny)
Diospyros mespiliformis	African ebony /Jackal Berry (tree)	Mupako (Lunda) Mchenja / Mvimbe (Nyanja)
Ficus capreifolia	River Sandpaper Fig (small tree)	Mukaramadzi / Munharauta (Shona)
Ficus ingens	Rock Fig (tree / shrub)	Mutsamvi (Shona), Idotsi / Inkiwane (Ndebele) Muteba (Lunda)
Garcinia livingstonei	African Mangosteen (shrub)	Himbi / Munhinzwa (Shona) Mpule (Nyanja)
Mimosa pigra	Sensitive Plant (invasive shrub)	-
Philenoptera violacea [formerly *Lonchocarpus capassa*]	Apple Leaf / Rain Tree (large tree)	Mumerafodya (Shona) Ichithamuzi (Ndebele) Chimpakasa (Nyanja)
Phragmites australis	Common Reed (tall reeds)	-
Salix mucronata	Cape Willow / Flute Willow (shrub)	Msondozi / Mtundu (Nyanja)
Searsia [Rhus] lucens	Wild Current (shrub)	Mtatu (Nyanja)
Sesbania sesban	Rattlebox (invasive shrub)	-

The riparian vegetation of the Batoka Gorge was assessed during the Environmental Flow field studies using the Vegetation Response Assessment Index (VEGRAI) (Kleynhans *et al.* 2007). The method compares the present day condition to that which would be expected under natural (reference) conditions. The riparian vegetation within the gorge was found to remain in a pristine state (reference condition), while the riparian vegetation downstream of the Gorge (site EF2) was slightly modified from the reference condition. A small change in natural habitats and biota has taken place downstream of the gorge, but the ecosystem functions were essentially unchanged

Side Gorge Woodlands

These Side Gorge Woodlands are essentially an extension of the above riparian habitat type, but modified by the local geology and soil types. An example of this type is the dense vegetation up the DibuDibu Gorge (Zimbabwe) which has distinctly different species growing on the limestone (travertine) areas (*Figure 8.27*). The semi evergreen trees are not as tall (8-12m), but there are several thicket species forming dense clumps in some places along the perennial rivers. The species diversity of woody plants appears to be higher in this type than along the banks of the Zambezi River, but as before, these are zones of high biodiversity and productivity, with 46 plant species recorded in this vegetation during the 1998 survey.

Figure 8.27 DibuDibu Drainage Line Showing an Example of Side Gorge Woodland

Mixed Upper Tributary Riparian Woodlands

The Matetsi and Deka Rivers in Zimbabwe, and the Songwe and Chise Rivers in Zambia support narrow strips of evergreen to semi-evergreen woodland along the alluvial soils of the river terraces. This habitat extends up the narrow drainage lines and tributaries of the rivers. The trees are medium sized, evergreen and deciduous with a variety of shrubs forming thickets in the lower levels. Common species are *Ficus sur, F. sycamorus, Diospyros mespiliformis, Acacia nigrescens, A. tortilis, Faidherbia albida, Nuxia oppositifolia, Strychnos potatorum*. These rivers and riparian strips are vital sources of water and forage for both wild and domestic animals and the local communities, particularly during the dry season (*Figure 8.28* and *Table 8-13*).

Patches of open *Hyphaene petersiana* grassland occur in the south of the Project area, near Ngoma village and Mununa School, Zimbabwe, (*Figure 8.28*) where there is an accumulation of limestone and saline deposits close to the surface. These sites have been modified through cultivation and are heavily grazed by livestock.

Figure 8.28 Examples of Mixed Upper Tributary Riparian Woodlands

Acacia-dominated riparian woodland near the Matetsi/Zambezi confluence

Hyphaene petersiana (Ilala Palms) on sodic / saline soils south of Mununa School

Table 8-13 Characteristic Plant Species for the Mixed Upper Tributary Riparian Woodlands

Species Name	English Name (and Form)	Local Names
Acacia nigrescens	Knob Thorn (tree)	Chinanga (Shona) Isinanga / Katopa (Ndebele) Mkunku / Nyamamponombwe (Nya.)
Acacia tortilis	Umbrella Thorn (tree)	Ingoka / Umsasane (Ndebele) Mzunga / Nyoswa (Nyanja)
Diospyros mespiliformis	African ebony /Jackal Berry (large tree)	Mchenja / Mvimbe (Nyanja)
Faidherbia albida	Ana-tree / Apple-ring (large tree)	Musangu / Musenga (Shona) Umpumbu (Ndebele) Nsangusangu / Mtubetube (Nyanja)
Ficus sur	Broom Cluster Fig (tree)	-
Ficus sycamorus	Sycamore Fig (tree)	Mukuyu / Muonde (Shona) Umkhiwa (Ndebele) Mkuyu (Nyanja)
Hyphaene petersiana	Vegetable Ivory (tall palm tree)	Murara /Muzira (Shona) Ilala (Ndebele) Kakoma / Mlala /Mlaza (Nyanja)
Nuxia oppositifolia	Water Elder (shrub)	Rutsanzuti (Shona) Ihlotshane (Ndebele)
Strychnos potatorum	Black Bitterberry (tree)	Mudanhapfunye (Shona) Umlombelombe (Ndebele) Msimbiti (Nyanja)

Cultivated, Urban and Industrial Areas

Cultivated and urban areas are zones of high disturbance and are characterised by a decrease in biodiversity and indigenous plants and an increase in weedy and invasive species. The alien shrub, *Lantana camara* is an invasive species in the Rain Forest and side gorges near Victoria Falls, in the moister areas around Hwange town in Zimbabwe and also in Zambia.

The industrial zone around Hwange town is subjected to high levels of air and water pollution from the coal mines and the Hwange thermal-coal power station.

Considerable areas of cultivation exist within the Project area. The peripheries of the Kalahari Sand habitats are extensively cultivated outside of protected areas (*Figure 8.18*), to take advantage of the water seepage from the sands. The transmission line evacuating electrical power into Zambia passes through extensive areas of cultivation from approximately 60 km outside of Livingstone all the way to the town of Choma. These cultivated areas have little biodiversity value.

The Victoria Falls Master Plan (2002) drew upon the findings of the IUCN 1996 Strategic Environmental Assessment (SEA) report and attempted to rationalise the urban and industrial developments, and expansion of tourist facilities in Victoria Falls and Livingstone, but this Plan has not been implemented (S. Childes, *pers comm*.).

IUCN Red Listed, Rare and Endangered Plants

The IBAT database lists one highly threatened plant species, *Nymphoides tenuissima*. This is a waterlily considered unlikely to be present in the fast flowing conditions that characterise the Batoka Gorge.

A checklist of Zimbabwean vascular plants (Mapaura and Timberlake, 2004) was analysed for all species recorded from the north and west of the country. The IUCN threatened status of those species that are known or likely to occur in the study area were examined according to the online Flora Zimbabwe and the IUCN Red List databases (both accessed in 2015).

Four critically endangered species could occur, with one species (*Jamesbrittenia zambesica*) confirmed within the Batoka Gorge. One vulnerable species is also known to occur in the Batoka Gorge. Given that there has not been any comprehensive survey of the ferns, succulents and forbs in the Batoka Gorge, it is possible that several species may have been missed. *Table 8-14* summarises the findings of the desktop review.

Table 8-14 Rare and Threatened Plant Species potentially occurring in the Study Area (SABONET, 2003)

Species (English Name)	Growth Form	Flora Zimbabwe	Habitat / Comment
Croton leuconeurus	Shrub	CR	May occur. Occurs in the riparian belt upstream of the Victoria Falls
Homalium abessammadii (Zambezi Brown-ironwood)	Shrub	CR	Known to occur in the riparian belt upstream of the Victoria Falls.
Jamesbrittenia zambesica	Forb	CR	Rare. Known from only one specimen in Batoka Gorge
Ochna afzelioides	Shrub	CR	May occur
Euphorbia decidua	Succulent	EN	May occur
Acanthosicyos naudinanus	Creeper	VU	May occur
Acacia hebeclada subsp. chobiensis	Shrub	VU	Known to occur upstream of Victoria Falls
Cyclantheropsis parviflora	Creeper	VU	May occur
Euphorbia fortissima	Succulent	VU	Batoka Gorge and side gorges
Geigeria schinzii	Forb	VU (Endemic)	May occur
Huernia hislopii subsp. robusta	Succulent (Stapeliad)	VU (Endemic)	May occur
Maerua salicifolia	Shrub/tree	VU (Endemic)	May occur
Asplenium sebungweense	Mesic fern	NT	May occur, not confirmed
Baikiaea plurijuga (Teak)	Tree	NT (IUCN: NT)	Kalahari sand woodland. Threatened by logging, carving and agriculture
Dalbergia melanoxylon (Zebrawood)	Tree	NT (IUCN: NT)	Mixed Deciduous Woodland. Threatened by wood carving
Aristida brainii	Grass	DD (Endemic)	May occur
Danthoniopsis petiolata	Grass	DD	Range restricted. Batoka Gorge and side gorges
Eragrostis glischra	Grass	DD (Endemic)	May occur
Orbea (Pachycymbium) lugardii	Succulent	DD	May occur
Rhus (Searsia) lucens	Shrub	DD	Range restricted. Batoka Gorge and side gorges.
Afzelia quanzensis (Pod Mahogany)	Tree	LC	Mixed Deciduous Woodland. Threatened by logging, wood carving and agriculture
Euphorbia cooperi var. *calidicola* (Candelabra Euphorbia)	Succulent	LC	May occur
Orbea (Pachycymbium) schweinfurthii	Succulent	LC	May occur
Selaginella imbricata	Poikilo-hydrous fern	LC	Batoka Gorge and side gorges
Strophanthus nicholsonii	Shrub/climber	LC	Known to occur near Hwange on basalt and gneiss
Xylopia odoratissima (Kalahari Bitterwood)	Shrub/ tree	LC	May occur

IUCN status refers to the IUCN Red List (2015)

For a full list of the IUCN categories for these plants, please see *Annex F*.

In Zimbabwe, all Aloe and epiphytic orchids species are listed as Specially Protected Species (Parks and Wildlife Act Chapter 20:14, 1996). Many aloes occur on the sides of the Batoka Gorge and a limited diversity of orchids are expected in the riparian vegetation of the Batoka Gorge.

8.3.7 *Assessment of Biomass and Carbon Values*

The 1998 ESIA report applied an allometric equation developed by Guy (1981) for vegetation in Sengwa, an area south east of the project site in Zimbabwe that contains species of woody plants that are common to both countries. The biomass of the Side Gorges and Zambezi riparian zone were calculated to be 30 Mg/ha (or 30,000 kg/ha).

With the recent increased interest in carbon fixing and carbon values, several other authors have estimated biomass and carbon values for areas similar to the project site. Frost (1996) developed the following regression equation based on the relationship between rainfall and biomass, using data collected from miombo woodlands in Zambia and Zimbabwe:

$Y = 0.14X – 56.21$
Where:
Y = above ground biomass in Mg or tonnes/ha; and
X = annual rainfall in mm.

Frost (1996) calculated the above ground biomass for mixed age, old growth miombo woodlands to be 55 Mg/ha which is the equivalent of 25.85 tC/ha.

Table 8-15 Biomass and Carbon Estimates for the Project Area and Adjacent Areas

Project Area	Rainfall Station	Mean annual Rainfall (mm)[1]	Predicted Biomass Mg/ha	Predicted Carbon value (tC/ha)[2]
Binga	Binga	731.7	46.2	21.7
Sengwa	Siabuwa	645.5	34.2	16.1
Sengwa	Gokwe	762.7	50.6	23.8
Batoka	V Falls	657.2	35.8	16.8
Batoka	Hwange	560.0	22.2	10.4

[1] http://www.climate-charts.com/Locations/z/ZI6700000MK47690.php
[2] assuming Carbon is 47% of dry biomass

Table 8-15 shows the predicted biomass for Binga, Siabuwa and Gokwe, which are sites outside the project area but support similar soils and vegetation. Using rainfall data for the two towns within the project area: Victoria Falls and Hwange, the estimated above ground biomass for general vegetation based on Frost (1996) within the study area ranges from 22.2 – 35.8 Mg/ha which translates to 10.4 -16.8 tC/ha. This is lower than the miombo woodlands and lower than that found by Ryan, Williams and Grace (2011) who reported 21.2 tC/ha for woodlands in Mozambique. A higher biomass would be expected in Mozambique due to the higher rainfall levels there.

On the shallow basalt derived soils, which carry a medium-low density of woody plants per hectare, these values appear to be fairly consistent for most of the project area. The Kalahari Sand woodlands should yield a carbon value similar to that of miombo woodlands and the Gokwe site but the *Baikiaea* woodlands in the Project area have been logged and subjected to fire, so the carbon values are probably lower than expected.

The estimated biomass value in the 1998 report therefore correlates fairly well with published values. However, given the density of the wood of the dominant riparian species, *Diospyros mespilformis* (Jackal Berry), the value of 30Mg/ha = 14.1 tC/ha in the 1998 report is definitely an under-estimation for the Zambezi riparian woodlands and woodlands in the side gorges.

8.3.8 Faunal Communities

The 1998 report noted that the area around the Batoka Gorge did not appear to support major populations of large wild mammals, and in the 1997 aerial survey of 300 km^2 around the proposed BGHES dam site, only domestic livestock were seen. Anecdotal evidence indicated that the only significant populations of large mammals were seen east of the Kanyembezi River, 25 km downstream of the dam site (this is now known as Sidinda Ward in Hwange Communal Land). Some of these animals moved in and out of the rugged, uninhabited country west of the Gavu River in the south of the Project area.

The report uses the term wildlife to refer to all wild animals including birds, reptiles and amphibians and mammals, but excludes fish and invertebrates. The 1998 wildlife report listed the mammals, birds, reptiles and amphibians that were either recorded or were likely to occur in the Batoka Gorge, and adjacent Project area. Protected Species and Red Listed species were specifically noted. Mention in the 1998 report was made of the tourism potential of wildlife, but with the comment that this would need careful planning to take into account the increasing size of the surrounding settlements. The key faunal groups of conservation concern were the raptors and other birds that nest in the Batoka Gorge, and the bats. This importance was re-iterated in the recent 2014 ERM Inception Report.

The first aim of this study was to verify presence or absence of wildlife species and their status in the ecological AoI, through a combination of limited ground truthing, desktop data review, and engagement with local wildlife specialists.

The second aim of this study was to update the status of the raptor populations in the Batoka Gorge, with the emphasis on the Taita Falcon and to gather more information on the bat species.

Large Mammals

The focus of this section of the report is upon those species that are considered vulnerable or under threat and that are known to occur, or are likely to occur, in the Project area.

IUCN Red Data Species and CITES Species

Table 8-16 lists the large mammals that are known to occur in the Project area, or that occur in sites immediately adjacent to the Project area.

Table 8-16 ***Large Wildlife Species Potentially Occurring in the Project Area with their IUCN Threatened Status, Protected Status and CITES-listed Status***

Family	Species (and Common Name)	Threat Status	Protected Species	CITES Listed	Current Status in Greater Project Area
MANIDAE	*Smutsia (Manis) temmincki* Pangolin	VU	Both	x	Scarce, restricted to areas of protection
RHINOCEROTIDAE	*Ceratotherium simum* White Rhinoceros	NT	Both	x	Introduced to Mosi-oa-Tunya Nat. Park
RHINOCEROTIDAE	*Diceros bicornis* Black Rhinoceros (IBAT)	CR	Both	x	Restricted to areas of protection
CANIDAE	*Lycaon pictus* African Wild Dog (IBAT)	EN	Both	x	Scarce, restricted to areas of protection
FELIDAE	*Acinonyx jubatus* Cheetah	VU	Both	x	Scarce, restricted to areas of protection
FELIDAE	*Panthera leo* African Lion	VU	-	x	Present, some protected areas and occasional vagrants
FELIDAE	*Panthera pardus* Leopard	VU	-	x	Widespread but uncommon
FELIDAE	*Felis silvestris* Wild Cat	LC	-	x	Widespread
HYAENIDAE	*Crocuta crocuta* Spotted Hyaena	LC	-		Present in protected areas, scarce elsewhere
HYAENIDAE	*Proteles cristata* Aardwolf	LC	Both	x	Present in protected areas, scarce elsewhere
MUSTELIDAE	*Mellivora capensis* Honey Badger	LC	-		Present in protected areas, scarce elsewhere
BOVIDAE	*Damaliscus lunatus* Tsessebe	LC	Zambia		Restricted to protected areas
BOVIDAE	*Hippotragus equinus* Roan Antelope	LC	Both		Scarce, restricted to protected areas
BOVIDAE	*Kobus ellipsiprymnus* Waterbuck	LC	-		Restricted to protected areas
BOVIDAE	*Syncerus caffer* African Buffalo	LC	-		Restricted to protected areas
GIRAFFIDAE	*Giraffa camelopardalis* Giraffe	VU	Zambia		Restricted to protected areas
HIPPOPOTAMIDAE	*Hippopotamus amphibius* Hippopotamus	VU	-	x	Present above Victoria Falls and present within Batoka Gorge
ELEPHANTIDAE	*Loxodonta africana* African Elephant	VU	Zambia	x	Present in protected areas and occasional migrants elsewhere

Threat. Status refers to the IUCN Red List of Threatened Species (accessed in Nov 2014). Key to the categories: CR = Critically Endangered; EN = Endangered; VU = Vulnerable; NT = Near Threatened; and LC = Least Concern (Lower Risk);

IBAT refers to those species listed as species of concern in the IBAT report (Appendix …)

Key to Protected Species: Zambia = Protected species in Zambia only; Both = Protected species in both Zambia and Zimbabwe

Many of the above mammal species do occur, or could potentially occur in the Project area and immediate surounds, however none of these species are considered heavily dependent on the Batoka Gorge habitat.

Of the 18 species on the IUCN Red Data List, six are listed as Specially Protected Species under the Zimbabwe Parks Act (1996), 10 species under the Zambian National Parks and Wildlife Protected Species (1993) and eight species are also protected under the Convention for International Trade in Endangered Species (CITES), which controls the export of these animals and their products (*Table 8-16*).

Summary of Large Mammals and their Distribution Around the Project Area

<u>Rhino</u>

Whilst the critically endangered Black Rhino no longer occurs in the Project area, there is a small population on a private game ranch adjacent to the Victoria Falls National Park in Zimbabwe. The Mosi-oa-tunya National Park in Zambia is home to eight White Rhino, which have bred from a re-introduction in 2008, of four animals from South Africa. White Rhino are not indigenous to Zambia.

<u>Elephant</u>

The aerial elephant censuses of north west Matabeleland has been conducted intermittently over a series of years from 1980 to 2001, but did not survey the Project area or the Hwange Communal Lands due to the low density of elephant there. Dunham (2002) reported that the elephant density in 2001 for the Matetsi complex (comprising the Safari Area and adjacent Forestry Areas) was 0.95/km^2. The density in the communal land is probably less than this. Reports from a local safari operator indicate that the resident breeding herds in the Gwayi and Matetsi river valleys are declining through a combination of loss of habitat and high levels of hunting under the guise of Problem Animal Control (PAC).

There is seasonal movement of elephant through the eastern and southern sections of Hwange Communal Land in Zimbabwe as they move up and down the Matetsi and Deka river systems. In the western part of the Project area, elephant move in and out of Fuller Forest and Zambezi National Park into the communal land.
Spoor of elephant (several months old) was noted on the Matetsi River as well as in the southern parts of the Zimbabwean component of the proposed transmission lines routes.

<u>Hippopotamus</u>

These animals are found in the eastern section of the Project area downstream of the Batoka Gorge, where the river widens and there are extensive reedbeds and grazing on the shoreline. Spoor of hippo was seen in this area during field visits, but safari operators report that populations have declined to 20 % of the level they were in the 1990's under pressure of poaching in Zambia and Zimbabwe. Conflict arises where the hippos' habitat is replaced by agricultural fields, and snaring is common.

Lion

Lion are also periodically reported to move through the area but are not resident. Since most of the populations of their prey species have been considerably reduced in the past two decades (see below), lion numbers have declined.

Cheetah

These animals very occasionally move through the western section of the Project area, in and out of the Parks and Fuller Forest.

Pangolin

These are known to occur in the area but are rarely seen and there is no estimate of the populations. The species is under a rapidly increasing threat from illegal trade to Asia.

Status of Other Large Mammal Species

The declining trend in wild herbivore populations is clearly reflected in the status of the buffalo. In the 1990s, there were approximately 250 resident buffalo in the Sindinda and Matetsi river valleys. All have gone now, except for the occasional transitory bulls along the boundaries of Matetsi and Deka Safari Areas (M. Butcher, pers comm.).

There was a translocation of about 200 impala from Sinamatella into the Sidinda Valley in the 1990s but this population has dwindled to about 30 individuals in 2013. Only a few Kudu and Waterbuck remain in the Sidinda Valley and the resident herds of Sable and Zebra have disappeared. Whilst some of the smaller antelope: duiker, grysbok, klipspringer, bushbuck still occur, their numbers have also decreased in the past 20 years, due to a combination of poaching and habitat loss.

Field Observations

In Zimbabwe, it was quite apparent that the wildlife populations within the northern section of the study area are severely depleted and no evidence (visual sightings, spoor or dung) was noted. There is a high density of domestic livestock: goats, cattle and donkeys around the settlements.

Closer to the BGHES site, signs of smaller mammals such as spoor of porcupine, African civet, baboon were noted and duiker and rock hyrax were seen. Klipspringer was seen in the Batoka Gorge in the vicinity of the dam site.

Although this site is fairly remote from settlements, there was sign of cattle grazing and there has been widespread hunting by local villagers.

In Zambia, the situation is similar: there was no evidence of large wild mammals during the field visit. Settlements are localised around Mukuni village and there was widespread grazing of cattle and goats. With the rehabilitation of the access road to the Gorge, settlement is likely to spread along the roads, deeper into the wild area, thus further impacting negatively on wildlife numbers.

Human Wildlife Interactions

Various ecological and socio-economic impacts are associated with the presence of wildlife in an area that has growing human populations and subsistence agriculture. The fact that there is sometimes human-wildlife conflict shows that some wildlife still persists in the area, and therefore there is still some potential economic benefit to the wildlife. Opportunities for mitigating the human wildlife conflict are to generate an income from wildlife through various forms of tourism (such as photographic safaris and/or tourist hunting), promoting community based natural resource management practices (such as CAMPFIRE), use of wildlife deterrent strategies (such as chilli pepper to deter elephants), and discourage encroachment of human settlement and cultivation into existing wildlife habitats or migration corridors.

The patches of *Baikiaea* woodland along the Jambezi road and the remote parts in the south of the Project area are refuges for the wildlife. Periodic crop raiding and killing of livestock cause a conflict with local villagers. The level of conflict is sometimes exaggerated for several reasons, such as maximising potential compensation benefits. In order to obtain accurate data, a monitoring programme has been implemented by the Carnivore Research Unit (CRU) (A.Loveridge, pers comm.).

Table 8-17 shows the incidence of conflict between wildlife and humans within the whole of Hwange Communal Land. It is clear that elephant and lion create the greatest conflict but this has to be viewed in context. The loss of 66 cattle from 2011-2013 represents 0.12 % of the District's cattle population. Much of the conflict is focussed in the Matetsi Ward, which comprises former privately owned game ranches that have recently been re-settled through land reforms. Here, wildlife numbers are high and conflicts arise with the encroachment of settlement into the former wildlife habitats. The 2012 population census reveals that 3 369 cattle and 4 076 people are now found in this area, resulting in high human and wildlife conflict (Campfire, report, 2013).

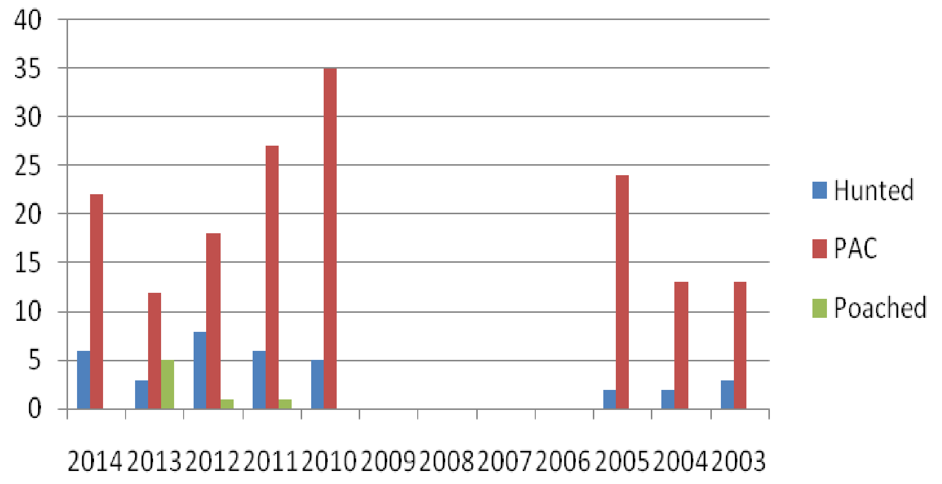
Table 8-17 ***Human Wildlife Conflict Statistics: Hwange District Council (HRDC) Number of Reports (1)***

Species	2011	2012	2013	Incident
Baboon	3	-	3	Crop raiding
Crocodile	-	4	-	Attacks: 1 human fatality
Elephant	114	95	129	Crop raiding: 2 human fatalities
Hippo	3	-	2	Crop raiding
Hyaena	-	1	1	Livestock raiding
Leopard	2	-	-	Livestock raiding
Lion	28	26	19	Livestock raiding

(1) Data from Campfire Association reports

The general reaction to reports of crop raiding or livestock raiding by wildlife is retaliatory hunting, known as Problem Animal Control (PAC). Significant numbers of animals are killed in this manner as illustrated in *Figure 8.29*.

Figure 8.29 ***Numbers of Elephant Killed through Hunting, Problem Animal Control (PAC) and Poaching based on Available Data (2003-2014)***



Source: Data from Campfire Association and HRDC. Data from 2006 to 2009 was missing.

Safari Hunting: Balancing the Conflict

Trophy hunting generates a significant income for the area and in addition to employment, and a supply of game meat, the revenue is split up into dividends for each ward, which are destined for community projects. A key species that attracts safari hunters is the elephant, while other draw card species are buffalo, lion and leopard. Consequently, with the decline in populations of these species, the income from safari hunting is also decreasing and there is little incentive for protection (*Table 8-18*).

Table 8-18 HRDC Campfire Dividends for Wards 2 to 10 sourced from the Campfire Association

Year	Income
2011	$ 20528.50
2012	$ 23947.35
2013	$ 18881.55

Small Mammals

Of all the small mammal species, it was clear in the 1998 report that there might be significant populations of Bats (Chiroptera) in the Gorge, and they are thought to migrate there on a seasonal basis. The combination of riffles and rapids in the river, with clefts and caves in the gorge sides, makes an ideal habitat for bats, proving both food and shelter. This potential importance was again raised in the recent 2014 ERM Inception Report. The 1998 report listed 35 bat species that were likely to occur in the Project area, and 11 of these were confirmed records from the survey within the Gorge. One bat species, *Otomops martiensseni,* Martienssen's Free tailed Bat was listed as Vulnerable (IUCN Red List, 1996 criteria).

The more recent IUCN Red List (2014) in *Annex F* shows the possible number of bat species to be 47, of which the populations of four species are known to be decreasing and two are listed as Near Threatened (NT):

- *Hipposideros caffer* (Sundevall's Roundleaf Bat);
- *Hipposideros vittatus* (Striped Leaf-nosed Bat);
- *Otomops martiensseni* (Large-eared Free-tailed Bat) Near threatened; and
- *Nycteris woodi* (Wood's Slit-faced Bat) Near threatened.

No bat surveys were undertaken in this current study due to timing constraints, however a bat monitoring programme is recommended as an action component of the Biodiversity Management Plan.

8.3.9 *Avifaunal Ecology*

The Batoka Gorge is listed as an Important Bird Area (IBA) of continental significance (Childes & Mundy, 2001) based on the presence of breeding Taita Falcons (*Falco fasciinucha*), a threatened and range restricted species (*Figure 8.30*). Other criteria for this classification as an IBA are that the Batoka Gorge also contains an important breeding population of the White collared or Rock Pratincole (*Glareola nuchalis*), and Black Stork (*Ciconia nigra*), and a high diversity of raptor species.

The IBAT database identifies 18 threatened bird species, which includes eight highly threatened species and two endemic range species (*Table 8-19*).

Table 8-19 Bird Species of Conservation Concern identified from the IBAT Database

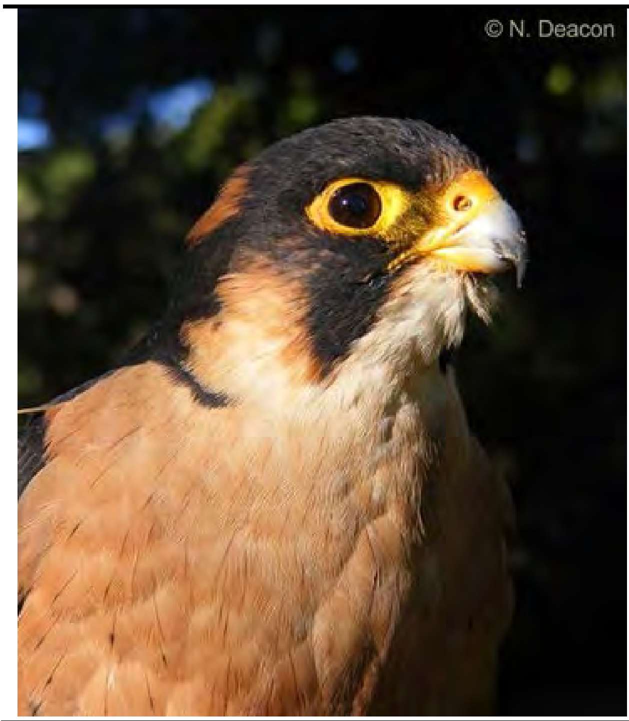
Scientific Name English Common Name	IUCN Red List Status	Relevance to this Study
Oxyura maccoa Maccoa duck	VU	Both species prefer wetlands, unlikely within Batoka Gorge but likely in surrounding areas
Egretta vinaceigula Slaty egret	VU	
Balearica regulorum Grey crowned-crane * #	EN	Tall elegant birds largely confined to wetland and grassland habitats, unlikely within the Batoka Gorge, but possible occurrence within the EAoI.
Bugeranus carunculatus Wattled crane	VU	
Gyps africanus White-backed vulture * #	CR	Vultures are wide-ranging birds attracted to large conservation areas where wildlife carcasses are available, and known to occur in the greater vicinity. Expected to occur within the Batoka Gorge where they are attracted to cliffs or large riparian trees
Gyps coprotheres Cape vulture * #	EN	
Necrosyrtes monachus Hooded vulture * #	CR	
Neophron percnopterus Egyptian vulture * #	EN	
Torgos tracheliotos Lappet-faced vulture * #	EN	
Trigonoceps occipitalis White-headed vulture * #	CR	
Polemaetus bellicosus Martial eagle	VU	Large raptor that breeds locally and preys on diversity of small to medium sized mammals. Likely to occur within the Batoka Gorge and the EAoI.
Aquila nipalensis Steppe eagle * #	EN	Non-breeding migrant attracted to carrion and favours dry savanna habitat. Unlikely to occur in the Batoka Gorge, but likely within the EAoI.
Aquila rapax Tawny eagle	VU	Large raptor that breeds locally, but similar foraging behaviour to the Steppe Eagle. Unlikely within the Batoka Gorge, but likely within the EAoI.
Falco fasciinucha Taita falcon	VU	Small rare falcon with specialised predation on small birds, reported to breed on cliffs of the Batoka Gorge. Known to still occur, but uncertainty regarding the local population status.
Sagittarius serpentarius Secretarybird	VU	Largely terrestrial raptor that favours open habitat. Unlikely within the Batoka Gorge, but likely within the EAoI.
Bucorvus leadbeateri Southern ground-hornbill	VU	Largely terrestrial bird that forages on diversity of prey. Largely restricted to conservation areas, unlikely within the Batoka Gorge, but possible occurrence within the EAoI.
Lybius chaplini Zambian barbet	VU	Woodland birds nesting in holes that require availability of medium to large trees. Possible occurrence in both the Batoka Gorge and EAoI.
Agapornis nigrigenis Black-cheeked lovebird *(RR)*	VU	
Anthus hoeschi Mountain Pipit *(RR)*	NT	The pipit survives as a small population in Lesotho and northwestern Zambia, and potentially passess

Scientific Name English Common Name	IUCN Red List Status	Relevance to this Study
		through the project area on route between these areas. Not dependent on the project area.

Key: RR – Range restricted; EAoI – Ecological Area of Influence.
IUCN Red List Status: CR – Critically Endangered, EN – Endangered, VU – Vulnerable, NT – Near Threatened.
* - Highly threatened species (Endangered or Critically Endangered);
# - Wide-ranging species

Many of the above bird species are known to expected to occur within the Batoka Gorge and/or the within the Ecological Area of Influence. It is noted that all of the highly threatened species can be considered to be wide-ranging species, which has an implication for recognition of critical habitats.

Figure 8.30 Adult Taita Falcon



General Ecology and Raptor Diversity

The ecological significance of the Batoka Gorge is that it represents an isolated cliff and gorge habitat in a landscape that is broadly dominated by woodland vegetation. The nearest equivalent habitat is approximately 300 km away on the Gwayi River in Zimbabwe. Amongst the 38 raptor species that occur in the Batoka Gorge and the vicinity, 15 species are recorded to breed within the confines of the Gorge itself. Four of these species are dependent on cliffs for breeding sites and this is the preferred habitat for a further two species. Three of these cliff dwelling raptors not only rely on cliff habitat for breeding but are also confined to the gorge system on ecological grounds since their prey is also predominantly limited to within the Gorge. On the other hand, nine of the raptor species that breed within the Gorge utilize trees. This is primarily related to nesting requirements as few southern African raptor species exhibit absolute loyalty to specific vegetation types and none of these occur within the Batoka Gorge. Amongst the total 38 recorded raptor species, three are listed by the IUCN Red List as Critically Endangered, three are listed as Endangered, and four species are Vulnerable with extinction. Additionally 17 species are designated as Specially Protected in terms of the Zimbabwe National Parks Act. The Zambian Protected Species list includes all falcons, eagles, hawks, buzzards and owls.

Cliff Dependent Raptors

The sensitivity of populations of certain cliff dwelling raptor species, specifically African Peregrine (*Falco peregrinus minor*) and Taita Falcons were highlighted in previous assessments of the potential impacts of developing the BGHES. In contrast, the African Peregrine Falcon is considered to have made a full recovery following dramatic population declines as result of the impact of D.D.T. and Dieldrin poisoning, and is consequently of lesser conservation concern. There are an additional four cliff dwelling raptor species, including Spotted Eagle-owl (*Bubo africanus*), Verreaux's (Black) Eagle (*Aquila verreauxii*), Augur Buzzard (*Buteo augur*) and Lanner Falcon (*Falco biarmicus*), that are known to have bred in the Batoka Gorge. Lanner Falcons are relative newcomers to the Gorge with the first nest site recorded in 2001 (Hartley & Deacon) and by 2005 there were two pairs of Lanner Falcons in the first 12 km (Middleton & Middleton, *pers comm*.). Occupation of the Gorge by Lanner Falcons may not have been considered in previous impact assessments and is significant as it potentially affects the nesting dynamic of Peregrine Falcons and Taita Falcons. The recent appearance of Lanner Falcons in the Batoka Gorge is also indicative of degradation or at least a change in the surrounding environment, as this quintessential desert falcon is a generalist hunter with a wide prey base, and greater adaptability than either Peregrine or Taita Falcons. Elsewhere in Zimbabwe, deforestation and environmental degradation has resulted in replacement of Peregrines by Lanner Falcons with the latter occupying traditional Peregrine Falcon nest sites. However, in the Batoka Gorge the presence of Lanner Falcons appears to have coincided with a decrease in the number of Taita Falcons as the number of Peregrine Falcon territories has remained stable and current population is estimated at 9-10 pairs in the first 25 km of the Gorge, so is unchanged from previous estimates, despite the presence of Lanner Falcons.

Taita Falcons (Falco fasciinucha)

Despite a wide distribution that spans from the Taita Hills in Kenya to northern South Africa, the global population of the Taita Falcon is estimated to be 300 pairs or less, the IUCN Red List quotes Jenkins *et al.* (2008) stating there are "probably substantially fewer than 500 breeding pairs". The absence of the Taita Falcon from its known distribution in East Africa has increased the importance of southern African populations for the conservation of this species. Hartley's 1995 estimate of 50-60 pairs in Zimbabwe is based upon 23 active nest sites, included 8-10 pairs in the Batoka Gorge. The estimate for the Batoka Gorge, based upon a combination of individual sightings and active nest sites surveyed from 1984 to1995, was later reduced to a maximum population of 8 pairs, and probable population of six pairs nesting above the proposed BGHES dam site. This still represented the highest density of Taita Falcons anywhere in its known range and suggested that the Batoka Gorge was a key stronghold for this species. However, review of Zimbabwe Falconer's Club unpublished annual Batoka Gorge Survey Records from 2000 to 2007 indicated much lower Taita Falcon density (Deacon, 2008). These data indicated a decline in the Taita Falcon population to only two pairs in the first 25 km of the Gorge downstream of the Victoria Falls. This estimate was based upon records of observed breeding activity at two nest sites in 2000 and a combination of observed breeding activity at one nest sight and consistent sightings of individuals in another section of the Gorge, particularly in 2006 and 2007. A recent survey (2013) of the Batoka Gorge did not yield any sightings of Taita Falcons in the first 14 km of the Gorge, however this was considered inconclusive as it was conducted outside of the peak breeding season, so greatly reduced the likelihood of observing this reclusive species. Further surveys were conducted in 2001 and 2004, but yielded only a suspected sighting of an individual falcon in 2004. Furthermore, it is noted that Taita Falcon breeding activity was not subsequently confirmed at any of the five potential falcon nest sites in the lower section of the Gorge identified in the 1998 EIA report.

A 2018 joint survey (1) of the upper 25 km stretch from the edges of the Batoka Gorge by the Wildlife Departments of both Zambia and Zimbabwe conducted from the gorge edge and by boat yielded a single confirmed Taita Falcon sighting, but no evidence of breeding was found.

The status of Taita Falcons in the 30 km section of the Batoka Gorge upstream of the proposed BGHES site remains a significant gap as this part of the Gorge has still not been adequately surveyed. A suggested approach to address gaps is presented in *Chapter 10*.

(1) Wildlife Departments of Zambia and Zimbabwe. 2018. Joint Report on the Reconnaissance Survey for Status of Taita Falcon(*Falco fasciinucha*) and Rock Pratincole (*Glareola nuchalis*) In the Batoka Hydro Electric Project Area. Report issued to the Zambezi River Authority.

Figure 8.31 Cliff Potholes in the Batoka Gorge are Nesting Sites for Taita Falcons and other Raptors

Photo: N. Deacon

While the actual causes of the observed decline of the Taita Falcon in the Batoka Gorge are unknown, there are number of factors that may have affected the success of this species. Levels of human disturbance within the Gorge have increased substantially over the last decade and highly invasive activities such as helicopter tours conducted within the confines of the Gorge could be especially detrimental to Taita Falcons. Since helicopter tours may run the whole length of the Gorge, all nest sites are equally disturbed irrespective of their location. Low key activities such as white water rafting also make extensive use of the Gorge; however this activity is confined to the floor of the Gorge so is unlikely to have a disturbance effect on Taita Falcon nesting activity which is generally around the upper part of the cliffs. Other tourist activities such as the "Gorge Swing" are confined to the section of the Gorge immediately below the Victoria Falls, therefore have limited impact on most of the Taita population. However, at least one Taita Falcon nest site may have been impacted by these activities. Undoubtedly human activity also affects the other falcon species but both Lanner and Peregrine Falcons are perhaps more tolerant of this, having shown the adaptability to nest even on buildings in the city centre of Harare (Tanser *et al.* 2002). As indicated previously, the presence of Lanner Falcons has potentially changed the falcon nesting dynamic within the Gorge. There are records of both Peregrine and Lanner Falcons occupying Taita Falcon nests in the sub-region and the Taita Falcon as a species is definitely subservient to both these larger falcons, although they seem able to co-exist better with Peregrines than with Lanner Falcons.

It is likely that the colonies of swifts (*Apus sp.*) and rock martins (*Hirundo spilodera*) are the predominant food source for Taita Falcons in the Batoka Gorge. These are in turn dependent on aquatic insect fauna biomass that is associated with the riffle and rapid habitats along the river. There is concern that the loss of riffle and rapid habitats resulting from inundation of the reservoir will reduce the populations of swifts and rock martins with a knock-on effect to Taita Falcons.

Verreaux's Eagle (*Aquila verreauxii*) and Other Raptors

There are currently at least three breeding pairs of Verreaux's Eagles in the first 25 km stretch of the Gorge below the Victoria Falls. This number is lower than that indicated in the 1998 EIA report, which reported five breeding pairs over the same distance. The reason for this change is unknown, although breeding failure at chick stage seems to be an annual problem in recent years (Tirran, pers. comm). Since this species is essentially confined to patrolling the Gorge on account of its preferred prey, it is possible that disturbance from helicopters would affect its ability to hunt effectively as well as disturb breeding efforts. Since Verreaux's Eagles prey mainly (50-90 %) upon Rock Hyrax (*Procavia capensis*) and Yellow spotted Hyrax (*Heterohyrax brucei*), populations of these animals strongly influence density of these eagles.

The Bat Hawk (*Macheiramphus alcinus*) is perhaps one exception amongst this group of raptors in that it relies heavily upon the Gorge for its' primarily food source which as it name suggests is bats, but does not nest within the Batoka Gorge. The Gorge harbours large numbers of cave dwelling bats, which provide a consistent food source for this species. One active Bat Hawk nest site is known in the vicinity of the Gorge but typical nesting habitat of this species falls outside of routinely surveyed areas.

Other cliff dwelling species that are of low conservation concern are the Augur Buzzard and Spotted Eagle-owl. There has consistently been only one pair of Augur Buzzards recorded in the Batoka Gorge and the position of this nest site has been unchanged for more than 20 years.

Raptors associated with Riparian Habitat

As indicated previously, nine raptor species nest in trees within the Gorge. Amongst these it is only the species that depend on riparian vegetation, specifically large trees that are at any risk from development of the BGHES. Pel's Fishing Owl (*Scotopelia peli*) which has not been recorded as breeding, but is resident in the Gorge is ranked as Vulnerable. The previous 1998 EIA report records one pair of Crowned Eagles (*Stephanoaetus coronatus*) nesting in the Gorge approximately 3 km below the Victoria Falls. This pair subsequently abandoned this nest and it is unknown whether this species still breeds in the Gorge. The African Goshawk (*Accipiter tachiro*) is a species frequently associated with riparian forest, but is not dependent on this habitat alone having adapted to nesting in exotic trees.

Other Birds associated with Riparian Habitat

Rock (White-collared) Pratincole (*Glareola nuchalis*)

These are small, fast flying birds that inhabit and nest on the exposed rocks in the middle of fast flowing rivers where there is protection from predators. Rock Pratincoles feed predominantly on emerging aquatic insect larvae, such as caddisflies, that they forage from rocks midstream and on the margins of rivers. They are found along the Zambezi River, upstream of the Victoria Falls, and in the Batoka Gorge, Devil's Gorge, Kariba Gorge and Mupata Gorge. The impoundments of Lake Kariba and Cahora Bassa have greatly reduced the birds' habitat (Hockey *et al*. 2005). The species is an uncommon intra-African migrant that arrives late July-August as the water level drops and departs in December-January as the river rises and the rocks are flooded. Their non-breeding grounds are unknown.

The 1998 report noted a total of 103 birds in the Batoka Gorge, which represented 5.9 % of the 1986/87 total population estimate for the Zambezi from Katima Mulilo to the headwaters of Cahora Bassa (Williams *et al*. 1989). However the situation has changed in the past 26 years and the number of Rock Pratincoles currently (2014) utilizing the Gorge is estimated to be 500 individuals (D. Tirran, *pers. comm*). Approximately 300 Rock Pratincoles were counted above the Victoria Falls feeding on insect emergence following early rainfall in mid-October 2014. This individual count represents 28 % of the population estimated by Williams *et al*. (1989). Batoka Gorge is thought to have become an important refuge for Rock Pratincoles displaced by increased human disturbance through boating and fishing in the river above the Victoria Falls. Obviously, navigation of the Batoka Gorge by motor boats is not feasible, so the chance of disturbance from these sources is remote. However, white water rafting does constitute disturbance as their presence may panic immature Pratincoles resulting in them falling into fast flowing water. Rock Pratincoles are not confined to using rocky islands for nesting in the Gorge as individual pairs even select single in-stream boulders as nesting sites. This behaviour makes estimation of actual breeding population in the Batoka Gorge very difficult as counting breeding colonies results in underestimation of the population. Furthermore, counts of adult birds is reported to be a poor indicator of breeding activity as in one area a count of 42 adults represented 12 active nests (Williams *et al.*,1989). Even on these grounds, the Batoka Gorge could support at least 147 pairs of breeding Rock Pratincoles, although this figure could exceed 200 pairs (D. Tirran. *pers. comm*).

A 2018 survey (1) of transects within a 24 km stretch downstream of the Victoria Falls yielded a count of 53 Rock Pratincoles, and 26 birds in transects within a 11 km stretch upstream of the Victoria Falls. The report raises concerns about impacts of boats to Rock Pratincole, but the population does appear to be relatively stable.

(1) Wildlife Departments of Zambia and Zimbabwe. 2018. Joint Report on the Reconnaissance Survey for Status of Taita Falcon(Falco fasciinucha) and Rock Pratincole (Glareola nuchalis) In the Batoka Hydro Electric Project Area. Report issued to the Zambezi River Authority.

All surveys indicate that the Batoka Gorge is an important habitat for the conservation of this species, which is already one of regional conservation concern.

Black Stork (*Ciconia nigra*)

This large wading bird is an uncommon resident that is thought to have complex nomadic movements in the non-breeding season (Hockey *et al*. 2005). The 1998 EIA Report made brief mention of suitability of the Batoka Gorge for Black Stork nesting. One potential nest site was identified below the proposed BGHES dam wall site in the Chisi River Gorge on the Zambian side of the Zambezi River. Mention was also made of a pair of Black Storks seen near Songwe Gorge in the upper section of the Gorge. Current estimates indicate that there are at least six pairs of Black Storks nesting in the first 25 km of the Gorge below Victoria Falls. There are also additional individuals, which utilize the Gorge but may be non-breeding. The Black Stork's dependence on the Gorge is limited to providing suitable nesting sites for this species. Although Black Storks are restricted to using ledges and potholes on cliffs they feed in shallow water where they forage for a diversity of prey, including fish and amphibians. Around the Victoria Falls they feed away from the Batoka Gorge and are typically found at temporary water bodies, in particular pans, where they prey on stranded fish and other aquatic fauna (Tirran, pers. comm).

8.3.10 Herpetofauna (Reptiles and Amphibians)

The 1998 EIA report, quoting Broadley (1990), listed three species of terrapin, two species of tortoise, 22 lizards, 42 snakes and amphisbaenids and 24 frogs, together with one species of crocodile as either occurring or likely to occur in the Batoka Gorge and Victoria Falls region. Many of these species are widespread and comparatively common throughout the region, but the Four Corners herpetofaunal checklist (Broadley, 2004), noted the following significant species were present in or around the Project area.

Frogs (Amphibia)

Annex F (Table 1.2) presents an overview of the species that could potentially occur or have been confirmed as present in the Project area. Some of the important species are described below.

Poyntonophrynus (Bufo) fenoulheti fenoulheti (Dwarf Toad) is a small toad that occurs on or near rock outcrops, where it breeds in shallow pools. There is an isolated record from the Batoka Gorges in Zambia (Poynton and Broadley, 1988 in Broadley 2004), although the species is widespread in Zimbabwe.

Tomopterna cryptotis (Common Sand Frog). This sand frog breeds in ephemeral pans in the Kalahari Sands. Although widespread in the western parts of the Four Corners, it is considered Vulnerable in Zimbabwe, presumably through this destruction of its habitat.

Tomopterna mamoratus (Russet-backed Sand Frog). Associated with sand rivers, burying itself in the damp sand during the dry season. It is found along the Zambezi and its tributaries in Hwange District.

Hyperolius rhodesianus (Reed Frog). This Reed Frog, listed by IBAT, is range restricted and known only from the reedbeds along the Matetsi River in Hwange District. It is therefore likely to occur within the project area, but is unlikely to be adversely impacted.

Amphibaenids and Snakes

Dalophia pistillum (Blunt-tailed Worm-Lizard). This amphisbaenid inhabits Kalahari Sands and is listed as Vulnerable in Zimbabwe in the 1998 report.

Lycophidion variegatum (Variegated Wolf Snake). This snake is a small rare constrictor, which has been recorded in Livingstone, Zambia.

Psammophis jallae (Jalla's Sand Racer). This sand snake has a restricted range in the Four Corners *i.e.* Zimbabwe, Zambia, Botswana, Namibia and Angola.

*Python natalensis (*Southern African Python). This large snake is a Specially Protected Species in Zimbabwe. It frequents riparian habitats and rocky outcrops. Broadley (2004) notes that it is frequently eaten by man and has been exterminated in some parts of the Four Corners.

Varanus niloticus (Nile Monitor) and *Varanus albigularis* (Savanna Monitor) both occur in the Project area. These are listed species on Annex C2 of CITES.

Colopus wahlbergii (Wahlberg's Kalahari Gecko). This small burrowing gecko has a wide range in Kalahari Sand areas and has been recorded in Victoria Falls and Hwange National Park (Broadley and Rasmussen, 1995 in Broadley, 2004)

Nile Crocodiles (*Crocodylus niloticus*)

Nile Crocodiles occur throughout Upper Zambezi river system and probably constitute one of the most important large predators in the Batoka Gorge, feeding on fish, mammals and birds.

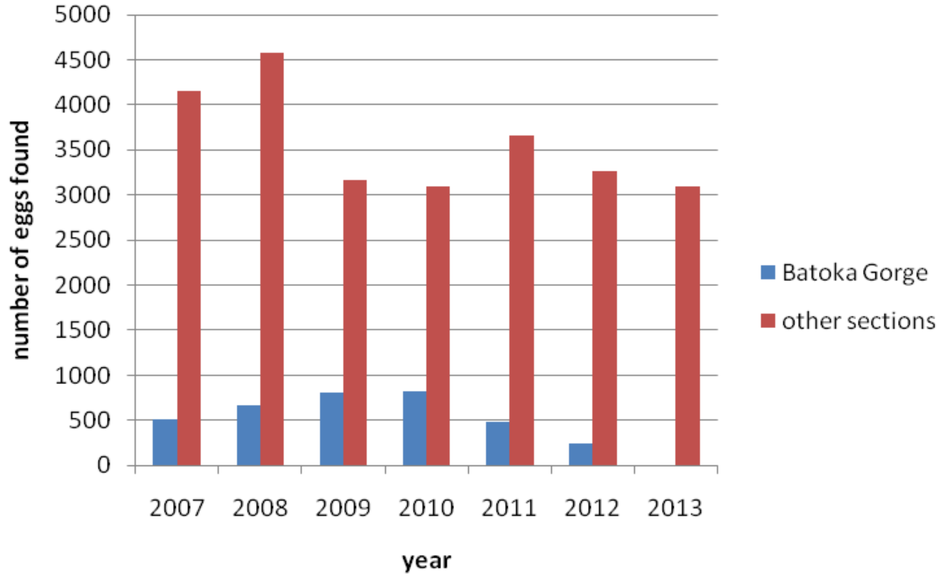
In Zimbabwe, crocodiles are listed on CITES Annex C2, meaning that export trade is regulated and monitored. In keeping with the concept of conservation through sustainable utilisation, crocodile eggs have been collected every year for the past three decades in Zimbabwe under a Parks and Wildlife Management permit. Payments are made to the relevant authority for the land, in this case, the Hwange District Council, as presented in *Table 8-20*.

Table 8-20 Payments for Collection of Crocodile Eggs by the Hwange District Council

Collection Year	USD Paid
2009	7 744.00
2010	11 760.00
2011	12 288.00
2012	10 476.00
2013	9 207.00

Figure 8.32 illustrates the changes in egg collection along the section of the Zambezi River from below Victoria Falls to the Devil's Gorge. The data specifically for the Batoka Gorge is shown separately. This data was provided courtesy of the Crocodile Farmers Association of Zimbabwe (CFAZ).

Figure 8.32 Numbers of Crocodile Eggs Collected in the Batoka Gorge and Downstream to the Devil's Gorge



Eggs have been collected over the past seven years from at least 20 nest sites within the Batoka Gorge, although the exact location of these sites relative to the proposed BGHES dam wall is not known.

The egg collection data provides a general index of the crocodile population status. Although there are several factors involved in interpreting the data, in particular the level of 'collection effort', it is clear that there is a slight decline in numbers. This is supported by anecdotal evidence from crocodile farmers and hunters who report increasing conflict with fishermen and nets, combined with the deliberate destruction of crocodile nests along the sections of river that are close to human habitation. The data does however suggest that a substantial crocodile population is present in the Project and the greater area.

8.4 AQUATIC ECOLOGY

8.4.1 *Present Ecological State (based on 2014 Environmental Flow Assessment)*

The BGHES EF (Environmental Flow) assessment concentrated on two sites on the Zambezi River between the proposed BGHES and Kariba Dam (*Table 8-21; Figure 8.33* and *Figure 8.34*). The sites were selected considering:

- Geomorphologically different river reaches;
- Biological variations along the length of the river;
- Different types and levels of impacts likely to be incurred as a result of BGHES location and operation; and
- Access and safety.

Table 8-21 EF Sites for the Batoka EF Assessment

Site No.	Site	Description	Coordinates
1	EF Site 1	Represents the Zambezi River in Batoka Gorge from downstream of the tailrace of the proposed BGHES to the end of the gorge	17°56'17.45"S 26°18'34.37"E
2	EF Site 2	Represents the Zambezi River from the end of Batoka Gorge to Lake Kariba.	18° 3'21.62"S 26°38'33.05"E

The flow regimes at the EF sites will be affected by BGHES in three main ways.

1. EF Site 1 (*Figure 8.34*) represents the Zambezi River within Batoka Gorge. It will be affected by releases from the BGHES tailrace. It will also be affected by the barrier effect of BGHES dam, which will have consequences as mentioned above and will also alter the thermal, sediment and physicochemical regimes along the river downstream of the dam.

2. EF Site 2 (*Figure 8.34*) represents the Zambezi River between Batoka Gorge and Lake Kariba. It will be affected by releases from the BGHES tailrace and by the barrier effect of BGHES dam and will be used to predict any anticipated recovery of the river ecosystem with distance downstream of the BGHES.

Figure 8.33 The Zambezi River between Victoria Falls and Lake Kariba, showing the approximate position of the BGHES, and EF Sites 1 and 2

Figure 8.34 Images of the Aquatic Assessment Sites with Locations illustrated in Figure 8.32

	
EF Site 1 in the Batoka Gorge at the site of the BGHES dam	EF Site 2 approximately 46 km downstream of BGHES and 3 km upstream of the full supply level of Kariba Dam

The data collected for EF Site 1 (*Figure 8.34*) adequately represents the Batoka Gorge from downstream of BGHES to the end of the gorge. In addition, although not evident in *Figure 8.33*, the backup of water from Kariba Dam occasionally extends to the Hwange Fishing and Boating Club, which is located approximately 3 km downstream of EF Site 2.

Present Day Ecological Condition of the EF sites

The Present Ecological Status of the sites is provided in *Table 8-22*, with discipline specific details available in Volume 2 of this report. In summary, the Present Ecological State of the Zambezi River within the study area is Category B (slightly modified from pristine condition). A small change in aquatic biota has taken place but the ecosystem functions are essentially unchanged.

The aquatic ecosystem of the Batoka Gorge retains viable assemblages of plant and/or animal species of largely native origin, and human activity has not essentially modified an area's primary ecological functions and species composition. The aquatic ecosystem of the Batoka Gorge therefore qualifies as a natural habitat based on criteria provided within the PS6 (paragraph 13).

Table 8-22 Present Ecological Status for the Batoka EF sites

Discipline	EF Site 1	EF Site 2
Hydrology	A/B	B
Geomorphology	A	A
Vegetation	A/B	B
Aquatic macro-invertebrates	A/B	A/B
Fish	A/B	B
Crocodiles	B	B/C
Total	**A/B**	**B**

Where: A or A/B represent conditions still in a Reference (Pristine) State;
B and B/C represent conditions slightly modified from the Reference Condition.

Hydrology

There are currently no artificial obstructions such as dams on the Zambezi River above the gorge and no major water abstraction. The Victoria Falls hydroelectric turbines operate as run-of-the-river with no storage, therefore water flows either over the falls or through the turbines with no effect on river level downstream. The flow regime is therefore close to pristine at EF Site 1.

At EF Site 2, there is some abstraction for water to Hwange and surrounding areas, but there are no available river data to assess the extent of the impact of this abstraction. Presumably its biggest effect is on the dry season flows, particularly in dry years, in the reach represented by EF Site 2. For this reason the present status of the hydrology at EF Site 2 was set at a B-category.

Geomorphology

The present ecological condition of the geomorphology at each EF site was assessed using the South African Department of Water Affairs' Geomorphological Assessment Index (GAI) Level 4 EcoStatus assessment tool (Rowntree and du Preez, *in press*).

The geomorphology at EF Site 1 is a Category A. This very high score is due to the fact that there are no large dams and thus relatively minor changes to flow upstream of Victoria Falls (i.e. upstream of the site), any changes in sediment loads are also similarly relatively small and, moreover, are attenuated in the large wetlands and slow flowing depositional areas of the upper Zambezi. Furthermore, the gorge in which EF Site 1 is located is insensitive to small-scale changes in sediment and flow due to its resistant, bedrock dominated morphology.

The geomorphology at EF Site 2 is a Category A. This high score is due to the fact that there are relatively minor changes to flow upstream of the site through the gorge or above Victoria Falls; any changes in sediment loads are similarly relatively small and are attenuated in the large wetlands and slow flowing depositional areas of the upper Zambezi. The reach where EF Site 2 is located is only moderately sensitive to changes in sediment and flow due to the widespread resistant bedrock outcrops alongside and within the channel. There is a small degree of degradation to the geomorphology at EF Site 2, but this is from on-site (non-flow related) bank disturbances associated with landuse activities. The small pockets of riparian agriculture on the Zambian side and recreational/residential encroachment into the upper riparian areas on the Zimbabwean side would have very slightly reduced the integrity of the riparian vegetation and bank stability.

Vegetation

The Vegetation Response Assessment Index (VEGRAI) (Kleynhans *et al.* 2007) was used to assess the condition of the riparian vegetation at each EF Site [(1)]. The method compares the present day condition to that which would be expected under natural (reference) conditions, and considers how past impacts may have influenced the ecological condition over time. The reference condition was taken from ZRA (1998).

At EF Site 1, there were no obvious disturbances to the ecological condition of the riparian area, which scored an Ecological Category A/B. At this EF Site the riparian area was narrow and patchily distributed along the edge of the gorge. The marginal zone normally comprises a mixture of graminoids (such as reeds and sedges) and small trees (such as figs or willows) but here the marginal zone was sparse. There were some marginal graminoids present on lateral bars (of alluvial sand) downstream of this EF Site but overall these constitute a small proportion of the gorges riparian flora. The non-marginal zone was narrow and comprised a mixture of trees, shrubs and their saplings, indicative of healthy relationship between the natural flow regime and the life histories of the plants.

At EF Site 2, there were few disturbances to the ecological condition of the riparian area, and was allocated an Ecological Category of B. In contrast to EF Site 1, both the marginal and non-marginal zones of the riparian area were well established. The marginal zone comprised a mixture of marginal graminoids (such as reeds and sedges) and small trees (such as figs or willows). The population of trees and shrubs of the non-marginal zone comprised a mixture of adults and saplings, indicative of a healthy relationship between the natural flow regime and the life histories of these plants. The only visible impacts were related to use of woody plants for firewood or construction material; grazing of saplings or reeds in the marginal area; and the presence of one alien species (Sesbania sesban).

Aquatic Macro-invertebrates

Little is known about the aquatic macro-invertebrate in the mid-Zambezi system, however the area is reported to support a rich diversity (Suhling *et al.* 2004, 2009), and is important for the conservation of Odonata (Dragonflies) diversity.

Aquatic macro-invertebrates were collected at EF Sites 1 and 2, and identified to family level according to the Zambian Scoring System (ZISS) biomonitoring method (Lowe, 2012). The ZISS method was developed for aquatic macro-invertebrates expected in streams and rivers in Zambia. The ZISS is similar to the South African Scoring System version 5 (SASS5) (Dickens & Graham 2002), but the sensitivity scores have been adjusted and taxa added to account for the regional differences.

(1) Please note: this method does not take plants of the aquatic zone into account.

At both EF Site 1 and EF Site 2, many sensitive taxa were recorded. The diversity and the average sensitivity score per taxon were high, although slightly lower than expected under undisturbed conditions. No single taxon was dominant. Therefore, the PES was rated as Category A/B (very slightly impaired).

Crocodiles

The crocodile populations in the middle Zambezi River were near extinction in the 1950s, but concerned protection resulted in a considerable recovery (IUCN 1989). Nonetheless, it is likely that wild populations at EF Site 1 and 2 are depressed relative to natural levels as a result of conflict between humans and crocodiles (at EF Site 2) and direct pressure from egg collections to stock the nearby crocodile farm. Thus, the condition of the crocodile populations in the reach represented by EF Site 1 was assigned a Category B and that at EF Site 2, a Category B/C.

Fish Ecology (2014 Assessment)

The fish fauna in the Middle Zambezi River between Victoria Falls and Lake Kariba is naturally depauperate (Jackson 1961; Minshull 2010; Marshall 2011) because of the character of the river. The river flows through the steep-sided rocky Batoka Gorge, and below that it is a 'sandbank' river with marked seasonal flow and a resulting paucity of weed cover. Sampling in the Middle Zambezi River before and during the construction of Kariba Dam yielded only 22 species (Jackson 1961), in marked contrast to the 80+ species found in the 'reservoir' type Upper Zambezi River above Victoria Falls (Tweddle, 2014). The limited sampling in the current (2014) field survey yielded 19 species, one of which, a species of *Cyphomyrus*, is a new record for the Middle Zambezi and is currently under taxonomic/genetic investigation.

EF Site 1: Minshull (2010) recorded 29 fish species in Batoka Gorge, including small numbers of juveniles of Upper Zambezi species. Of the 29 recorded species, only 12 species can be regarded as common 'permanent residents'. Some Upper Zambezi species have become established in the more complex habitats of Lake Kariba, but in general, such species can only be regarded as temporary inhabitants in the gorge.

The health of the fish population in Batoka Gorge has to be assessed in terms of the naturally hostile environment in the gorge. Anthropogenic effects are very low. Fishing is restricted to hook and line for predatory fish, Tiger fish (*Hydrocynus vittatus*) and Vundu (*Heterobranchus longifilis*). Access points are limited and thus fishing mortality is small. Some nutrient enrichment and presence of raised *E. coli* levels are reported from the gorge below the towns of Victoria Falls and Livingstone but at low levels, and thus the fish populations in the gorge can be regarded as near pristine, Category A-B.

EF Site 2: Anthropogenic impacts are much more evident at EF Site 2. Villages border the river and the banks are heavily grazed, by either hippos, cows, or both. Numerous, but small, sand beaches occur wherever there is human habitation, with such sites cleared for water collection and/or washing. Water quality, however, appears to remain healthy. Fishing activity is evident everywhere, particularly on the Zambian bank. Numerous makoros (dugout canoes) were seen and many monofilament gillnets were observed in makoros, on the river banks and in the water. These monofilament nets are a recent addition to the fishery, and have resulted in serious adverse effects on fish biomass in the Upper Zambezi above Victoria Falls. They are also much more damaging to other fauna than older multifilament nets because (a) they are cheap, easily damaged, not easily repairable, and are thus discarded after use, and (b) they are made of a material that does not lie limply on the ground but instead forms springy bunches of material in which animals of all varieties are trapped and die. Anthropogenic impacts are not on a scale that impacts on fish diversity, but probably sufficient to lead to changed species abundance ratios. Large cichlids, mainly tilapiines in this area, in particular are most reduced by targeted fishing, while *Labeo altivelis* abundance may be negatively affected by heavy exploitation during breeding migrations (Skelton *et al.* 1991). Thus, the fish populations in the reach represented by EF Site 2 can be regarded as Category B (slightly modified from natural condition).

8.4.2 Detailed Fish Ecology

A detailed fish survey was conducted in 1997/1998 as additional studies for the BGHES ESIA, and is included here due to the value of the study. Additional data from the 2014 survey supplements the original survey.

The species composition list from the isolated pools in the Batoka Gorge is given in *Table 8-23*. Brief comments on the more prominent fish species within each of the families identified in *Table 8-23* is given below. IBAT provides access to a downloadable list of 97 fish species potentially occurring within the Ecological AoI and surrounding areas, but it is not possible to distinguish between species in the Upper Zambezi, Batoka Gorge and lake Kariba, each of which are known to have their own fish ecology. The fish diversity for the Batoka Gorge presented in *Table 8-23* is based on multiple studies, both old and recent, and is considered sufficiently comprehensive.

Table 8-23 Fish Species Recorded in the Batoka Gorge and Downstream Habitat during 1997 and 2014 Assessments

Family and Species Names (IUCN Red List Status - 2014)	English Common Name	1997/98 Studies	2014 EF Studies
CHARACIDAE and POECILIIDAE			
Aplocheilichthys [Micropanchax] johnstoni (LC)	Johnston's Topminnow		x
Brycinus [Alestes] lateralis (LC)	Striped Robber	x	x
Brycinus imberi (LC)	Spot-tailed Robber		x
Hydrocynus vittatus (LC)	Tiger Fish	x	e
Micralestes acutidens (LC)	Sharp-tooth Tetra	x	x
DISTICHODONTIDAE			

Family and Species Names (IUCN Red List Status - 2014)	English Common Name	1997/98 Studies	2014 EF Studies
Distichodus mossambicus (LC)	Nkupe	x	e
Distichodus schenga (LC)	Chessa	x	x
CYPRINIDAE			
Barbus fasciolatus (LC)	African banded barb		x
Barbus lineomaculatus (LC)	Line-spotted Barb		e
Barbus trimaculatus (poechii) (LC)	Dashtail Barb	x	e
Barbus unitaeniatus (LC)	Slender Barb		x
Labeo altivelis (LC)	Sailfin Mudsucker	x	e
Labeo congoro (LC)	Redscub Mudfish	x	e
Labeo cylindricus (LC)	Red-eyed Labeo	x	x
Labeobarbus marequensis (LC)	Large-scale Yellowfish	x	x
Opsaridium zambezense (LC)	Dwarf Sanjika		x
CICHLIDAE			
Coptodon (Tilapia) rendalli (LC)	Northern Red-breasted Tilapia	x	x
Hemichromis elongatus (LC)	Banded jewel cichlid		x
Oreochromis mortimeri (CR)	Kariba Tilapia	x	x
Oreochromis niloticus (LC)	Nile Tilapia		x
Pharyngochromis darling / acuticeps (LC)	Zambezi Happy	x	x
Pseudocrenilabrus philander (LC)	Southern Mouthbrooder		e
Tilapia sparrmanii (LC)	Sparrman's Bream		(x)
MORMYRIDAE			
Cyphomyrus [Hippopotamyrus] discorhynchus (LC)	Zambezi Parrotfish	x	x
Marcusenius macrolepidotus (LC)	Bulldog		e
Mormyrops anguilloides (deliciosus) (LC)	Cornish jack	x	x
Mormyrus longirostris (LC)	Eastern Bottlenose	x	e
CLARIDAE, AMPHILIIDAE and SCHILBEIDAE			
Amphilius uranoscopus (LC)	Common Mountain Catfish		e
Clarias gariepinus (LC)	African Catfish	x	e
Eutropius depressirostris	African Butter Catfish	x	
Heterobranchus longifilis (LC)	Vundu	x	e
Malapterurus electricus (LC)	African Electric Catfish	x	
Malapterurus shirensis (LC)	Electric Catfish		e
Schilbe intermedius (LC)	Silver Butter Catfish		x
MOCHOKIDAE			
Synodontis nebulosus (LC)	Cloudy Squeaker		(x)
Synodontis zambezensis (LC)	Brown Squeaker	x	e
ANGUILLIDAE			
Anguilla nebulosa labiata (NT)	Indian Mottled Eel	x	
Mastacembelus vanderwaali (LC)	Ocellated Spiny Eel		(x)

Key: x denotes species recorded during the respective studies
(x) Denotes fish species recorded during previous studies (Minshull, 2010)
e Species expected to be present based on distribution and habitat assessment

***CHARACIDAE & POECILIIDAE** (Little Tetras, Robbers and Tiger Fish)*

Micralestes acutidens was numerically the most abundant species within the Batoka Gorge during both 1998 and 2014 studies, but was less abundant in the slower flowing downstream river habitats (*Table 8-23*). These are small shoaling fish and most of them were two to three years old. Holcik (1974) recorded dense populations of these fish in localities where the shoreline was covered with rocks, sand and gravel and where there is scant vegetation. In muddier conditions with more macrophytes, population densities were low. *M. acutidens* is very sensitive to lack of oxygen, and the presence of a hard bottom is a necessary prerequisite for spawning. They prefer a riverine habitat to a lacustrine one and are thus common in the Batoka Gorge; however, their contribution to biomass is insignificant because of their small size. This species nevertheless presents an important prey base for many of the predatory and omnivorous species present within the gorge and the health of those fish populations is dependent on the survival of this species. They are not an important commercial catch and will not occupy pelagic habitats in the BGHES reservoir and are not expected to be adversely impacted within the Gorge downstream of the dam wall.

Tiger Fish (*Hydrocynus vittatus*) are prominent predators in Southern African rivers and lakes and a healthy population exists within the Batoka Gorge and downstream habitats even though this species was not sampled in 2014. Tiger Fish are regarded as the premier freshwater game fish in the world and is also an important commercial and subsistence fisheries species in the gorge. Tiger Fish prefer well oxygenated water, and are open water predators often found near the water surface. It is postulated the lack of macrophytes in the Batoka Gorge may have exposed some smaller fish species to excessive predation pressure from *H. vittatus* leading to the generally low fish diversity there.

H. vittatus are likely to increase in the reservoir but will disappear if the water quality deteriorates and eutrophication sets in. The species breeds in flowing water and its uncertain if sufficient flowing habitat will be accessible upstream of the reservoir to sustain an adequate population. Tiger Fish are migratory and the Batoka Gorge and downstream populations can be considered as one with significant interaction with Tiger Fish in Kariba. These migratory movements will be cut through construction of a dam wall and some intervention may be necessary to sustain a healthy population within the BGHES reservoir. This species is vulnerable to water level fluctuations downstream of the dam wall, particularly during spawning period when eggs in shallow water may be exposed.

***DISTICHODONTIDAE** (Chessa and Nkupe)*

These two *Distichodus* were prominent in the catches of local fishermen, particularly *D. schenga* and are important to the commercial and subsistence fisheries in the Middle Zambezi system. These fish are omnivorous and their preferred habitat is the mainstream of large rivers. Even in Lake Kariba they are most common in the western basins, which are strongly influenced by the Zambezi River, indicating that both species prefer riverine conditions. Their biology and ecology is poorly understood. Only juveniles were found in the pools in the 1998 studies with a mean age of 1+ years. The mean age for the commercial catch was 5+ years. The largest specimen caught by local fishermen was 8+ years old. They are likely to be confined to river mouths and side gorges when the BGHES reservoir develops. These species are sensitive to low water levels and reduced flows could result in a significant reduction in their population downstream of the dam wall.

CYPRINIDAE *(Labeos, Barbs and Yellowfish)*

L. altivelis and *L. cylindricus* are commercially important species in the Batoka Gorge found to be abundant during both 1998 and 2014 assessments (*Table 8-23*). These fish are migratory and subject to natural population fluctuations. The Middle Zambezi population will be adversely affected by the loss of habitat as a result of the reservoir development. These fish are herbivorous grazers and organic detritus forms an important part of their diet. All these *Labeo* species are characteristically riverine species and prefer sandy or hard muddy substrates and scarce vegetation. Bell-Cross and Munshell (1988) noted that *L. altivelis* occurs where rocks and rapids abound. The Batoka Gorge is therefore an ideal habitat from them, although this species can also be found in non-rocky areas. The mean age of *L. altivelis* caught by fishermen in 1998 was 6 years. Like the *Distichodids*, the *Labeo* species are now rare in the lacustrine basins of Lake Kariba. These are potamodorous fish and the building of the BGHES is likely to interfere with their migration patterns. However, the tributaries and side gorges could potentially provide suitable breeding sites for them.

Labeo congoro was caught by the local fishermen but on a smaller scale. Marshall (2011) reports that the major populations of *L. congoro* in the Zambezi are in the gorges below Victoria Falls, and that dam construction has led to the extirpation of this species in river further south, thus the construction of the BGHES will have a major impact on this species' survival.

Labeobarbus marequensis (Largescale Yellowfish) was abundant in the Batoka Gorge during both 1998 and 2014 studies and is a commercially important species in the Batoka Gorge. This species is considered to be an important prey item for the large Vundu (*Heterobranchus longifilis*) that occur there. The Labeobarbus preferred habitat is fast flowing waters of perennial rivers, which are associated with rocky bottoms. This is a typically riverine fish and the Batoka Gorge provides suitable habitat.

The diversity of Barbus species is naturally low for the Middle Zambezi system but the populations that exist form an important prey base for other fish species. *Barbus poechii* (Dashtail Barb) is common in rivers and often found in association with *Brycinus lateralis* (Striped Robber). *B. poechii* is a shoaling species that migrates upstream to breed during the rains. They are not widely distributed, being recorded in the Upper Zambezi systems and more recently in the Middle Zambezi systems. *B. unitaeniatus* is found in a wide variety of habitats including both lotic and lentic environments. It is also a shoaling species subject to seasonal migrations. Both *B. poechii* and *B. unitaeniatus* are not of commercial importance. Barbus species will decline in the Batoka reservoir. *B. marequensis* has disappeared from most Zimbabwean reservoirs within the first two years after water impoundment. These species are shallow water breeders and are sensitive to reduced flows and daily level fluctuations.

CICHLIDAE *(Bream / Tilapia)*

None of these cichlids are commercially important in the Batoka Gorge. *P. darlingi*/acuticeps (Zambezi Happy) is numerically the most dominant cichlid in the gorge and tends to occur in a wide range of habitats wherever there is cover, including bottom rocks and areas with rooted vegetation. This species complex is difficult to identify to species level with certainty. Most of the sampled *P. darlingi/acuticeps* sampled in 1997 had a mean age of 1+ years. *P. darlingi/acuticeps* biomass in Lake Kariba is very high and there is no suitable gear to exploit it.

Oreochromis mortimeri is recognised as having been the primary indigenous Cichlid in the Middle Zambezi system, but has hybridised extensively with *O. niloticus* (Nile Tilapia). *O. niloticus* is an exotic species that has been introduced to Lake Kariba and is establishing itself upstream in the Zambezi River. *Pseudocrenilabrus philander* (Southern Mouthbrooder) is another alien species that has recently escaped into the system. This species was not detected by Minshull in 1997/98. It is expected to be largely restricted to riverine habitats but not a prominent species in the proposed reservoir.

Oreochromis macrochir is an Upper Zambezi species that has been widely stocked throughout Zimbabwe, including Lake Kariba (Marshall 2011) and provides competition for *O. mortimeri*. Only one specimen of *O. mortimeri* (Kariba Tilapia) was caught by fishermen during low flow 1997, but during the High Flow in February 1998, 23 specimens were caught. These fish were probably caught during their breeding migration. This fish thrives in the waters of large rivers, and is pre-adapted to lacustrine conditions. *O. mortimeri* is an important angling species in Lake Kariba. It is a highly adaptable species and size strongly depends on environmental conditions (Balon, 1974). It reaches a maximum size in large reservoirs while in small water bodies its growth is slow. In Batoka its growth is expected to be slow although its numbers may increase. *O. mossambicus* was introduced into the DibuDibu River and may have hybridised with *O. mortimeri* in the Batoka Gorge.

Coptodon rendalli [formerly *Tilapia rendalli*] (Northern Red-breasted Tilapia) were caught in both the fishermen's catch and sampled in both 1997 and 2014, but are not an important commercial catch in the Batoka Gorge, but is the dominant Cichlid species downstream of the BGHES. *C. rendalli* is also an adaptable fish species inhabiting most niches in a water body, but prefers quiet waters with good aquatic plant cover. It is pre-adapted to lacustrine conditions. *C. rendalli* is a macrophyte feeder and no major macrophytes development is anticipated in the Batoka reservoir and *T. rendalli* is likely to only increase slightly. This species is sensitive to daily water fluctuations as it breeds in shallow waters where eggs are vulnerable to being exposed.

Cichlids do not develop well in rivers. The Batoka Gorge is an unsuitable habitat for them because there are no gentle vegetated slopes, which are required as breeding grounds. The BGHES reservoir will not provide the necessary lacustrine environment for these fish to thrive.

***MORMYRIDAE** (Nosed Fish)*

Both *Mormyrops anguilloides* [formerly *M. deliciosus*] (Cornish Jack) and *Momyrus longorstris* (Eastern Bottlenose) were part of the commercial catch of the Batoka Gorge in the 1998 studies and were sampled in 2014 (*Table 8-23*). Both species prefer quiet waters with a soft muddy base, and occur in river estuaries amongst boulders. *H. discorhynchus* (Zambezi Parrotfish) is a small Mormyrid and were abundantly sampled. Their preferred habitat is large rivers but they are also found in swampy environments, but are not commercially important. The increase in the BGHES reservoir will only be slight because their primary prey, benthic fauna, will be scarce due to the deep water conditions. The *Prosobranch* snails, *Bellamya capillita* and *Mellamoides tuberculata* were observed in the Batoka Gorge but their biomass will not increase significantly in the reservoir, which has a small littoral zone. One pulmonate snail, *Bulinus* sp. was also identified.

***CLARIDAE** etc (Catfish)*

Heterobranchus longifilis (Vundu) is an iconic, very large but fairly uncommon catfish species that is restricted to deep pools in the main river channels. This species thrives in both riverine and lacustrine environments. They tend to be found in large deep rivers within the mainstream or deep pools such as the one sampled in the Batoka Gorge. The oldest fish caught during this study was 8 years old, but they can live up to 12 years. This is the largest freshwater fish in Southern Africa, but is not an important commercial species in the Batoka Gorge as they are not abundant there.

Clarias gariepinus (African Catfish) is a common and widespread species throughout sub-Saharan Africa and the most widely distributed fish in Zimbabwe having been recorded from all of the river systems in the country. This fish is able to adapt to most water bodies but absent from the rockier fast-flowing areas such as Batoka Gorge, however it is found in deeper pools below the gorge in the dry season and in flooded estuaries during the flood season (Marshall 2011). The species prefers floodplains, large sluggish rivers, lakes and reservoirs. This species was observed in the fishermen's catch but in small numbers. A slight increase in this catfish is expected in the BGHES Reservoir.

***MOCHOKIDAE** (Squeakers)*

Synodontis zambezensis prefers pools and slow-flowing reaches of perennial and seasonal rivers, and is a commercially important species in the Batoka Gorge (*Table 8-23*). This is the most widespread demersal (bottom-feeder), omnivorous species in the Middle Zambezi river system with a wide range of habitat tolerance and resilience to fishing pressure. Fishermen caught a number of them in February 1998 as they made their upstream migrations. In Lake Kariba the biomass of this species has increased during the 10 years up to 1998 (LKFRI, 1997 statistics). An increase in abundance of this species is anticipated in the BGHES Reservoir.

***ANGUILLIDAE** (Eels)*

Two Mottled Eels (*Anguilla labiata*) were recorded with a standard length of 130cm and 132cm respectively in 1997 and both were estimated to be 17 years old. Adult eels live in freshwater for 20 years before migrating to the sea to spawn in the Indian Ocean, yet the Kariba and Cohora Bassa dam walls would represent impassable barriers for these fish. It is unlikely that these eels could have surpassed these barriers, either their age determinations may not have been accurate or a batch of young eels may have been released above Lake Kariba years earlier. No evidence of this species has been detected during recent studies, and it is no longer expected to be present. The BGHES dam wall will act as an additional barrier and special mitigation measures should be considered to retain the natural fish species composition of the Zambezi River.

Mastacembelus vanderwaali (Ocellated Spiny Eel) was not recorded in the Middle Zambezi prior to the construction of Kariba but has become increasingly common in the Batoka Gorge (Minshull 2009; 2010) and has been found downstream of Lake Kariba (Marshall 2011). It is likely, therefore that the species always occurred in appropriate rocky habitats in the Middle Zambezi and was overlooked in earlier surveys.

8.5 ECOLOGICAL HABITAT SENSITIVITY AND CRITICAL HABITAT ASSESSMENT

The IFC Performance Standard 6 *Biodiversity Conservation and Sustainable Management of Living Natural Resources* classifies habitats under the three main categories of modified, natural or critical habitats. This section evaluates the level of disturbance to the main habitats identified within the Ecological AoI to classify these as modified or natural based on the IFC Performance Standard 6 criteria. An assessment of the presence of Critical Habitats is presented thereafter. This classification of habitats represents the natural functioning of the ecosystems and is therefore used as the key driver for the assessment of habitat sensitivity.

Presence of Modified Habitat

Modified habitats are areas that may contain a large proportion of plant and/or animal species of non-native origin, and/or where human activity has substantially modified an area's primary ecological functions and species composition. Examples of this habitat are the urban areas around Victoria Falls and Hwange town, as well as cultivated fields in the rural areas.

The Victoria Falls Combination Master Plan (2002) noted that there was a significant increase in cultivation and settlement and therefore a loss of woody cover in the Communal Areas and in Victoria Falls town over a seven year period (1992-1999), as indicated by the data in *Table 8-24*. Although superficially the vegetation remaining in the Communal Lands is mostly *Baikiaea* woodland, it exists in a rather depleted ecological state. Many of the commercially valuable timber trees have been felled and the understorey has been thinned by cutting out poles. The Landsat images also reveal a pattern of settlement and cultivation starting along the drainage lines (Lukunguni and DibuDibu vleis in Zimbabwe and around Mukuni village in Zambia). These areas represent the contact zone between Kalahari Sands and clays and also the zones of higher moisture content. The clearing then proceeds up into the woodlands on the sand ridges. Settlements also follow the road network and the distribution of boreholes and wells.

Table 8-24 Changes in Woody Cover in DibuDibu and Lukunguni Drainages (1)

Cover Type	Area (ha)		% Change
	1992	1999	
Cultivation	11 549	14 672	+27.04
Urban settlement	811	1 104	+36.13

[1] based on Landsat imagery. Data from Victoria Falls Combination Master Plan report (2002).

The Lukunguni and the DibuDibu streams pass through largely modified habitat but are considered to be High Sensitivity due to their importance as a water source for maintenance of biodiversity and for communities, also as focal points for cultivation and grazing resources in the area.

Presence of Natural Habitat

Natural habitats are areas composed of viable assemblages of plant and/or animal species of largely native origin, and/or where human activity has not essentially modified an area's primary ecological functions and species composition. An example of this habitat is the Mixed Deciduous Woodland and *Baikiaea* Woodland that are located away from human habitation.

Table 8-25 provides an overview and arguments for the classification of habitats and the levels of biodiversity sensitivity recognised. The sensitivity of habitats is illustrated in *Figure 8.35*.

Table 8-25 Classification of Modified and Natural Habitat based on Levels of Transformation

Habitat Type	IFC Habitat Classification	Levels of Modification and Comment	Biodiversity Sensitivity
Batoka Gorge			
Batoka Gorge	Natural habitat	Remains in a near pristine state.	Highest Sensitivity
Basalt Soil Habitats			
a) *Kirkia-Sterculia-Commiphora* woodland	Natural habitat	*Limited transformation* - Only modification is around settlements. Trees are cut for poles (housing) and firewood.	Medium Sensitivity These are widespread

Habitat Type	IFC Habitat Classification	Levels of Modification and Comment	Biodiversity Sensitivity
b) *Combretum-Commiphora* – Mopane open woodland	Natural habitat	*Limited to medium level of transformation*. Some of the deeper soils have been cleared for agriculture and settlements.	habitats within the project area
c) *Terminalia stuhlmannii* open woodland	Natural habitat	*Medium to high levels of transformation*: Much of this type appears to now be under cultivation in Zambia	
Kalahari Sand Habitats			
a) *Baikiaea* woodland	Natural to partially modified habitat	*Medium to high levels of transformation*. There has been extensive logging (intermittent from 1919 to 1985) and removal of trees for construction, wood carving and firewood. The woodland edges are being modified through the expansion of agriculture. Some weedy species are present.	Medium Sensitivity. Although a widespread habitat, it is very important from an ecosystem services perspective, i.e. as an aquifer and source of timber.
b) *Terminalia sericea* shrubland / vlei	Natural habitat with some modification	*High levels of transformation*. High intensity of grazing; frequent fires have led to a degradation of the vleis and an encroachment of the woody species e.g. *Terminalia Sericea* trees	
Alluvial Habitats			
a) Zambezi river riparian woodland, side gorges and sandbanks	Natural habitat	Largely Pristine habitat.	Very High Sensitivity
b) Mixed Upper tributary and riparian woodlands	Natural with some modification	*Medium and varied levels of transformation*. Where these types occur close to settlement, the habitat is often highly modified and degraded: removal of trees; over grazing; soil erosion; river bank cultivation	High Sensitivity
c) *Hyphaene* open woodland (on saline or sodic alluvium)	Natural – some modification	*Medium levels of transformation*. Riparian woodlands are important sites of biodiversity in an otherwise dry and nutrient poor environment.	High Sensitivity
Aquatic Ecosystem			
Zambezi River within the Batoka Gorge	Natural habitat	A small change in aquatic biota has taken place but the ecosystem functions are essentially unchanged, with primary ecological functions and species composition intact.	Very High Sensitivity
Other Modified Habitats			
Cultivation areas	Modified	*High levels of transformation*. Where the cultivation has been intense and long term, the level of modification is high, although some ecological processes still continue, albeit at a reduced rate: e.g. nutrient re-cycling. Invasive or Weedy species are common	Low Sensitivity
Urban areas	Highly modified	*High levels of transformation*. Many ecological processes have been	Low Sensitivity

Habitat Type	IFC Habitat Classification	Levels of Modification and Comment	Biodiversity Sensitivity
		compromised, except in suburban gardens. Weedy species common. There may be more species than in cultivated areas due to the introduction of ornamental plants into gardens.	

Occurrence of Critical Habitat

Critical habitats are a subset of either natural or modified habitats, and describe the areas with high biodiversity value. Critical habitats are recognised based on any one of the following five criteria:

i. Habitat of significant importance to Critically Endangered and/or Endangered species;
ii. Habitat of significant importance to endemic and/or restricted-range species;
iii. Habitat supporting globally significant concentrations of migratory species and/or congregatory species;
iv. Highly threatened and/or unique ecosystems; and/or
v. Areas associated with key evolutionary processes.

Guidance notes to the IFC PS6 (June 2019) require that critical habitat is assessed for an appropriate Ecological Area of Analysis (EAA). Two EAAs are appropriate for this assessment of critical habitat, namely (i) the Batoka Gorge IBA, which is associated with the Batoka Gorge from Victoria Falls to the start of Kariba Dam, and (ii) the remaining area of the Ecological AoI defined in *Section 8.1.* Reasons for separation of these areas into two EAAs are that the Batoka Gorge exists as a fundamentally different ecosystem to the surrounding habitats. The Ecological AoI excludes the large Hwange National Park where abundant large mammal populations create a different ecological balance to the Project area.

Table 8-26 provides a structured assessment of the presence of Critical Habitat for the Batoka Gorge and the remaining Ecological AoI based on the above criteria.

Table 8-26 Analysis of Critical Habitat for the Batoka Gorge and Remaining Areas of the Ecological Area of Influence

Critical Habitat Criterion	Comment	Occurrence of Critical Habitat
i. Habitat of significant importance to Critically Endangered and/or Endangered species, with consideration of Vulnerable species (see text below) [(1)];	**Batoka Gorge:** No mammal, reptile or amphibian species would trigger critical habitat within the Batoka Gorge. Birds - Taita Falcons are currently listed as Vulnerable. Recent Taita Falcon reconnaissance surveys (2019) have demonstrated the continued presence of Taita Falcons, but did not confirmed the presence of a breeding population. Various highly threatened bird species do occur in the Batoka Gorge, but all are wide-ranging species (*Table 8.18*) that do not trigger critical habitat. [(2)] The critically endangered fish, Kariba Bream (*Oreochromis mortimeri*) has been recorded, but this fish interbreeds with the Nile Tilapia that has been introduced. Populations are therefore genetically contaminated, and not considered as a critical habitat trigger. The small herbaceous plant *Jamesbrittenia zambesiaca* is regionally considered to be Critically Endangered (SABONET, 2003), but insufficient data regarding occurrence is available.	Taita Falcons have the potential to trigger critical habitat. Taita Falcons are therefore recognised as a provisional critical habitat trigger, pending availability of additional data. Other species provide no justification for critical habitat recognition.
	Remaining Ecological AoI: Mammals - African Wild Dog could potentially occur but their presence would be erratic, and dependent on protected areas with large wildlife populations. Considered unlikely to be dependent on the EAoI. Birds – Vultures do occur and cranes are likely, but are considered wide-ranging species.	No justification for critical habitat recognition.
ii. Habitat of significant importance to endemic and/or restricted-range species	**Batoka Gorge:** The following two bird species could potentially be recognised as restricted range species: • The Taita Falcon exists in small isolated populations but with a wide distribution, [(3)] making the range restricted concept difficult to apply. • The Rock Pratincole is a bird species locally confined to emergent rock habitat within the Zambezi but present within the upper Zambezi far beyond the project area. This species migrates northwards within Africa with a wide distribution. Restricted range and endemic floral species occur	The IUCN Red List distribution data for Rock Pratincole show a large distribution in Africa. This species therefore not considered to trigger Criterion ii for the Batoka Gorge. Taita Falcons are discussed above.

(1) Guidance Note 72 (6 February 2019), presents the following thresholds for Criterion 1 Critical habitat:

(a) Areas that support globally-important concentrations of an IUCN Red-listed EN or CR species („d 0.5% of the global population AND ≥ 5 reproductive units of a CR or EN species).

(b) Areas that support globally-important concentrations of an IUCN Red-listed Vulnerable (VU) species, the loss of which would result in the change of the IUCN Red List status to EN or CR and meet the thresholds in GN72(a).

(c) As appropriate, areas containing important concentrations of a nationally or regionally-listed EN or CR species.

(2) Guidance Note GN54 (Feb 2019) states "for wide-ranging species, critical habitat may be informed by areas of aggregation, recruitment, or other specific habitat features of importance to the species".

(3) Taita Falcon distribution data: http://maps.iucnredlist.org/map.html?id=22696523

Rock Pratincole distribution data: http://maps.iucnredlist.org/map.html?id=22694144

Critical Habitat Criterion	Comment	Occurrence of Critical Habitat
	Remaining Ecological AoI: Habitats surrounding the Batoka Gorge are not unique, and no endemic or range restricted species are known to be dependent on this area.	No justification for recognition of critical habitat.
iii. Habitat supporting globally significant concentrations of migratory species and/or congregatory species	**Batoka Gorge:** Migratory insectivorous bat species are reported to congregate in significant numbers in the Batoka Gorge, however population size and migratory patterns for these species are not understood, and it is not possible to determine whether congregations represent globally significant populations of the relevant species.	Threshold criteria for African bat populations are not available and there is insufficient basis to recognise triggers for Criterion iii.
	Remaining Ecological AoI: No important concentrations of congregatory species are known in this area.	No justification for critical habitat recognition.
iv. Presence of highly threatened and/or unique ecosystems	**Batoka Gorge:** The Batoka Gorge is a unique ecosystem based on the combined consideration of magnitude of the geomorphological formations (terrain) and the volume of water flows associated with the Zambezi River. These features support important biodiversity that has resulted in international recognition of Batoka Gorge as a Key Biodiversity Area (KBA), with parts of the gorge protected as national park and granted UNESCO World Heritage status.	The Batoka Gorge qualifies as a Critical Habitat for criterion iv based on its unique features and KBA status.
	Remaining Ecological AoI: The World Heritage Site does extend into the Remaining Ecological AoI, but these areas are not considered to be unique.	No additional justification for critical habitat recognition above the protected status.
v. Areas associated with key evolutionary processes	Cotterill & de Wit (2011) argue that processes occur all the time; however, no key evolutionary processes are documented within the Batoka Gorge or the remaining Ecological AoI.	Not considered a likely Critical Habitat trigger.
Protected Areas Guidance Note GN54 to the IFC PS6 states that Protected Area with IUCN Management Categories I and II and KBAs may be recognised as critical habitat.	The Mosi-Oa-Tunya National Park and the Victoria Falls National Park are both rated as a Category II protected areas on the IUCN Management classification. The Mosi-Oa-Tunya / Victoria Falls World Heritage Site encompasses the two national parks and extends for 18.6 km along the Zambezi River downstream from the Victoria Falls. The Batoka Gorge is recognised as a KBA based on its Important Bird and Biodiversity Area status identified by Birdlife International.	Multiple reasons are identified that justify a critical habitat status that support the findings under Criterion iv above.

Based on the analysis in *Table 8.25*, the Batoka Gorge can be recognised as a Critical Habitat based on the presence of a unique ecosystem under Criterion iv. The unique geomorphology and large river conditions collectively support important biodiversity that has resulted in international recognition of Batoka Gorge as a Key Biodiversity Area (KBA), with parts of the gorge protected as national park and granted UNESCO World Heritage status. The recognition of critical habitat based on Criterion iv is therefore justified.

Taita falcons present an anomaly, as they are extremely rare and exist in a few small isolated populations across East and Southern Africa, yet the species is classified on the IUCN Red List as vulnerable. The reported population within the Batoka Gorge comprising less than 10 breeding pairs has for a long time been considered by species specialists to be globally the most important population of this species. Guidance Note GN72 to the PS6 acknowledges that areas supporting globally-important concentrations of an IUCN Red-listed vulnerable species, and the loss of which would result in the change of the IUCN Red List status to EN or CR could trigger critical habitat. A recent Taita Falcon survey by species specialists has demonstrated the continued presence of the species in the Batoka Gorge, but was unable to find evidence of breeding. Taita Falcons are therefore recognised as a provisional critical habitat trigger, and *Chapter 10* presents a set of measures to further assess the occurrence and likely impact to this species.

8.5.2 Implications Resulting from the Occurrence of Natural and Critical Habitat

The IFC PS6 stipulates requirements for situations where natural habitats and critical habitats are impacted, as presented in *Box 8-1* and *Box 8-2*. Many of these requirements, such as an analysis of alternatives and stakeholder consultation are provided within this ESIA; however, the following two requirements are highlighted:

- Demonstrate no net loss of biodiversity where feasible in response to impacts within natural habitats, and
- Demonstrate net gains for components that trigger critical habitats, where these habitats are impacted.

Box 8-1 Requirements for Natural Habitats in Paragraphs 14 and 15 of the Performance Standard 6

The client will not significantly convert or degrade natural habitats, unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the Project on modified habitat;
- Consultation has established the views of stakeholders, including Affected Communities, with respect to the extent of conversion and degradation; and
- Any conversion or degradation is mitigated according to the mitigation hierarchy.

In areas of natural habitat, mitigation measures will be designed to achieve no net loss of biodiversity where feasible. Appropriate actions include:

- Avoiding impacts on biodiversity through the identification and protection of set-asides;
- Implementing measures to minimize habitat fragmentation, such as biological corridors;
- Restoring habitats during operations and/or after operations; and
- Implementing biodiversity offsets.

Where natural habitats are impacted, the IFC PS6 requires that No Net Loss of biodiversity is demonstrated where feasible. No net loss is defined as the point at which project-related impacts on biodiversity are balanced by measures taken to avoid and minimize the project's impacts, to undertake on-site restoration and finally to offset significant residual impacts, if any, on an appropriate geographic scale (e.g., local, landscape-level, national, regional).

Box 8-2 Requirements for Critical Habitats in Paragraphs 16, 17 and 18 of the Performance Standard 6

In areas of critical habitat, project activities will not be implemented unless all of the following are demonstrated:

- No other viable alternatives within the region exist for development of the project on modified or natural habitats that are not critical;
- The project does not lead to measurable adverse impacts on those biodiversity values for which the critical habitat was designated, and on the ecological processes supporting those biodiversity values;
- The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time; and
- A robust, appropriately designed, and long-term biodiversity monitoring and evaluation program is integrated into the client's management program.

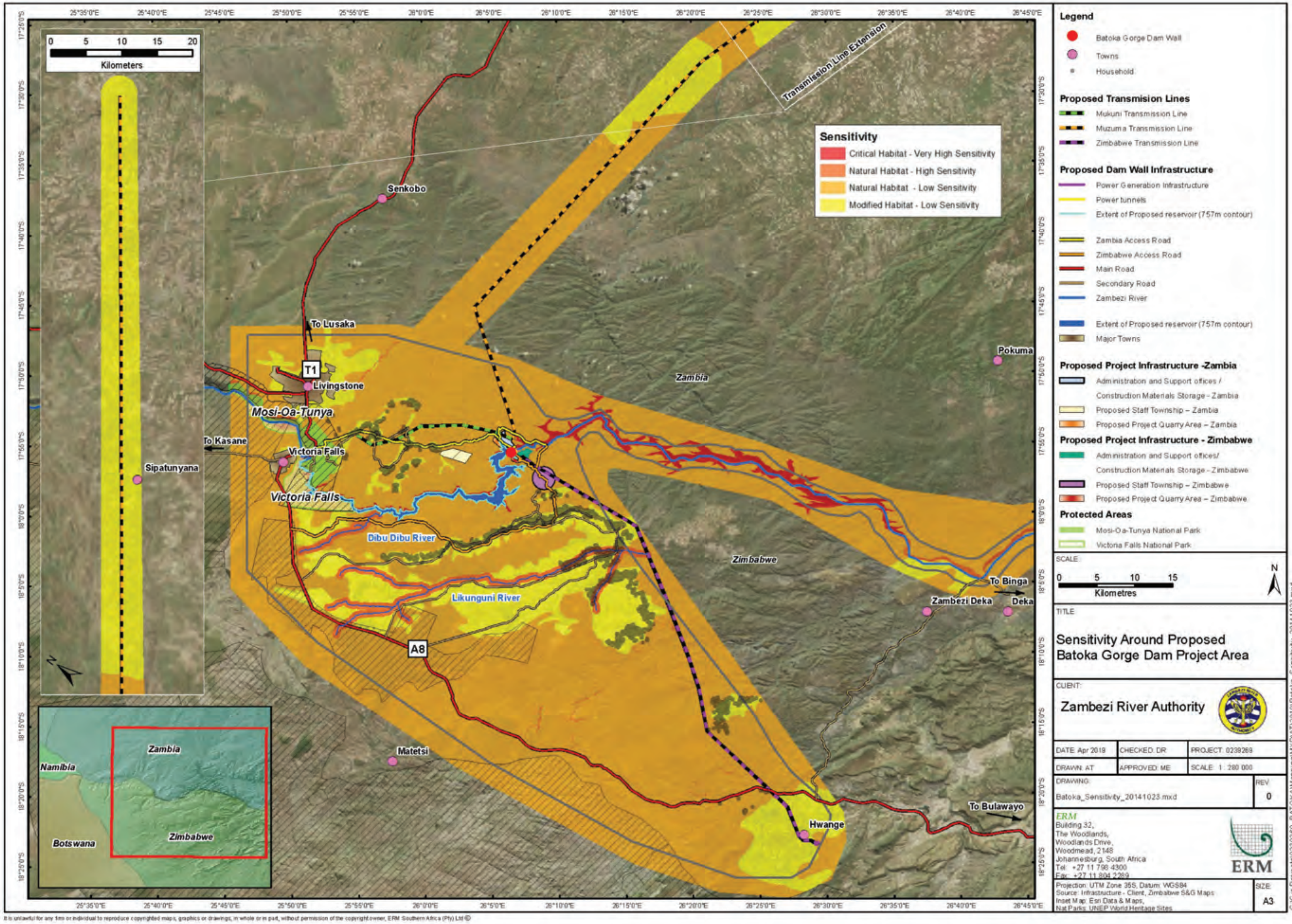
In such cases where a client is able to meet the above requirements, the project's mitigation strategy will be described in a Biodiversity Action Plan and will be designed to achieve net gains of those biodiversity values for which the critical habitat was designated.

Net gains are additional conservation outcomes that can be achieved for the biodiversity values for which the critical habitat was designated. Net gains may be achieved through the development of a biodiversity offset and/or, in instances where the client could meet the critical habitat requirements (paragraph 17 of the PS6) without a biodiversity offset, the client should achieve net gains through the implementation of programs that could be implemented in situ (on-the-ground) to enhance habitat, and protect and conserve biodiversity.

Table 8-25 reveals that extensive natural habitat occurs within the Project area. Selected parts will be impacted through specific development footprints such as transmission lines, construction camps, access roads, quarries and borrow pits. No net loss of biodiversity needs to be demonstrated for these footprints on a case-by-case basis.

Construction of the BGHES and inundation by the reservoir will impact a large area of the Batoka Gorge, which qualifies as a critical habitat. Triggering components include Taita Falcons, a large part of the key biodiversity area and national parks and the World Heritage Site associated with Victoria Falls. Relocation of the BGHES site will not avoid the critical habitat, and reduction of the full supply level (reservoir extent) to avoid the World Heritage Site renders the project unviable (refer to *Chapter 6*). A net gain of the biodiversity associated with the Batoka Gorge, including specific reference to Taita Falcons, therefore needs to be demonstrated to achieve alignment to key elements of the standard.

Figure 8.35 Habitat Sensitivity Map for the Ecological Area of Influence for the Proposed BGHES



8.5.3 *Key Ecological Sensitivities*

- The upper parts of the Batoka Gorge fall within a World Heritage Site and within the Mosi-oa-Tunya and Victoria Falls National Parks.

- The Batoka Gorge qualifies as a Critical Habitat due to it being a highly unique ecosystem (criterion iv). The Batoka Gorge has also been categorised as an internationally Important Bird Area (IBA) due to its importance for breeding raptor species, which results in the inclusion of the Batoka Gorge within the global set of Key Biodiversity Areas recognised by the IUCN.

- A key component of the important raptor habitat is a small resident breeding population of the very rare Taita Falcon reported to occur within the Batoka Gorge. Little is known about the ecology of this falcon but it is considered to be threatened through general disturbances, loss of breeding habitat and potentially the loss of prey (small swifts feeding on midges emerging from the rapids) if the BGHES is developed. Taita Falcons are included as a provisional critical habitat trigger pending the availability of data that demonstrates the presence of a breeding population.

- Rock Pratincoles depend on the specific habitat of emergent rocks within fast flowing rivers. The global population of these migratory birds is limited and an important population occurs seasonally within the Batoka Gorge, but is not restricted to the gorge.

- The threatened plant species diversity is important for the upper scree slopes of the Batoka Gorge, where a diversity of threatened plant species are known to occur and others are expected to occur.

8.6 *DATA GAPS*

The Terrestrial Ecology Baseline presents a great deal of information on the Batoka Gorge and surrounding habitats, and complements existing studies conducted in 1993 and 1998 for these same habitats. Available data has been sufficient to identify the ecological sensitivities associated with the terrestrial ecology resulting from construction of the proposed BGHES.

Box 8-3 lists gaps in information identified and how these will need to be addressed.

Box 8-3 Current Biodiversity Knowledge Gaps

- The botanical knowledge of the Batoka Gorge floral diversity is limited. This relates particularly to the side walls of the Gorge and associated tributaries.
- Past and recent raptor surveys have focussed on the first 25 km stretch of the Zambezi River downstream from the Victoria Falls. There have been no comprehensive surveys undertaken for the lower sections of the Batoka Gorge affected by the BGHES. A proposed action plan for Taita Falcons and other raptors is presented in *Chapter 10* of this ESIA.
- The Batoka Gorge is known to support a high abundance and diversity of bats, which includes two near threatened species, but little is known about the ecology of these populations. Bat monitoring is recommended as an action in the management plans associated with this ESIA.
- Gardiner (2004) mentions several butterfly species that are endemic to the Rain Forest vegetation associated with the Victoria Falls and the Upper Zambezi islands. The habitats of the Batoka Gorge are different but may support unique Lepidoptera (butterfly) assemblages, particularly within the, but these are currently not known.
- Data presented for the terrestrial ecology has been built upon the existing data for previous ESIA studies (1993 and 1998) for the proposed BGHES. The terrestrial ecology of the Zambian side less represented than the Zimbabwean side. The Zambian side of the Zambezi River has far fewer protected areas and receives less protection and is therefore less diverse and less sensitive than the ecology on the Zimbabwean side, which is part of the reason for the reduced assessment there.

9 DESCRIPTION OF THE SOCIO-ECONOMIC ENVIRONMENT

9.1 INTRODUCTION

An initial social baseline study was undertaken by ERM in 2014. However, due to the time that has elapsed since the initial study was undertaken, the baseline was considered outdated. As such, this social baseline study seeks to update the existing 2014 social baseline data with information collected in the field between June and July 2019.

The baseline information in this Section has been derived from the Focus Group Discussions (FGDs) and Key Informant Interviews (KIIs) with Chiefs, Headmen, government officials and communities between June and July 2019, and reflects site information on a broad level. Where applicable, data from the social baseline studies undertaken by ERM in 2014 have been included to support new data.

The baseline first seeks to describe information derived at desktop level for National, Provincial and District levels, after which it describes conditions at local level through primary data collection findings from the July 2019 FGDs, KIIs and specialist observations while in the field.

The key sensitivities of the socio-economic and cultural landscape are presented in *Box 9.1*.

Box 9.1 Key Sensitivities

- *Impacts to tourism industry:* The project is likely to significantly reduce white water rafting opportunities on the Zambezi River. Tourism was noted as a key income source in the project area.
- *Health:* Health infrastructure and the health profile of the communities was reported as poor. Influx of workers for construction of the dam may place further strain on health facilities and detrimentally affect health care services and health status.
- *Ecosystem Services* – The rurality of most of the villages, particularly those affected by the transmission line and dam in in Zambia and the roads on the Zimbabwe side of the Project means that many communities rely on ecosystem services for both subsistence and income. The loss of access to these resources is a key social sensitivity for both Zambia and Zimbabwe.
- *Cultural heritage:* Stakeholders were also concerned about the impact on Victoria Falls as a World Heritage site and potential impact to access to Chemapato hill, a site of cultural significant to some.

A number of data gaps were identified and should be considered when reading this Section. These gaps are outlined in *Box 9.2*.

Box 9.2 Key Data Gaps

- This is a high-level social baseline update study. As such, household level surveying and information collection was not undertaken.
- Information in this report is derived from the existing social baseline, FGDs, KIIs as well as field observations.
- Secondary data is limited at local level (District, Ward and Village).
- There is limited information available on intangible heritage and sacred sites because this information is often considered confidential by communities and as such not shared with the field team.

The scope of the current ESIA was therefore developed so as to:

- Update primary and secondary baseline data;
- Identify and engage with vulnerable groups;
- Develop an understanding of proposed developments in the project area;
- Undertake further site reconnaissance for the heritage impact assessment;
- Consider all infrastructural components.

9.2 DEFINING THE PROJECT AREA

This Section discusses the potential geographic extent of social impacts related to the proposed Batoka Gorge Hydro-Electric Scheme (BGHES), which is referred to as the Project Area throughout this Section. The Project therefore in the context of this social baseline is defined as the area in which communities will experience social impacts as a result of the Project, both direct and indirect. Communities experiencing direct impacts will be affected by economic and physical displacement as a result of the location of Project infrastructure and restricted access to natural resources. Indirect impacts will be experienced in neighbouring communities. The villages within the Project Area are highlighted in *Figure 9.1*.

In Zambia, the Project falls within the Southern Province and in the Districts of Kazungula, Zimba, Kalomo and Choma. Kazungula District; and in particular, Mukuni Ward, is under the jurisdiction of Chief Mukuni, and is anticipated to be directly affected due to the placement of the BGHES infrastructure, access roads and project township. The proposed transmission line alignment has direct impacts on villages in Kazungula District, as well as Zimba District, (namely Zimba ward), which is under the jurisdiction of Chief Sipatunyana, Kalomo District, also under Chief Sipatunyana and Choma District (in the ward of Singani). The Project area also covers Livingstone District, as impacts are also likely to be experienced there. Downstream impacts will particularly affect those communities identified in the Simwatachela Chiefdom.

The administrative breakdown of affected communities is provided in *Table 9.1*

In Zimbabwe, the Batoka Gorge Hydro-Electric Scheme (BGHES) falls within the province of Matabeleland North and in the Hwange Rural District. It includes the wards of Matetsi, Chidobe, Katchecheti, Nemanhanga, Mbizha, Jambezi, Sizinda, Mashala and Chinkandukubi. The affected chiefdoms are Hwange, Mvuthu and Shana.

Social Study Communities

High-level baseline data was obtained during public consultation meetings. However, more detailed baseline data collection and household questionnaires were conducted in a sample of communities within the SAoI in Zambia and Zimbabwe. These are referred to as the social study communities.

High-level baseline data was obtained through public consultation meetings with Chiefs, Headmen, District officials and community members conducted in July 2019. Communities were chosen through grouping communities together that were in relatively close proximity to each other spatially and with similar Project impacts (e.g. impacts associated with the dam and associated infrastructure and impacts associated by land take for the project township). These clusters are demonstrated in *Table 9.1* and are referred to throughout this Section. *Table 9.1* also outlines the settlements engaged during the June 2019 update to the social baseline as well as the cluster they have been grouped in.

The social study area did not include detailed FGDs with downstream communities at the time of data collection, as impacts to these areas were not established due to limited information pertaining to the expected water flows. However, downstream village Headmen and Chief Simwatachela were engaged as part of the Zambian social study. FGDs were undertaken as far downstream as Choma District (up to 193km away) with government representatives and traditional authorities.

Table 9.1 Settlements Sampled for the Social Baseline

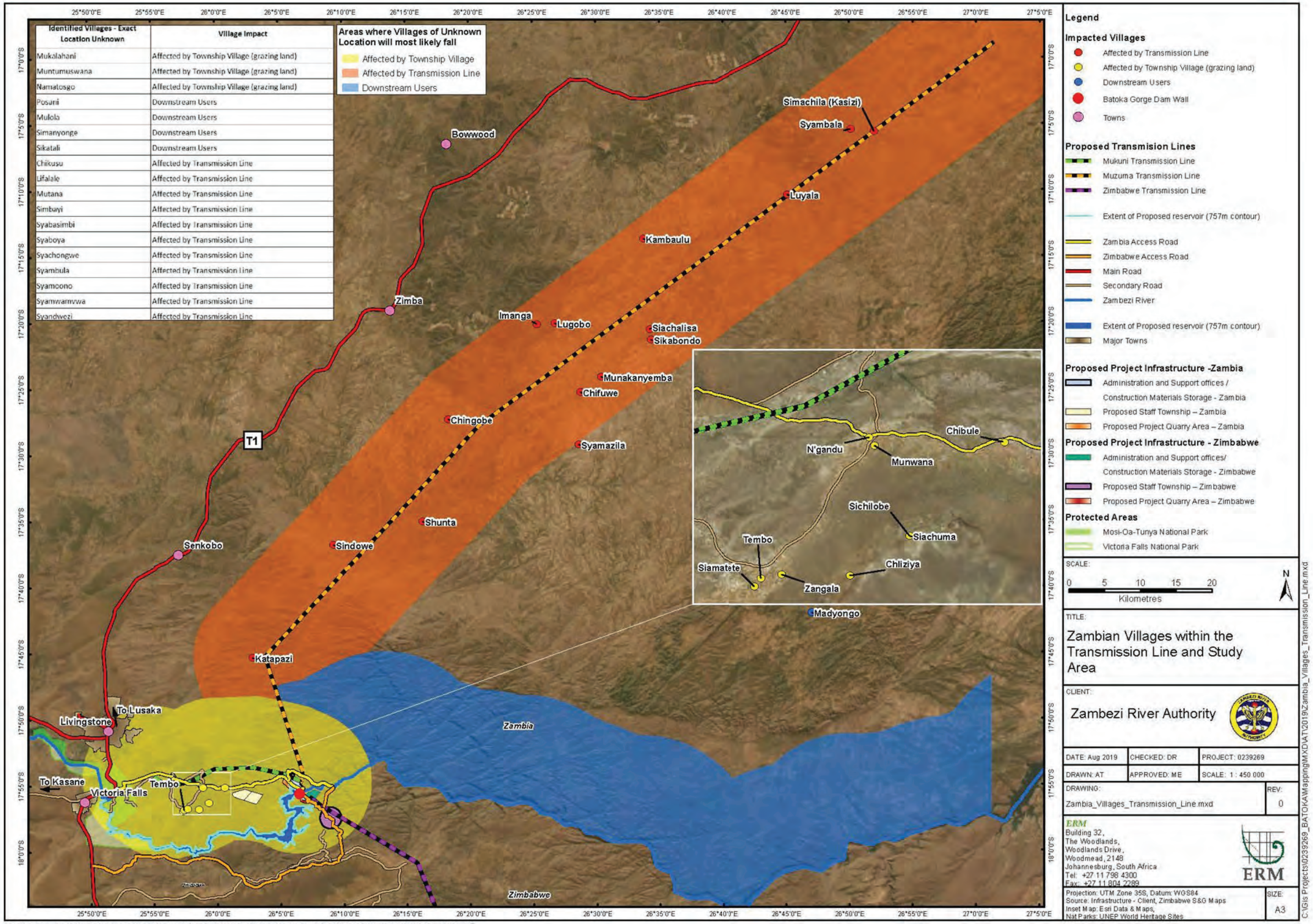
Village Cluster	Affected Village	District	Province	Chiefdom	Data Collection Activities
ZAMBIA					
Dam and Project Township					
Katapazi	Katapazi (including 17 villages)	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
Ng'andu	Muntumuswana	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Chibule	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Ng'andu	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen,

Village Cluster	Affected Village	District	Province	Chiefdom	Data Collection Activities
					including vulnerable groups
	Munwana	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Mukalahani	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Siachuma	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Chilizya	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Zangala	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Namatosgo	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Siachalisa	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Sichilobe	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Siamatete	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups
	Tembo	Kazungula	Southern	Mukuni	FGDs with villagers and Headmen, including vulnerable groups

Village Cluster	Affected Village	District	Province	Chiefdom	Data Collection Activities
Downstream Water Users					
Valley	Mulola	Zimba	Southern	Simwatachela	KII's with Chief and Headman
	Madyongo	Zimba	Southern	Simwatachela	KII's with Chief and Headman
	Sikatali	Zimba	Southern	Simwatachela	KII's with Chief and Headman
	Simanyonge	Zimba	Southern	Simwatachela	KII's with Chief and Headman
	Posani	Zimba	Southern	Simwatachela	KII's with Chief and Headman
	Siampondo	Zimba	Southern	Simwatachela	KII's with Chief and Headman
ZIMBABWE					
Dam, Associated Infrastructure and Project Township					
Sizinda	Chidobe	Hwange	Matabeleland North	Mvuthu	FGDs with villagers and Headmen, including vulnerable groups
Chisuma	Katchecheti	Hwange	Matabeleland North	Mvuthu	FGDs with villagers and Headmen, including vulnerable groups
Jabula	Nemanhanga	Hwange	Matabeleland North	Mvuthu	FGDs with villagers and Headmen, including vulnerable groups
Bhiss	Jabula	Hwange	Matabeleland North	Shana	FGDs with villagers and Headmen, including vulnerable groups
Batoka	Nemanhanga	Hwange	Matabeleland North	Shana	FGDs with villagers and Headmen, including vulnerable groups
Kasikiri	Nemanhanga	Hwange	Matabeleland North	Shana	FGDs with villagers and headmen, including vulnerable groups
Monde	Chidobe	Hwange	Matabeleland North	Mvuthu	FGDs with villagers and Headmen, including vulnerable

Village Cluster	Affected Village	District	Province	Chiefdom	Data Collection Activities
					groups
Jemwe	Katchecheti	Hwange	Matabeleland North	Mvuthu	FGDs with villagers and Headmen, including vulnerable groups
Milonga	Mbizha	Hwange	Matabeleland North	Shana	FGDs with villagers and Headmen, including vulnerable groups
Sidakeni	Sidinda	Hwange	Matabeleland North	Shana	FGDs with villagers and Headmen, including vulnerable groups

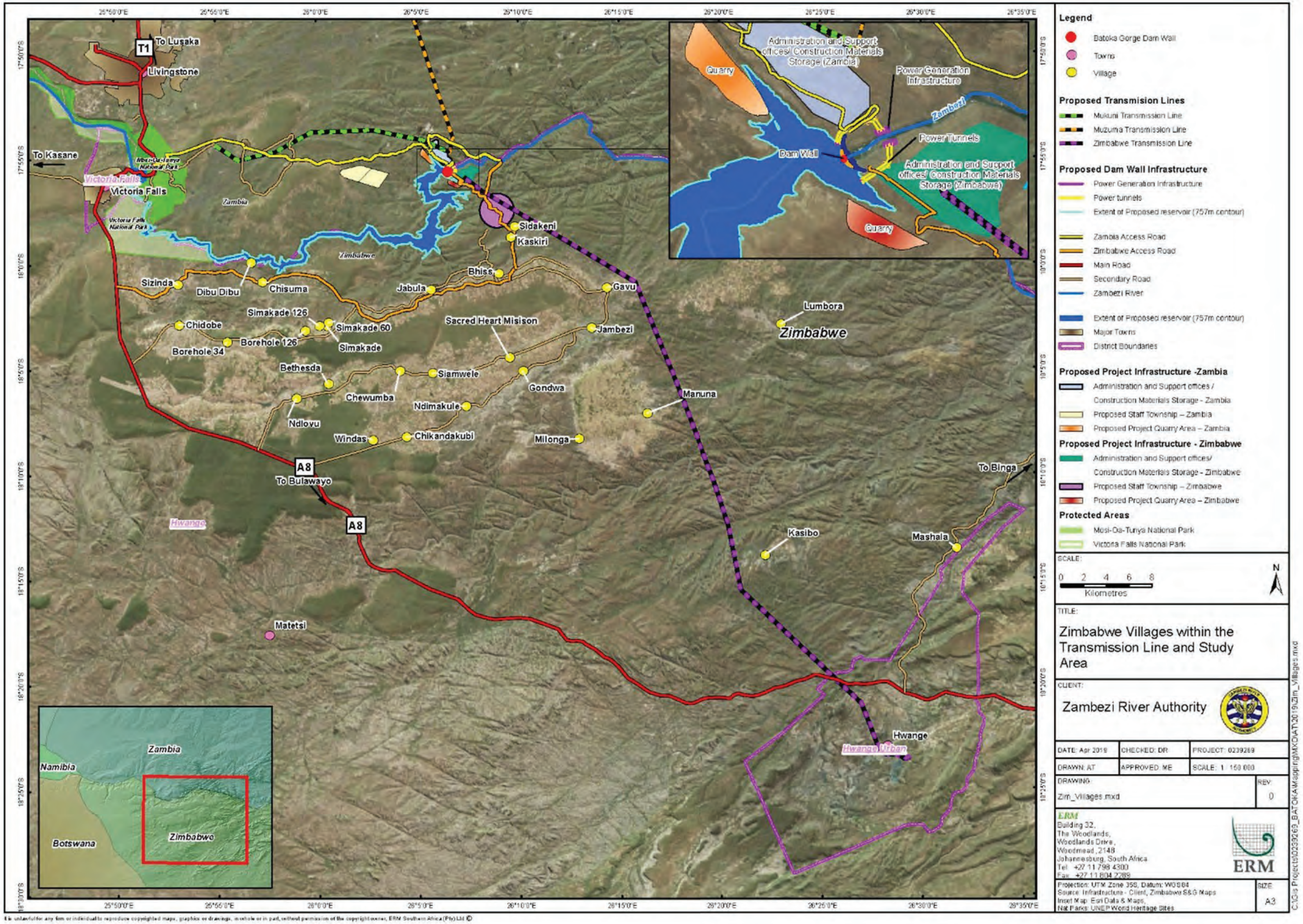
Figure 9.1 *Social Study Project Area - Zambia*



Identified Villages - Exact Location Unknown	Village Impact
Mukalahani	Affected by Township Village (grazing land)
Muntumuswana	Affected by Township Village (grazing land)
Namatosgo	Affected by Township Village (grazing land)
Posani	Downstream Users
Mulola	Downstream Users
Simanyonge	Downstream Users
Sikatali	Downstream Users
Chikusu	Affected by Transmission Line
Lifalale	Affected by Transmission Line
Mutana	Affected by Transmission Line
Simbayi	Affected by Transmission Line
Syabasimbi	Affected by Transmission Line
Syaboya	Affected by Transmission Line
Syachongwe	Affected by Transmission Line
Syambula	Affected by Transmission Line
Syamoono	Affected by Transmission Line
Syamwamvwa	Affected by Transmission Line
Syandwezi	Affected by Transmission Line

Note: The figure above shows three proposed locations for the Construction Camp and Permanent Township (labelled 'Proposed Villages' on the Legend). The suitability of these sites is being investigated as part of the ESIA.

Figure 9.2 Social Study Project Area - Zimbabwe



Note: The figure above shows three proposed locations for the Construction Camp and Permanent Township (labelled 'Proposed Villages' on the Legend). The suitability of these sites is being investigated as part of the ESIA.

9.3 GOVERNANCE AND ADMINISTRATION

9.3.1 National, Provincial and District Governance in Zambia

National Government

Officially known as the Republic of Zambia, the country has a land area of 752,000 km^2. It is located in Southern Africa and is landlocked by Zimbabwe, Namibia and Botswana to the south, Angola to the west, Mozambique, and Malawi to the east and the Democratic Republic of Congo and Tanzania to the north. At National level, governance structures comprise of elected members of parliament. Government functions are performed by the Cabinet through various ministries. These ministries are headed by a Minister at National level and representatives at provincial and District levels.

Zambia gained independence from the United Kingdom in 1964. Since 1991, the country has been ruled as a multi-party state. The political governance of the country is structured into three tiers; the Executive, the Judiciary and the Legislature. The President (or Executive) is both head of state and government and the commander-in-Chief of the country's armed forces. He is directly elected through National presidential and parliamentary elections every five years. The President has the power to dissolve the National Assembly and call for elections. According to the constitution a President can only serve for two terms. The last National presidential and parliamentary elections were held in 2016.

The Supreme Court is the highest court of appeal and is headed by the Chief Justice. Zambia's Parliament, also known as the National Assembly is made up of 156 elected members of parliament and up to ten members nominated by the President.

Provincial Government

Zambia is divided into ten Provinces: Copperbelt, Central, Luapula, Eastern, Northern, Lusaka, Southern, North-Western, Western and Muchinga, which are subdivided into 118 Districts. Each Province is headed by a Provincial Minister who is appointed by the President. Each District is divided into constituencies which are made up of a number of wards. The planning and implementation of provincial social and economic development programmes is done by Provincial Development Coordinating Committees (PDCC). District Development Coordinating Committees (DDCC) were established by the Government in 1995, to co-ordinate development activities at a District level.

Local Government

The local governance system is governed by the Local Government Act of 1991 (Cap 281 of the Laws of Zambia), which gives central government supervisory powers over local government and local authorities. The local government structure is a single tier comprising of City, Municipal or District Councils. In general, city councils are located in the urban Districts, which have higher populations and diverse economic activities while the municipal councils cover the peri-urban regions. District councils are located in the rural Districts, which have smaller populations that rely on agriculture. Hence, the District Councils generate less local tax revenue than those of the City Councils.

Legally, all District Councils are responsible for the provision of services as laid down in the Local Government Act. The Act also stipulates that the Local Council consist of members of Parliament in the District, two Chief Representatives (who are appointed by the consortium of local Chiefs within the District), and all the elected Councillors within the District. District Councils are further divided into Wards represented by elected Ward Councillors. In Zambia, the proposed Project falls under Kazungula District (which is divided into 14 wards), Zimba District (seven wards), Kalomo (15 wards) and Choma (25 wards).

The District elections take place every five years to align with the National elections. The District Council is headed by the Council Chairperson. The Council is responsible for the formulation of all local developmental policies in the District. Furthermore, the Council is required to work in three committees responsible for various service provisions, these committees include:

- The finance, commerce and general purposes committee;
- The plans, works, water and sanitation committee; and
- The staff establishment and social committee.

The District Commissioner (DC) is the most senior government official in the District. In addition to general District administration, the DC coordinates all District developmental activities, such as those related to education, health and agriculture, etc. To discharge these functions, the DC heads the DDCC, whose composition encompasses District government departments, the Council, major companies in the District, community based organizations (CBO's) and Non-Governmental Organizations (NGO's). The District council has elected officials i.e. Councillors who represent the wards. Villages are administered by a traditional leader or village head, who are under the jurisdiction of the Chief.

9.3.2 National, Provincial and District Governance in Zimbabwe

National Government

Officially known as the Republic of Zimbabwe, the country has a land area of 390,757km². Like Zambia, Zimbabwe is landlocked and is bordered by South Africa to the south, Botswana to the southwest, Mozambique to the east and Zambia to the northwest. The Zambezi River forms a border between Zambia and Zimbabwe.

There are three tiers of governance at the National level; the Executive for policy implementation, the Judiciary for interpretation of the law and the Legislature for law making. Policy implementation and service delivery at the National level is implemented by ministries that are based in the administrative capital, Harare. They are overseen by Cabinet Ministers, who are the political appointees answerable to the President of the Republic and the Legislature, and are assisted by technical professionals such as Permanent Secretaries to Ministries, as well of the Ministries

Directors and Heads of Departments. Provincial and District heads or representatives of ministries oversee policy implementation and service delivery at the Provincial and District level respectively.

National Government is accountable to the citizens through elected Members of Parliament (MPs) who hold five-year terms. The winning political party in National elections for MPs form a government (the Executive branch of Government). The Parliament of Zimbabwe makes laws for the republic while local authorities (Rural District Councils, Town Boards, Town and City Councils) make by-laws that regulate the functions of their local constituencies.
For the interpretation of the law and arbitration in disputes the Judiciary has primary and local courts that deal specifically with civil customary matters in rural and communal areas. These are administered by local Chiefs and Headmen. The next level of courts is general and special courts that are also used as appeal courts after the primary and local courts. General courts start from the magistrates' courts, which deal with civil and criminal matters and have limited jurisdiction, high courts that have an inherent jurisdiction for both civil and criminal matters, also operating as courts of appeal from the magistrate's court; the Supreme Court with inherent jurisdiction operating as courts of appeal. The Constitutional Court is the last court of appeal with inherent jurisdiction in constitutional matters only. There are also special courts that deal with special matters. These comprise of the Labour Court and the Administrative Court that respectively deal with exclusively labour matters and exclusively administration issues.

Provincial Government

Zimbabwe is divided into ten provinces: Manicaland, Mashonaland Central, Mashonaland East, Mashonaland West, Masvingo, Matabeleland North, Matabeleland South, Midlands, Bulawayo and Harare (the latter two are technically cities that have Provincial status for administrative purposes). As per the situation in Zambia, each province is divided into Districts, which are subdivided into wards. The country has 59 Districts and 1,200 wards. In Zimbabwe Provinces are administered by a presidentially elected Provincial Governor who is supported by the Provisional Administrator and several ministries.

The Provincial Governor is the head of Provincial Councils (PCs) whose members include:

- Mayors and one Councillor from each municipality and City Council in that province;
- Chairperson and one Councillor from Town Councils, Local Boards and Rural District Councils in that province; and
- Representatives from the Provincial Assembly of Chiefs.
- The PCs' main functions are co-ordination and development and they are supported by the Provincial Development Council (PDC). The PDC is comprised of:

    - Provincial Governor as Chairperson;

- Heads of line ministries in the Province including the security ministries;
- District Administrators in the Province;
- Town Clerks, Town Secretaries and Local Board Secretaries in the Province;
- Chief Executive Officers of Rural Development Councils;
- Captains of Commerce and Industries in the Province;
- Heads of parastatals in the Province; and
- Heads of civil society organisations in the Province.

Provinces are further comprised of Councils (urban and rural local authorities).

The Councils are divided into Wards (and villages in rural, and neighbourhoods in urban areas), with each ward represented by a Councillor elected by a simple majority. Ward boundaries in rural areas do not always coincide with a mosaic of hereditary chieftainships, which are subdivided into areas governed by Headmen and Village Heads. These structures of local government are discussed below.

Local Government

Local government in Zimbabwe is governed by the Ministry of Local Government, Public Works and National Housing (MLGPWNH). The key local government legislation and its roles and responsibilities are indicated in *Table 9.2*.

Table 9.2 Local Government Legislation and Roles and Responsibilities of Local Government

Legislation	Roles and responsibilities
Rural District Councils Act (1996)	Plan and implement local development
Urban Councils Act (1996)	Provision and management of basic services, including health, education, refuse removal, water, and sanitation
Regional Town and Country Planning Act (1976)	Provision and maintain roads
Traditional Leaders Act (2000)	Provision of housing and serviced stands
Provincial Councils and Administration Act (1985)	Provision of social welfare

Source: Jaap de Visser, et al. 2010. Local Government Reform in Zimbabwe: A Policy, Community Law Centre, Cape Town.

Local government comprises of Rural District and Urban Councils. In 2010, Zimbabwe had 60 rural and 31 urban, local authorities. Council areas are divided into Wards, each represented by an elected Councillor. Local authorities function by, and are structured on, a committee system. These are set up in accordance to Sections 4 to 14 of the Rural District Councils Act and the Urban Councils Act of 1996.Urban Council (UC).

Urban District Council (UDC)

The UC comprise of cities, municipalities, town councils, and local boards. UDCs are hierarchically organised, based mainly on their size and functions. At the highest level, there are cities/town council (seven) and at the lowest level, local boards (four). Town Councils and Local Boards have Chairpersons and Secretaries as heads of their policymaking bodies and management, respectively. Whereas, Municipalities and City Councils have Mayors and Town Clerks and own land within their boundaries, Local Boards and Town Councils do not have that ability. Functions of UDCs range from the core business of council, which is service provision, to issues to do with allowances, mementoes, and orchestras and bands. To better conduct their responsibilities, councils have standing committees. Typically, UDCs have the following:

- Finance Committee – responsible for regulating the financial affairs of Council;
- Health and Housing Committee - responsible for health and housing matters; and
- Environmental Management Committee - responsible for environmental matters.

Rural District Council (RDC)

Rural District Councils (RDCs) are established in terms of section 8 of the RDCs Act [Chapter 29:13]. RDC boundaries coincide with boundaries of administrative Districts, minus UC land and land under National parks. The Act also provide for the appointment of Council Committees, which typically consist of:

- The Ward Councillor representing wards that falls wholly or partly within the urban land;
- Members of Village Development Committees or Neighbourhood Development Committees in the area; and
- No more than two co–opted members per ward in the area.

Each District is administered by the Rural District Council, which comprises of ward councillors, a District Administrator, and a representative of a traditional leader (Chief) which is appointed under customary law. Other government functions at District level are administered by District offices of National government departments.

The Act also provides for the appointment of a Town Board for each town area. The Council is composed of councillors for the town wards and such number of persons, but not exceeding one person fewer than the number of ward councillors. The Town Board has no power to impose levies, special rates, rents or charges. Other committees of the RDCs include the Roads Committee, the Ward Development Committee and the Rural District Development Committee (RDDC). The RDDC consist of:

- The District Administrator as Chairman;
- The Chairperson of every Council Committee;
- The Chief Executive Officer of the Council and other senior officials of the Council;
- Senior Officers of security ministries;
- District Heads of ministries; and
- Other interest groups.

Ward Council

In rural local authorities, policymaking is done at village assemblies, ward assemblies, and the full Council; in ascending order. The Ward Assembly is made up of all Headmen, Village Heads, and the Councillor for the ward. The Ward Assembly is chaired by a headman, and its technical work is undertaken by a Ward Development Committee, which comprises of an elected Ward Councillor (as the chairperson), Headmen (traditional leaders subordinate to the Chiefs), and Village Development Committee representatives.

Wards are further divided into villages. Each village has a Village Development Committee and a traditional leader subordinate to the Headman. The committee is chaired by the Village Head. The assemblies are chaired by Village Heads, and are based on the principle of universal participation (in other words by all villagers above 18 years of age). Technical matters of the assembly are handled by a committee that draws on technical input of people from within the village.

9.3.3 *Traditional Governance - Zambia*

The traditional governance system remains a strong and respected administrative structure throughout Zambia, especially in rural areas. The country is divided into 287 Chiefdoms of which 27 Chiefs make up the House of Chiefs, which runs in parallel to the National Assembly. It acts as an advisory body to the Government on traditional, customary and any other matters referred to it by the President.

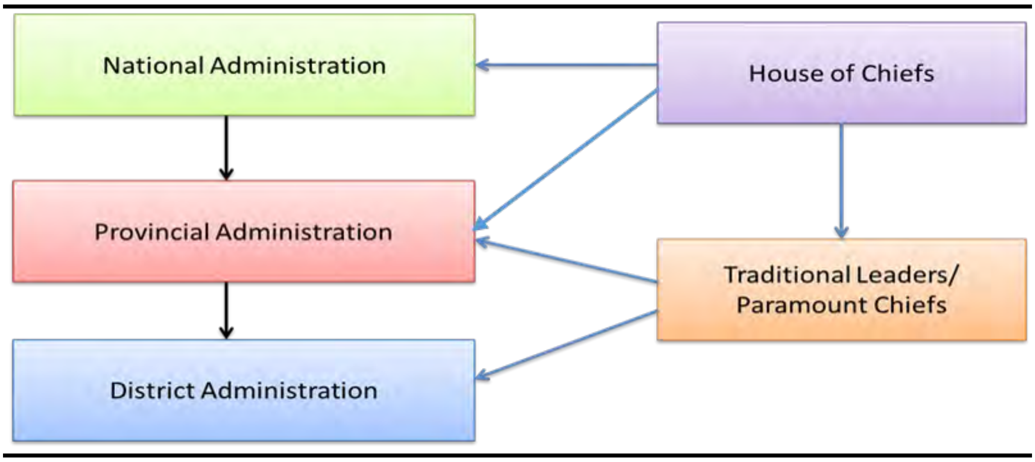
In 2011, the Ministry of Chiefs and Traditional Affairs was established to administer and promote Chief's affairs and traditional governance systems, as well as to facilitate the conservation and preservation of Zambia's heritage, culture and arts.

At the village level, the responsibilities of the Chiefs include:

- Dealing with all customary matters in the Districts;
- Governing people in accordance with tribal customs;
- Allocating land through the Headmen/ Headwomen;
- Sensitisation of population for socio-political or developmental activities;
- Conflict and dispute management;
- Representation of villagers at District level;
- Assist District authorities with provision of services in the Chiefdoms; and
- Acting as custodians of customary land that falls within their Chiefdoms.

The Chiefs are assisted by Headmen/Headwomen and Councillors in the administration of their Chiefdoms. In turn, Headmen/Headwomen are helped by village committees and village coordinators. Mukuni Chiefdom, which is one of the Chiefdoms that falls within the Project Area in Zambia, is unique in that it has the Bedyango (or Chieftainess) who co-rules with the Chief. Whilst the Chief oversees political governance, the Bedyango deals with land allocation in the Chiefdom. *Figure 9.3* shows the linkages between the political and traditional governance structures in the country.

Figure 9.3 Links between Political and Traditional Governance Structures



9.3.4 *Traditional Governance – Zimbabwe*

The Traditional Leaders Act (1998) provides for the appointment and duties of Chiefs, Headmen and Village Heads. Chiefs are appointed (and dismissed) by the President to preside over communities inhabiting communal land and resettlement areas. The appointment takes into consideration the prevailing customary principles of succession, if applicable to the community over which the Chief is to preside; and the administrative needs of the communities in the area concerned in the interests of good governance. A Chief qualifies for the payment of a salary, allowances, gratuities and a pension. The Chief's roles include performing of functions associated with the office of a Chief as community leader, as well as the maintenance and promotion of community cultural values. Functions further include:

- Promoting and upholding cultural values among members of the community under his jurisdiction, particularly the preservation of the extended family and the promotion of traditional family life;
- Supervising Headmen and Village Heads in the performance of their duties; and discharging any functions conferred upon him in terms of the Customary Law and Local Courts Act;
- Overseeing the collection of levies, taxes, rates and charges payable in terms of the Rural District Councils Act by Village Heads;
- Ensuring that Communal Land is allocated in accordance to the Communal Land Act;
- Ensuring that the land and its natural resources are used and exploited within legal boundaries;
- Protection of public infrastructure and services;
- Adjudicating in and resolving disputes related to land in his area; and
- Maintaining up-to-date registers with all villages' names, their inhabitants and copies of land certificates.

Traditional leadership and jurisdiction over arbitration and law enforcement is provided for under the Customary and Local Courts Act (Chapter 7:05).

At Provincial level, there is a Council of Chiefs, which is comprised of between three to five members from each province, who are elected by Provincial assemblies at the same time as the general election. The Council meets at least twice a year with the mandate to:

- Make representations to the Minister of Local Government concerning the needs and wishes of the inhabitants of communal and resettlement land;
- Consider any representations made to it by a Provincial Assembly and, in its discretion, to report thereon to the Minister;
- Consider and report on any matter referred to it by the Minister for consideration; and
- Superintend the activities of the ward assemblies and village assemblies and to give them such directions, as it considers necessary.

The Chief nominates a person to serve as Headman and the Minister appoints the Headman. A headman qualifies for a salary and allowances.

The Village Heads are nominated by the Headmen, and appointed by the Secretary of the Minister of Local Government, along with the written approval of the relevant area Chief. Village Heads assist Headmen in their duties and they qualify for payment from the rural District council. The duties of Headmen and Village Heads are summarised below in *Table 9.3.*

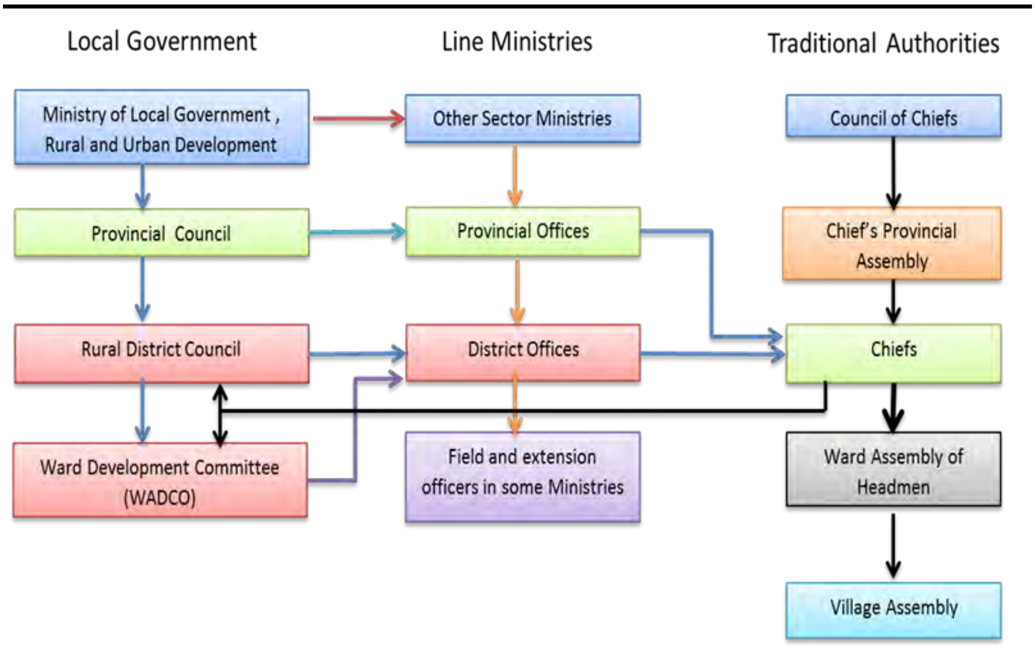
Table 9.3 Duties of the Headmen and Village Heads

Headmen	Village Heads
To report to the police any crime or offence in his area and any actual or threatened public unrest likely to disturb the public peace;	To consider requests for settlement by new settlers into the village and, in consultation with the Village Assembly, to make recommendations on the matter to the Ward Assembly;
To report all criminal acts, acts of misconduct and violations of customs and traditions to the Chief and any other appropriate authority;	To settle disputes involving customary law and traditions, and to refer these matters for settlement by the headman;
To preside over a Ward Assembly when elected as chairman;	To preside over the Village Assembly;
To oversee the disposal of settlement rights in Communal Land and the admission of new settlers in the area under him;	To produce, in consultation with the Village Assembly, Village Development Plans for his area and to submit them to the Ward Assembly;
To keep an up-to-date register of the villages and Village Heads under him and to keep the Chief and the Rural District Council informed of any changes to the register; and	To preside over the Village Development Committee;
To mediate in local disputes involving customary law on matters such as lobular, elopement, and others.	To collect levies, taxes and other charges payable in terms of the Rural District Councils Act; and
	To maintain an up-to-date register of names of the inhabitants of his village, and their settlement permits.

Source: Jaap de Visser, et al. 2010. Local Government Reform in Zimbabwe: A Policy, Community Law Centre, Cape Town.

The linkages between the political and traditional governance structures in Zimbabwe are depicted in *Figure 9.4.*

Figure 9.4 Links between Political and Traditional Governance Structure



9.3.5 *Development Policy and Planning in Zambia*

National Level Economic and Development Plans - Zambia

The National Long Term Vision 2030 (Vision 2030), published in 2006, is Zambia's first long-term development plan that sets itself the aspiration to become a 'prosperous middle income nation by 2030'. It sets objectives to attain and sustain annual real growth of 10% by 2030; maintain an inflation rate of 5%, reduce the poverty head count to less than 20%; provide secure access to safe potable water sources and improved sanitation facilities, improve access to education; and, to provide equitable access to quality health care by 2030.

Vision 2030 is supported by shorter-term development plans of five years. The current one, 'The Seventh National Development Plan' (SNDP), establishes the government's plan to achieve 'sustained economic growth and poverty reduction' from 2015 until 2021. The objectives of the SNDP are to:

- Accelerate infrastructure development, economic growth and diversification;
- Promote rural investment
- Reduce poverty; and
- Enhance human development.

Infrastructure development in the SNDP focuses on roads, railways, schools, health facilities and public–private partnerships and the priority growth sectors are defined as being agriculture, livestock and fisheries, mining, tourism, manufacturing and commerce and trade. As part of the focus on tourism, plans are in place to develop the Livingstone area further, so that it is recognised as a world-class tourism resort. This includes facilitating public and private sector investment in order to achieve developments in tourist accommodation and related amenities, such as casinos, housing units, shopping facilities, roads, airports and airport infrastructure, water, Information and Communication Technology (ICT) and electricity. Emphasis is also placed on the energy sector as a key driver of socio-economic development and strategies are identified to increase electricity generation capacity by at least 1,000 MW and rural electrification to 15%.

District Level Development Plans - Zambia

At the District level, there are DDCC, responsible for developing District Development Plans that identify development priorities and set out budgets and approaches to meeting set targets. DDCCs are comprised of heads of government ministries, which are represented at the District level and NGOs).

At the time of writing the social baseline, Kazungula and Zimba Districts were in the process of updating their District Development Plans.

Kazungula

An interview with the District Planning Officer for Kazungula District provided information about recent development in the District. This includes the ongoing Kazungula Bridge Project, a joint initiative between the governments of Zambia and Botswana to build a road and rail bridge across the Zambezi River. The project is being pursued to facilitate movement between the two countries and to enhance trade in Southern Africa. Construction has already commenced and 40 households have been relocated. In addition, roads in the District are also being rehabilitated, including the upgrading of the Simoonga-Makunka road to gravel standards. Telephone masts are being installed in rural areas to improve communications. A District hospital is also under construction and plans are underway to construct 10 Rural Health posts in various wards.

The District Planning Officer indicated in KIIs that there is great potential in the District regarding surface water, which is an abundant resource that has yet to reach full economic potential (tourism, energy, agriculture etc.). Development of the agricultural sector is a priority for the District. The District has plans in place to enhance and increase agricultural production and productivity in order to attain and sustain food security and income generation. To this end, it continues to improve and develop rural infrastructure such a roads, as well as storage facilities, to assist access to markets. It has also constructed new dams and rehabilitated older ones to foster irrigation schemes.

Zimba

Recent development in Zimba has included the construction of District administration offices (including a civic centre), a police station and housing for government personnel. The District Council is also selling a large plot of land for residential purposes. The KII with the Zimba authorities included numerous discussions around Council and National Government plans to improve its road network through the rehabilitation of District and feeder roads, which is ongoing. The District faces significant water shortages an issues around access to education, healthcare and sanitation.

<u>Choma</u>

Choma KIIs revealed similar focus on prioritising and developing public infrastructure. The council continues to rehabilitate clinics and primary schools, and has completed the construction of a District administration office and residential housing for government staff. A number of roads in the District are being updates to bituminous standards, including in Kulundana and Simacheche wards, where the road network was reported to be particularly poor. Like Zimba, Choma District suffers water scarcity and lacks access to basic sanitation.

<u>Kalomo</u>

The majority of villages affected by downstream impacts are located within Kalomo District. Road infrastructure within the District is poor, and District planners in Kalomo noted that there are plans in place to upgrade more roads to bituminous standard. In addition, a bus station is under construction, as well as a number of schools. Like Kazungula, the abundance of water in the District holds numerous untapped economic opportunities in fishing, tourism and agriculture. The District continues to work with government and NGOs to improve and increase education and health facilities, particularly in more remote areas.

Strategic Development Plan for the Mukuni Chiefdom - Zambia

A new Strategic Development Plan for the Mukuni Chiefdom is currently being finalised by the Chiefdom and builds on from the 2013-2017 plan. There is continued focus on agriculture, tourism and natural resources, livestock, food security, infrastructure, education, health and Human Immunodeficiency Virus / Acquired Immunodeficiency Syndrome (HIV/AIDS), empowerment of women and youth. The Chiefdom has a number of development projects, including in the fields of HIV/AIDs and adult literacy, which are funded and overseen by NGO's including United States Agency for International Development (USAID) and the Butterfly Project (FGDs, 2019).

9.3.6 Development Policy and Planning in Zimbabwe

Zimbabwe National Level Country Strategic Plans (2017-2021)

The Country Strategic Plan is based on the 2015 Zero Hunger Strategic Review that presents a thorough analysis of the root causes of hunger and gaps in support where, through partnerships, World Food Programme (WFP) can add value and make a difference to people's lives. The review findings highlights the need to move away from short-term food assistance to longer-term technical assistance, building sustainable systems to eradicate hunger and improve nutrition. In Zimbabwe, WFP will help the government achieve this through six strategic outcomes, with closely inter-linked activities to amplify results:

- Food-insecure people, including refugees, in the most affected Districts are enabled to meet their basic food and nutrition requirements during severe seasonal shocks or other crises;
- Children in prioritized Districts will have stunting rates reduced in line with National and global targets by 2025;
- Smallholder farmers have increased access to well-functioning agricultural markets by 2030;
- Food-insecure rural households achieve food security and demonstrate resilience to seasonal shocks and stressors;
- Zimbabwe's social protection system ensures that chronically vulnerable populations across the country are able to meet their basic needs all year round; and
- Partners are reliably supported by world-class, cost-effective and efficient supply chain services

Zimbabwe Agenda for Sustainable Socio-Economic Transformation- Zim Asset (2013-2018)

At the National level, the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZIM ASSET) drives the development agenda through the Integrated Results Based Management (IRBM) system from October 2013 to December 2018. The vision of Zim Asset was "towards an empowered society and a growing economy", with the key themes (or clusters) been:

- Food Security and Nutrition;
- Social Services and Poverty Eradication;
- Infrastructure and Utilities; and
- Value Addition and Beneficiation.
- Sub-clusters are identified as:
- Fiscal Reform Measures; and
- Public Administration, Governance and Performance Management.

Drivers for economic growth are centred in the following sectors: mining, agriculture, infrastructure (especially power generation), transport, tourism, ICT and enhanced support for small and medium enterprises (SMEs) and Co-operatives. In terms of infrastructure, the priority areas were identified as energy and power development, roads, rail, telecommunications, water and sanitation. The BGHES is specifically referenced as an avenue in which access to electricity can be increased.

Zimbabwe United Nations Development Assistance Framework (ZUNDAF) 2016-2020

The 2016-2020 Zimbabwe United Nations Development Assistance Framework (ZUNDAF) is the United Nations (UN) strategic programme framework to support National development priorities as informed by the 2013-2018 Zimbabwe Agenda for Sustainable Socio-Economic Transformation (Zim Asset) and to advance on the achievement of the Sustainable Development Goals (SDGs) as well as other International commitments, norms and standards.

Transitional Stabilization Programme (TSP) October 2018 to December 2020 - Zimbabwe

The Transitional Stabilization Programme outlines policies, strategies and projects that guide Zimbabwe's social and economic development interventions while targeting a robust base for economic growth for the period 2021-2030. The programme prioritises creation of employment, economic stabilisation and stimulation of growth

District Level Development Plans - Zimbabwe

In Zimbabwe District Development Committees are responsible for developing District Strategic Plans that identify development priorities and set out budgets and approaches to meeting set targets. Similar to Zambia, District Development Committees are comprised of heads of government ministries, which are represented at the District level.

<u>Hwange Local Board Strategic Plan (2016- 2020)</u>

The Hwange Local Board Strategic Plan: 2016 – 2020, has been collectively formulated in the letter and spirit of the Constitution of Zimbabwe Amendment (No. 20) Act of 2013 section 264 (2) the objectives of the devolution of governmental powers and responsibilities to local authorities include, inter alia:

- To give powers of local governance to the people and enhance their participation in the exercise of the powers of the State and in making decisions affecting them;
- To promote democratic, effective, transparent, accountable and coherent government in Zimbabwe as a whole; and
- To recognise the right of communities to manage their own affairs and to further their own development.

The Strategic Plan is, therefore, essentially a localised effort to assess previous development efforts with a view to marry them with current variables in order to realistically shape municipal development and service delivery formalities by 2020. It is noteworthy that the Plan comes at a time when Government is making frantic efforts to realign the current legislative framework with the dictates of the new Constitution in those areas where there is incongruence. And, as the Strategic Plan was devised in the context of obtaining Government policies and strategies such as the Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZIMASSET) and the Integrated Results Based Management (IRBM) framework, due care and attention has been granted to logically and materially synchronise the dictates of the Constitution, Government policies and the Strategic Plan.

The Hwange Strategic Plan (2016-2020) is anchored on 16 goals as outlined below:

- Goal 1: Increase access to affordable housing from the current 2 500 to 4 000 by 2020;
- Goal 2: Increase the number of council primary schools from one to two schools by 2020;
- Goal 3: Improve access to health services by 2020;

- Goal 4: Increase the number of community facilities by 2020;
- Goal 5: Increase availability of serviced stands to 1 360 by 2020;
- Goal 6: Increase road network by 2020;
- Goal 7: Increase number of streetlights by 2020;
- Goal 8: Increase number of Tower lights by 2020;
- Goal 9: Improve the current fleet by 2020;
- Goal 10: Increase revenue collection from the current 33% to 70% by 2020;
- Goal 11: Increase income generating projects contribution from $300 000 to US$800 000 by 2020;
- Goal 12: Improve welfare for Employees from the current 10% to 100% by 2020;
- Goal 13: Improve Human Capital & Corporate Services from the current 25 % to 75 % by 2020;
- Goal 14: Increase Hwange Local Board administrative jurisdiction from 7 to 15 wards;
- Goal 15: Mainstream gender in line with the National Gender Policy of Zimbabwe;
- Goal 16: Improve the livelihoods of the vulnerable and disabled by 2020.

9.3.7 Role of Multi-lateral and Bi-lateral Agencies and NGOs in Zambia

A number of multi-lateral and bi-lateral agencies operate in Zambia to support government structures with service delivery, governance and social and economic development. At the National level, these include United Nations Development Programme (UNDP), World Bank, Africa Development Bank, European Union, USAID, Japanese International Cooperation Agency (JICA) and the Department for International Development (DFID). USAID operates in the Kazungula District and has run programmes to enhance farmer resiliency through a fodder management programme. International and local NGOs also operate at National and District levels including Plan International, World Vision, Save the Children, United Nations Children's Fund (UNICEF), CARE International, Caritas Zambia, Africa Impact, Corridors of Hope and many others. They are active in supporting economic and social development and environmental protection through a wide range of activities.

Smaller local NGOs include The Butterfly Tree based in Mukuni ward in Kazungula District, which supports school rehabilitation and health promotion activities, and Response Network, based in Livingstone District, which support infrastructure development, women empowerment and sports programmes. In Zimba and Choma District, the following NGO's are known to operate:

- World Vision has helped to improve water supply and sanitation;
- Land 'O' Lakes has supported conservation of animal pasture; and
- Kochebuka has sensitised communities around HIV/AIDS.

However, none of these agencies were reported to be actively working in any of the affected villages during FGDs in June and July 2019.

9.3.8 Role of Multi-lateral and Bi-lateral Agencies and NGOs in Zimbabwe

Zimbabwe also receives support from multi-lateral and bi-lateral agencies. NGOs active at the District and local level include:

- World Vision who have built schools and clinics and support in nutrition and Zimbabwe AIDS Project that offer support in HIV and Nutrition;
- Anglican Church Isdell Flowers that offer support in Malaria;
- Lubancho House who work with orphans and vulnerable children;
- Bird Life Zimbabwe with a mandate in conserving birds and their habitats, increasing awareness of birds through education and participating in scientific studies of birds;
- Intengwe – Victoria Falls who looks after the welfare of orphans, women's rights and HIV/AIDS;
- Dhibha Mombe who promotes animal health;
- Rose Charity (orphanage);
- World Wildlife Fund;
- Avangani Trust (PLWD);
- United Child Africa Trust (UNCAT) for rehabilitation;
- Campfire Project Catholic Development Commission and Christian Care Zimbabwe; and
- Environment Africa is also active in the area and has sensitized Wards about the need to look after the environment through various clean up campaigns.

NGOs reported to be actively working in the active in the Project Area during the KIIs and FGDs held on June and July 2019 include:

- Rose of Charity Orphanage;
- Chinotimba Old Peoples Home;
- Sizinda Agricultural Training Centre;
- Lubancho House;
- Avangani Trust;
- World Vision; and
- United Child of Africa Trust (UNCAT).

Some of the NGOs observed along the access road during the site visit are shown in *Figure 9.5* below. Only the signposts for the Rose of Charity Orphanage and Sizinda Agricultural Training Centre will be impacted by the Project.

Figure 9.5 NGOs in the Zimbabwe Project Area

Photo 1: Rose of Charity orphanage sign post along the access road at Chidobe Ward, Hwange

Photo 2: Chinotimba Old peoples Home located at Hwange

Photo 3: Environment Africa in Victoria Falls was not active during the visit

Photo 4: Sizinda Agricultural Training Centre sign post along the access road

Source: ERM KIIs, 2019

Several KIIs were held with the NGOs along the Project access road on July 2019. A summary of their activities and concerns is shown in *Table 9.4* below.

Table 9.4 Activities and Concerns of the NGOs in the Zimbabwe Project Area

Headmen	Village Heads
Rose of Charity Orphanage	• It is a safe house for abused and vulnerable children in Victoria Falls. • Currently supporting about 96 children. Most of the children are at boarding schools and about 23 live at the orphanage. • The orphanage takes care of the children until they get to 18 years of age. • There are about seven (7) children living with HIV/AIDS supported by the NGO. • The children are supported with food supplies and education support e.g. school fees and clothes etc. • The vulnerable children are selected through the Ministry of Social Welfare. • Vegetables such as spinach and tomatoes are grown at the orphanage and are used to feed the children. They also rear poultry that is sold to the locals to generate revenue. • Main concern for the orphanage is dust, noise, safety of the children pertaining to traffic, inaccessibility during construction and potential loss of property and trees.
Chinotimba Old Peoples Home	• Was established in 1979 and take care of the aged people between 60-100 years old. • Operates under the Ministry Social Welfare. • Receives support (financial) from donations and community office.

Headmen	Village Heads
	• Currently caring for 37 elderly and infirm people. The number is reducing because of financial strain. • Main challenge faced is access to medical facilities and support services. Most of them have to travel long distances to get medical attention. • The mentally disabled people tend to be most affected and neglected in the area because most people do not understand their condition.
Sizinda Agricultural Training Centre	• Train and encourage people to venture into the agri-business concept where they can grow produce including tomatoes, lettuce, cabbages and onions etc. and drought resistant crops such as Cassava. • Fruits cultivated include; guavas, lemons and pawpaws. • Animals bred include cattle, poultry and pigs. • Crops produced are sold within Victoria Falls and around the area. • Offer free training on farming the different types of crops. • Source of water is a borehole based at Sizinda Secondary School. • Receives in-kind support from World Vision. • Challenges faced by the NGO and local agricultural sector include inadequate rainfall, crop disease, armyworm infestations and livestock diseases, especially among cattle. • Concerns regarding the project include creation of dust, noise and loss of agricultural land.

Source: ERM KIIs, 2019

9.4 *DEMOGRAPHICS AND GROWTH*

9.4.1 *National, Regional and District level Population Data - Zambia*

Population Size

In 2017, Zambia recorded a total population of 16,405,229 people (ZamStats, 2018), an increase of over 16% from 2010. In 2019 the total population is projected to reach 17,381,168. The average annual population growth rate in this ten-year period will therefore reach 2.9 %. Consequently, it has one of the fastest growing populations in Sub-Saharan Africa, largely due to its high fertility rates.

Zambia has a predominantly rural population; at the National level 53.8% live in rural areas and 46.2% in urban areas. It is sparsely populated, with a population density of 23.3 persons per km^2 (ZamStats, 2018).

The Southern Province covers an area of 68,410 km^2 and has an estimated 2019 population of 1,902,365, accounting for 11.0 % of the total projected National population. Its population density is 27.81 persons per km^2 and it has a larger rural population, with only a quarter of its inhabitants living in urban areas. *Table 9.5* presents the population figures for the Districts within the Project Area in Zambia. Choma, the provincial capital and has the largest population and a population density of 22.0 people per km2, while Kazungula has the smallest population density at 8.5 people per km^2. Livingstone District, the tourist capital of the country, is the most densely populated District in the Province, at 251.5 people per km^2 (ZamStats, 2018).

Table 9.5 Zambia Population Statistics – District Level

District	Population (2010 census)	No. of Households (2010 census)	Population density (km², 2019 Projection)	Population (2019 Projection)
Choma	180, 673	45,733	41.72 / km²	217,385
Kalomo	188,693	33,180	33.10 / km²	277,172
Kazungula	104,731	20,417	8.480 / km²	154,995
Livingstone	139,509	31,177	251.5 / km²	185,003
Zimba	69,877	13,284	18.44 / km²	102,643

Source: Central Statistical Office Zambia (2018)

The average household size in Zambia in 2010 was 5.2 persons (5.4 in the Southern Province) (ZamStats, 2010). No recent data was available at the time of updating the social baseline to determine the change in average household size and gender of household heads.

Population Movement and Migration

In-migration in Zambia is fuelled by the search for employment and business opportunities. There is a lack of valid data about the numbers of cross-border migrants (both regular and irregular) as well as internal migrants for the country (IOM, 2015). According to the International Organisation of Migration (IOM), both in– and out-migration in Zambia is undertaken by those in search of improved economic opportunities. Opportunities are largely pursued in the mines of the Copperbelt Province, on commercial farms, in small-scale fishing and fish trading and along the transport corridors that link Zambia with its neighbours. Natural disasters including drought and flooding also play a major role in migration patterns of the population. The Net Migration Rate (2015-2020) for Zambia was -0.5 migrants /1, 000 population, indicating more people leaving the country than entering it. In 2015, 0.8% of the Zambian population were classified as immigrants, 49.6% of whom were women (IOM, 2015).

At District level, all three Chiefdoms confirmed that both in and out migration was occurring. This was particularly true of Kazungula, which experienced high levels of migration due to its location on a National border with Botswana. A described "lack of economic activity" within the District was the reason for much outmigration form the District according to KII's held with members of the Kazungula District council. Displacement resulting from the Kariba dam project in the late 1950's reportedly resulted in a number of people moving into all three Districts, but more so into Choma due to its relative proximity to the Kariba Project-affected area.

Gender and Age Distribution

The National population is slightly weighted towards females, who account for 50.7% of the total population, compared to males at 49.3%. This is also reflected at the Southern Province and District level (ZamStats, 2018).

Table 9.6 Distribution by Gender – District Level

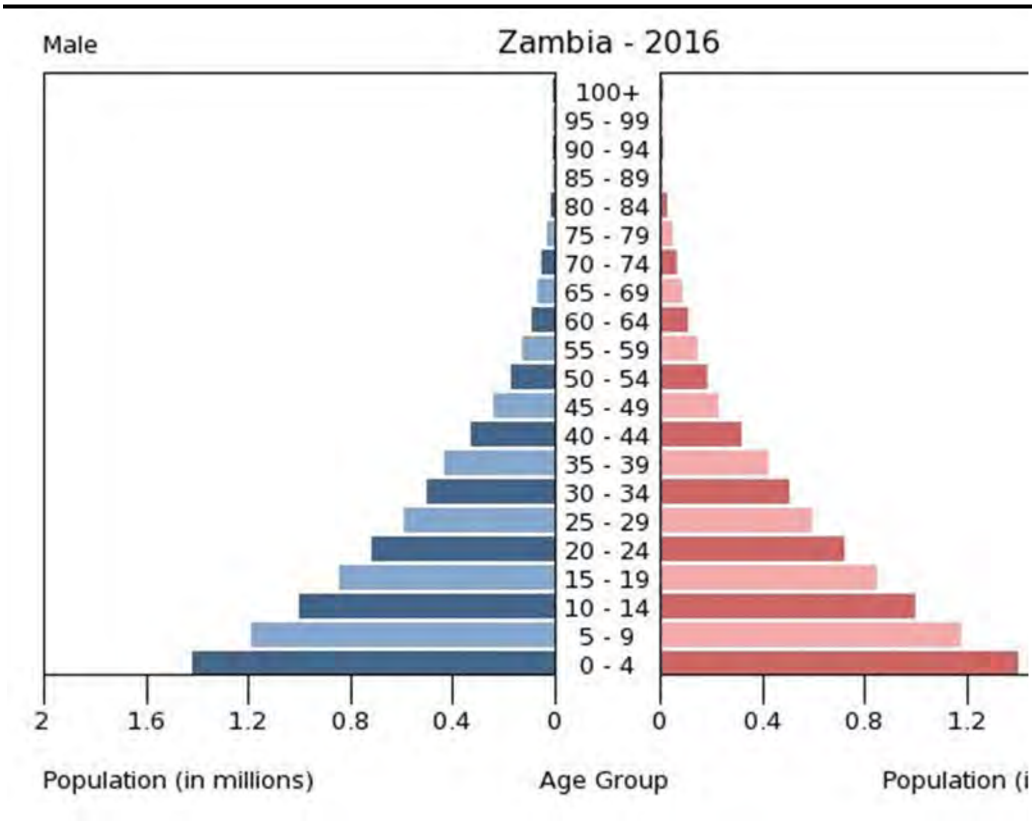
Area	Male (%)	Female (%)
Southern Province	49.0	51.0
Choma	48.9	51.1
Kalomo	48.7	51.3
Kazungula	49.7	50.3
Livingstone	49.3	50.7
Zimba	48.4	51.6

Source: Central Statistical Office Zambia (2018)

Like much of Southern Africa, Zambia has a youthful population. In 2015, over half of the population were aged 14 years and younger (World Bank, 2015). In the Southern Province, 50.1% of the population are between15 and 64 years of age. The most recent age distribution data for Districts in Zambia is the 2010 National census. From this data, the following was established:

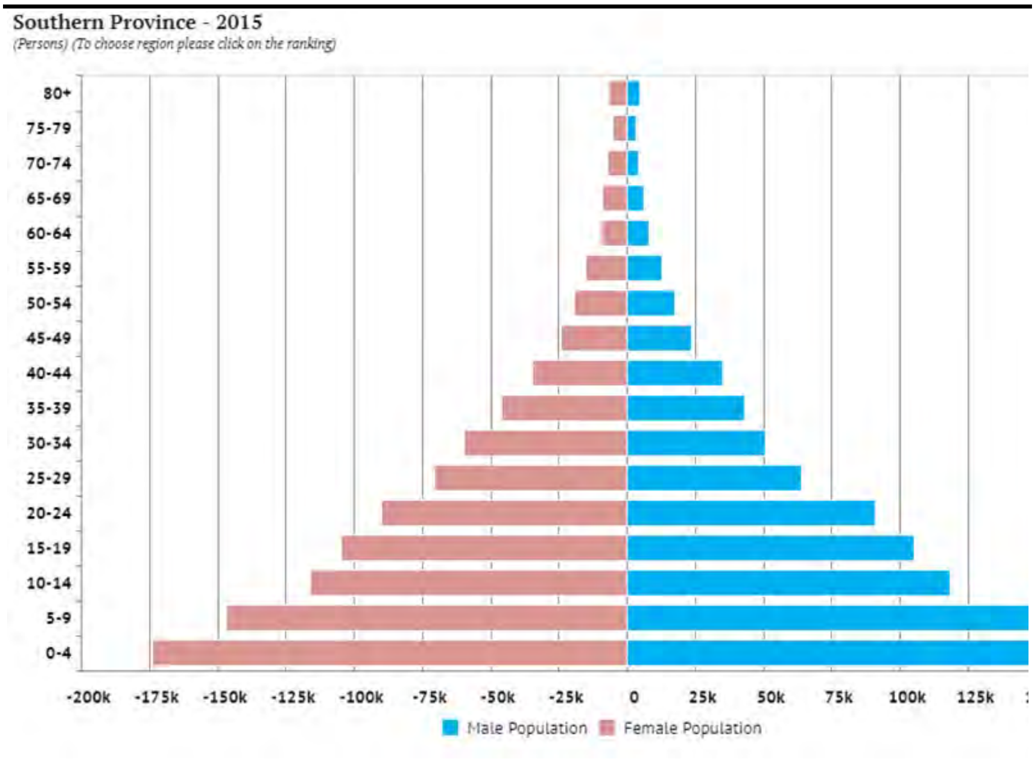
- Choma: 50.3% of the population was aged between 15 and 54 years old;
- Kalomo: 51.3% of the District was 14 or younger;
- Kazungula: 49.5% of the population were 14 or younger; and
- Zimba: 50.1% of the population was 14 or younger.

Figure 9.6 National Age Distribution in Zambia According to Gender



Source: Central Statistical Office Zambia (2018)

Figure 9.7 Southern Province Age Distribution According to Gender



Source: Central Statistical Office Zambia (2018)

Religion, Ethnicity and Language

The majority of Zambians practice Christianity. Protestants (32.4%), Catholics (17.7% and Pentecostals (15.4%) make up the largest Christian denominations nationally. Other, non-Christian religions, including Muslim, Hindu, Bahai and Traditional religions make up about 13.2% (Religious Characteristics of States, 2015).

Zambia is home to 73 ethnic groups. The Bemba is the largest group, accounting for 21% of the population. It is also the most commonly spoken language (33.5%). Tonga is the second largest group, accounting for 13.6% of people at the National level, but 74.4% in the Southern Province. Accordingly, it is the most common language spoken in the Province, including in the Project affected Districts. Other ethnic groups include Namwanga, Mambwe, Luvale and Lala (ZamStats, 2018).

9.4.2 *National, Regional and District level Population Data – Zimbabwe*

Population Size

The population of Zimbabwe was estimated at 14.65 million in 2019, an increase from the 2013 estimate of 14.09 million.

Hwange District, which incorporates Hwange Urban and Hwange Rural, District as well as the town of Victoria Falls; has the largest land area in comparison to other Districts within Matabeleland North Province.

Table 9.7 below, provides a summary of the population characteristics at District level.

Table 9.7 ***Zimbabwe Population Statistics – District Level***

District	Population (2012 census)	No. of Households (2012 census)
Hwange Rural	62,670	15,488
Hwange Urban	37,522	9,992
Victoria Falls	33, 748	9.262

Source: ZimStats, 2012 (Note that updated information is currently inaccessible for 2017 census)

The population of Hwange Rural District is 62,670 (2012). The District has a population density of 2.3 people per km^2 and has an estimated 14,893 households. Household size is typically estimated at an average of 4.2 persons per household.

Hwange Urban, which houses the local municipality and administrative, business and commercial centres in the Province, has a population of 37,522 people, made up of, with an estimated 9,992 households.

Population Movement and Migration

Migration patterns in Zimbabwe are mainly associated with lack of economic opportunities (i.e., employment opportunities, poor working conditions etc.)(1). The current economic situation is a major driver of the migration of skilled nationals (2). Over the past two decades, three million Zimbabweans are estimated to live outside the country (3).

Reduced opportunities for productive employment and career advancement, as well as unequal employer– employee relations in the local labour market, also influence decisions to emigrate. Migration is perceived as a way of overcoming the limitations imposed upon households by local economic conditions and socio-economic development (4). The top five destination countries for Zimbabweans are South Africa, the United Kingdom, Malawi, Australia and Botswana.

The migration patterns within the Hwange District in 2012 were predominantly within the same District, between provinces and countries. These patterns are summarised in *Table 9.8* (5).

(1) IMO. (2018). *Migration in Zimbabwe: A Country Profile 2010 – 2016*. [online] Available at: https://publications.iom.int/books/migration-zimbabwe-country-profile-2010-2016 [Accessed 22 Aug. 2019].
(2) Ibid
(3) BBC News. (2017). *Five ways to revive Zimbabwe's economy*. [online] Available at: https://www.bbc.com/news/world-africa-42079584 [Accessed 23 Aug. 2019].
(4) IMO. (2018). *Migration in Zimbabwe: A Country Profile 2010 – 2016*. [online] Available at: https://publications.iom.int/books/migration-zimbabwe-country-profile-2010-2016 [Accessed 22 Aug. 2019].
(5) Zimbabwe Statistics. (2012). Zimbabwe National Statistics Agency Census 2012 Provincial Report Matabeleland North, Harare, Zimbabwe

Table 9.8 Total Population by District of Enumeration and District of Usual Residence [(6)]

District	Residing in Same District	Residing in Other (Mashonaland, West District)	Residing in Other Provinces	Residing in Other Countries	Total
Hwange Rural	57,920	2,638	1,943	169	62, 670
Hwange Urban	33,274	2,484	1,609	155	37,522
Victoria Falls	27,882	2,522	2,693	651	33,748

Source: ZimStats, 2012

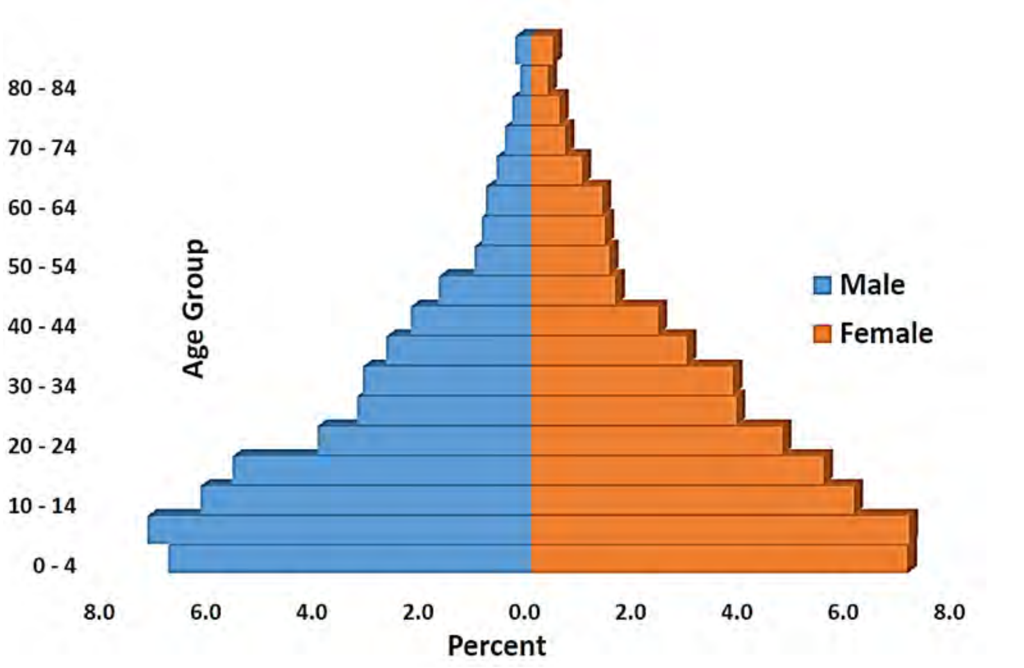
* There is a lack of information related to migration on district level following the 2012 Census Survey. The fieldwork conducted by International Organization for Migration (IMO) in 2017 found no evidence of any mechanism to collect comprehensive migration-related data. In addition, it was difficult to obtain administrative data from the Department of Immigration Control.

Gender and Age Distribution

The composition of population by age group and sex is for Zimbabwe is presented in *Figure 9.8*. The 0 to 4, 5 to 9, 10 to 14 and 15 to 19 year age groups had high proportions of the population, ranging from 11 to 14%. The 70+ year age groups had the least proportion (1%). It can be further observed that the proportion of the young population, that is those age under 15 years, is 40% while that of the old population, age 65 years and above is about 6%. It can be observed that the pyramid is broad-based and narrow at the top. This shows that this population is young since a sizeable proportion of the population belonged to the younger age groups. The number of males is less than that of females for all age groups save for 5-9, 10-14 and 15-19 age groups.

(6) Zimbabwe Statistics. (2012). Zimbabwe National Statistics Agency Census 2012 Provincial Report Matabeleland North, Harare, Zimbabwe

Figure 9.8 Population Distribution by Age and Sex



Source: Zimbabwe ICDS 2017.

Religion, Ethnicity and Language

Christianity is the dominant religion in Zimbabwe, comprising approximately 93% of the population (7). Other religions include Hinduism, Islam and traditional religions.

According to 2012 Census, 99.4% of the Zimbabwean population is of African origin. Whilst the census does not delve into specific ethnicities, Shona is the largest ethnic group in the country, accounting for around 80 to 84% of the National population. Ndebele make up 8 to 10% and the Bantus around 8 to10%. White Zimbabweans form less than 1% of the population (8).

Zimbabwe has three official languages: English, Ndebele, and Shona, which are also the most commonly spoken languages in the country. The 2013 draft constitution makes provision for the recognition of 16 official languages: Chewa, Chibarwe, English, Kalanga, Koisan, Nambya, Ndau, Ndebele, Shangani, Shona, sign language, Sotho, Tonga, Tswana, Venda and Xhosa.

Population Movement and Migration

Migration patterns in Zimbabwe are mainly associated with lack of economic opportunities (i.e., employment opportunities, poor working conditions etc.) (9). The

(7) Cultural Atlas. (2019). Zimbabwean Culture - Religion. [online] Available at: https://culturalatlas.sbs.com.au/zimbabwean-culture/religion-155fc749-1ea1-49a3-9fc8-a4d9059f047a [Accessed 22 Aug. 2019]
(8) Cross Border Road Transport Agency. (2016). Zimbabwe Country Profile Report. [online] Available at: https://www.cbrta.co.za/resources/zimbabwe-country-profile-report-march-2016 [Accessed 22 Aug. 2019]
(9) IMO. (2018). Migration in Zimbabwe: A Country Profile 2010 – 2016. [online] Available at: https://publications.iom.int/books/migration-zimbabwe-country-profile-2010-2016 [Accessed 22 Aug. 2019].

economic crisis is a major factor that fuels migration of highly skilled nationals (10). Over the past two decade, three million Zimbabweans are estimated to live outside the country, having fled the dire economic conditions that emerged (11).

Decreased opportunities for productive employment and career advancement, as well as unequal employer– employee relations in the local labour market, influenced decisions to emigrate. Migration perceived as a way of overcoming the limitations imposed upon households by local economic conditions on development (12). The top five destination countries for Zimbabweans are South Africa, the United Kingdom, Malawi, Australia and Botswana.

The migration patterns within the Hwange District in 2012 were predominantly within the same district, between provinces and countries.

Religion, Ethnicity and Language

Christianity is the dominant religion in Zimbabwe, Nationally comprising approximately 93% of the population (13). Other religions include Hinduism, Islam and traditional religions.

According to 2012 Census, 99.4% of the Zimbabwean population is of African origin. Whilst the census does not delve into specific ethnicities, Shona is the largest ethnic group in the country, accounting for around 80 to 84% of the National population. Ndebele make up 8 to 10% and the Bantus around 8 to10%. White Zimbabweans form less than 1% of the population (14).

Zimbabwe has three official languages: English, Ndebele, and Shona, which are also the most commonly spoken languages in the country. The 2013 draft constitution makes provision for the recognition of 16 official languages: Chewa, Chibarwe, English, Kalanga, Koisan, Nambya, Ndau, Ndebele, Shangani, Shona, sign language, Sotho, Tonga, Tswana, Venda and Xhosa.

9.4.3 Local Level Population Data – Zambia

The original 2014 Social Baseline has been updated using information derived from field work undertaken between June and July 2019. Information was collected using FGDs and KIIs with Chiefs, Headmen, villagers and vulnerable groups. Household level data was not collected.

(10) IMO. (2018). Migration in Zimbabwe: A Country Profile 2010 – 2016. [online] Available at: https://publications.iom.int/books/migration-zimbabwe-country-profile-2010-2016 [Accessed 22 Aug. 2019].
(11) BBC News. (2017). Five ways to revive Zimbabwe's economy. [online] Available at: https://www.bbc.com/news/world-africa-42079584 [Accessed 23 Aug. 2019].
(12) IMO. (2018). Migration in Zimbabwe: A Country Profile 2010 – 2016. [online] Available at: https://publications.iom.int/books/migration-zimbabwe-country-profile-2010-2016 [Accessed 22 Aug. 2019].
(13) Cultural Atlas. (2019). Zimbabwean Culture - Religion. [online] Available at: https://culturalatlas.sbs.com.au/zimbabwean-culture/religion-155fc749-1ea1-49a3-9fc8-a4d9059f047a [Accessed 22 Aug. 2019]
(14) Cross Border Road Transport Agency. (2016). Zimbabwe Country Profile Report. [online] Available at: https://www.cbrta.co.za/resources/zimbabwe-country-profile-report-march-2016 [Accessed 22 Aug. 2019]

Population Size

Based on the data collected from the household survey in 2015, the average household size in the Project Area is 5.2 people. The largest villages in the Project Area were Siyambala and Lugobo, neither affected by the proposed dam and associated infrastructure.

Population increase has been experienced by the majority of communities in the Project Area. Headmen attributed this to an increase in birth rates and in all village clusters, improved understanding of HIV/AIDS and access to antiretroviral therapy (ART), thus reducing the number of deaths attributable to HIV/AIDS.

Table 9.9 displays the population statistics given by Headmen, where known.

Table 9.9 Population statistics for the Zambia Project Area

Village	Population count	Number of affected Households in the Project Area
Dam, Associated Infrastructure and Township Village (grazing land)		
Katapazi	*	*
Muntumuswana	231	66
Chibule	220	67
N'gandu	265	55
Munwana	50	14
Mukalahani	120	24
Siachuma	221	61
Chilizya	142	35
Zangala	112	21
Namatosgo	168	28
Siachalisa	79	18
Sichilobe	106	21
Siamatete	401	77
Tembo	157	35
Downstream Users (Valley Cluster)		
Mulola	*	*
Madyongo		
Sikatali		
Simanyonge		
Posani		
Siampondo		

Source: ERM FGDs and KIIs, 2019

* Population statistics for 2018/19 were not available at the time of FGDs and KIIs. These figures will be collected by the ERM stakeholder reengagement team in November 2019

Population Movement and Migration

In the valley village clusters, the existence of gemstone mining has attracted people to the area, particularly male youths. Furthermore, people in the FGDs of 2019 revealed that people were leaving rural villages to access job opportunities in urban areas and to access higher education. This was reported across the Project Area.

Migration into Project Area villages was reported to be driven by family matters (e.g. marriage), availability of fertile soils and peaceful social conditions. In village clusters located in Mukuni Chiefdom, fishing and tourism were key drivers of in-migration.

Religion, Ethnicity and Language

In the Mukuni Chiefdom, all FGDs participants were from the Toka Leya ethnic group, while in the remaining parts of the Project Area, the majority were found to be Tonga. As such, the most commonly spoken language in the Project Area is Tonga and Toka Leya (which is a dialect of Tonga).

Christianity was the dominant religion in all village clusters. Denominations included Roman Catholic, New Apostle, Apostolic Faith Mission, Church of Christ, Pilgrim Wesleyan Church, Baptist and Seventh Day Adventist.

Gender and Age Distribution

In the household surveys undertaken in 2014, the population in the Project Area was found to be slightly weighted towards males (51%). Youth (under 35 years old) made up the majority of the population within the Project Area, with 26% of the population falling within the age range of 6 to 14 years and 29% between 15 to 25 years. As such, it can be assumed that the Project Area has a high dependency ratio.

9.4.4 *Local Level Population Data – Zimbabwe*

Population Size

Population statistics for the Project Area were collected during the 2019 field survey and are presented in *Table 9.10.*

Table 9.10 Population Statistics for the Study Area in Zimbabwe

Village	Population Count	Number of Households
All villages fall under Hwange District		
Jambezi Ward		
Jambezi	765	160
Nemananga Ward		
Jabula 8 (Kasikiri & Sidakeni, Borehole 55)	186	35
Jabula	652	121
Jabula 6&7	238	53
Mbizha Ward		
Makuni	553	94
Chenambi	567	101

Village	Population Count	Number of Households
Kwalala	758	143
Shantani	477	101
Sisyatwi	437	124
Mashala Ward		
Kasibo	2003	322
Chidobe Ward		
Sizinda	571	136
Chisuma	856	212
Monde	1,089	204
Katchecheti Ward		
Jembwe	985	220
Jambezi Ward		
Jambezi	765	160
Nemananga Ward		
Jabula 8 (Kasikiri & Sidakeni, Borehole 55)	186	35

Source: ERM KIIs, 2019

Population Movement and Migration

According to 2019 FGDs, land availability and tourism are the greatest migratory drivers into the Project Area. Village leaders in Monde suggested that overcrowding in Victoria Falls town by those seeking opportunities in tourism and other sectors in the town is resulting in urban to rural migration from the town into the Project Area villages.

In FGDs with Kasibo village leaders, it was suggested that fertile soil, better grazing land and better access to water sources were also resulting in in-migration into the Jambezi area. In Jembwe, immigration of people was also encouraging the construction and emergence of churches and businesses in the Project Area.

The majority of village leaders agreed that migrants were equally from the Project Area and from outside of the Project Area.

Religion, Ethnicity and Language

The dominant ethnic group in the Project Area is Nambya; however, other ethnic groups reported in the area included Ndebele, Dombe, Tonga, Shona, Lozwi and Sidombe.

The most commonly spoken language in the Project Area is Shona and Ndebele. Christianity was the dominant religion in all villages. Denominations included Roman Catholic, Assemblies of God, Methodist, Zionist, Anglican, Twelve Apostolic and Seven Day Evangelist.

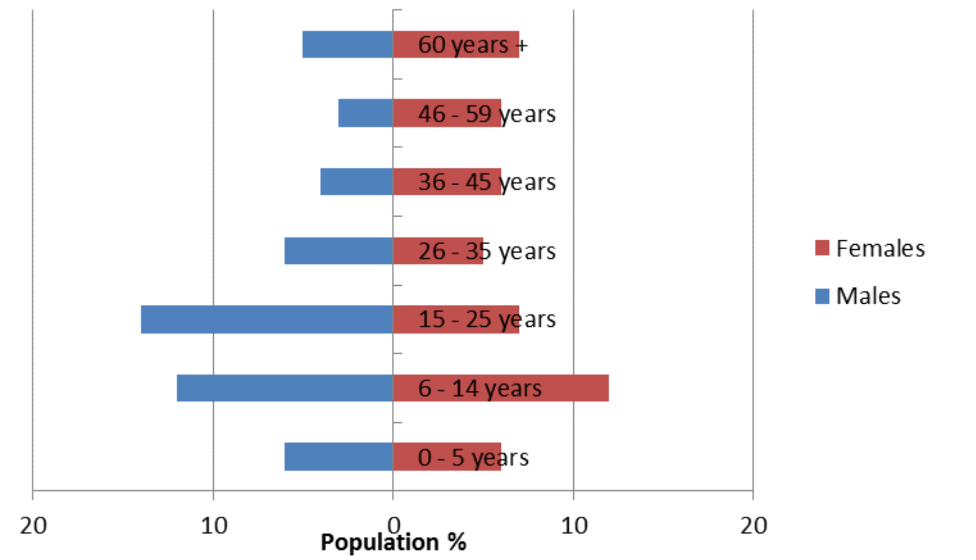
Gender and Age Distribution

Based on the 2014 ERM Social Survey (15) the population in the Project Area is slightly

(15) The data is based on the 2014 ERM Social Survey and has been used as supplementary and not primary data

weighted towards males (50.9%). Youth form the majority of the population, with those aged under 35 years totalling 68% of the population. Females outnumber males in the older age categories due to their higher life expectancies (*See Figure 9.9).*

Figure 9.9 *Age Distribution in the Zimbabwe Project Area*



Source: ERM Social Survey, October 2014

9.5 *LAND TENURE AND OWNERSHIP - ZAMBIA*

There are two types of land tenure in Zambia; customary (or traditional) land, and state leasehold land, both recognised in the Land Act No. 27 of 1995. Approximately 94% of land in Zambia is customary land and is formed of individual plots, forest land, common land within a village, and communal grazing land (ZamStats, 2015). In general, land belonging to a community is communally 'owned' but is allocated to individuals within the village by the Headman, under the chairmanship of the Chief or in the case of the Mukuni Chiefdom, the Bedyango (16). Land inheritance is hereditary, irrespective of gender; however, land tends to be allocated to men, or inherited by male family members. Women generally to access land through their husbands, though in the northern part of the country, where more matrilineal communities are found, land may be passed to female members of the family. Ownership in these cases is customary and is not formal (i.e. involving title deeds) and landholders do not pay land tax (USAID, 2018). In the Project Area, all of the households surveyed occupy customary land.

State leasehold land is land, which is not held under customary tenure. Such land is normally found in urban, mining and protected areas. Leases are granted for a set time period, depending on the type of land. For example, for un-surveyed land, individuals are granted a lease period of 14 years and for surveyed land, a 99 year leasehold. The conversion of customary land to leasehold title requires approval from the Chief, the

(16) In Mukuni Chiefdom, the Bedyango is a designated female within each village, responsible for the management and distribution of land

District Council, and the Commissioner of Lands, as well as any individuals who will be affected by the conversion. Having a lease for land (i.e. a leasehold title) is the only legal and formal means of holding land rights in Zambia.

9.6 *LAND TENURE AND OWNERSHIP – ZIMBABWE*

Land tenure and ownership in Zimbabwe can encompass some or all of the following rights:

- **Land Use Rights**: referring to the right to grow and harvest crops and trees and to make permanent improvements to the land;
- **Land Transfer Rights**: referring to the right to sell, give, mortgage, lease, rent or bequeath land;
- **Land Exclusion Rights**: referring to the right to exclude others from using or transferring land; and
- **Land Enforcement Rights**: referring to the legal, judicial, institutional and administrative provisions to guarantee use, transfer, and exclusion rights and to resolve disputes related to land.

Three forms of land ownership exist in Zimbabwe: private, communal and state. Commercial farming entities and commercial or residential properties occupy private land and are defined by title deeds. Communal land is held under the custodianship of the state and is managed under both local and decentralised government arrangements, as well as traditional leadership of Chiefs, Headmen and Village Heads [17].

Box 9.3 Zimbabwe's Land Reform Programme

The Land Reform Programme in Zimbabwe was part of a government initiate to promote more equitable access to land. After independence in 1980, it is estimated that over 40% of land was owned by white farmers, who constituted 3% of the National population. Land redistribution commenced in the early 1980s, where a "willing seller – willing buyer" approach was initially enacted, but from 2000 to 2002, the fast track land distribution was applied, which saw many white commercial farmers being forcibly removed from their farms and land being transferred to over 160,000 households. The issue is embroiled in controversy due to the high levels of violence that were involved however, as a result of land reform, many previously landless households now have access to land.

Source: Nelson Marongwe, Redistributive Land Reform And Poverty Reduction In Zimbabwe

In Matetsi Ward, land was acquired by the state as part of the land reform programme. Consequently the Ministry of Lands distributes land. Resettled farmers enter into agreements with the government that stipulates that they can own the land for 99

(17) Chigwata, T. (2016). The role of traditional leaders in Zimbabwe: are they still relevant?. Law, Democracy & Development, [online] 20(1), p.69. Available at: http://www.scielo.org.za/scielo.php?script=sci_arttext&pid=S2077-49072016000100003. Accessed 21.08. 2019.

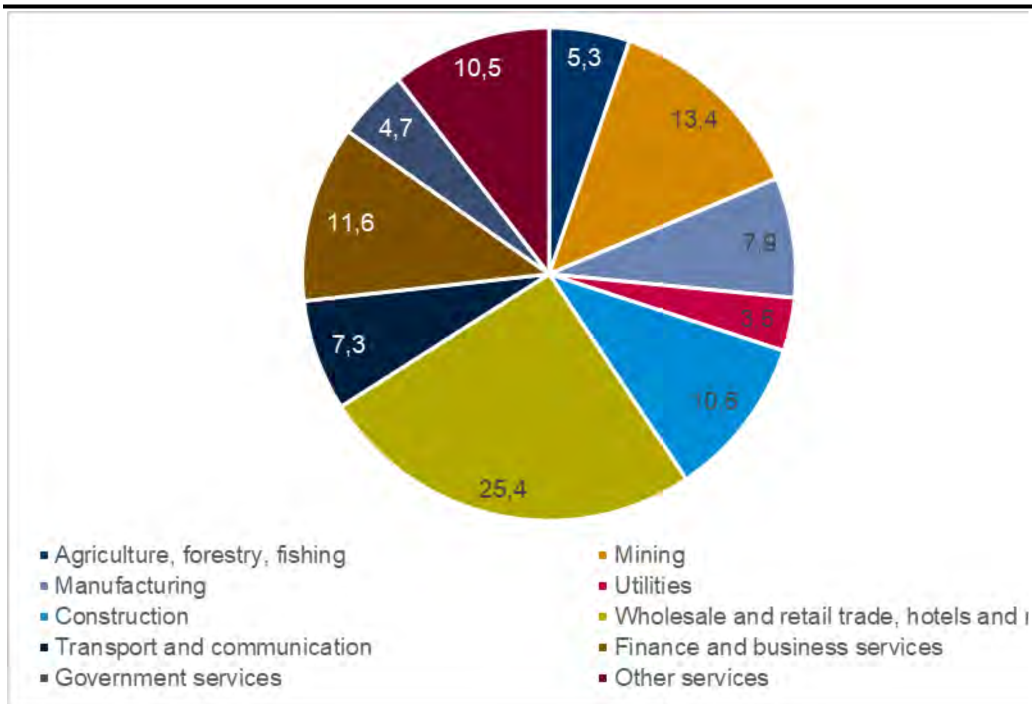
years. Communal land is regarded as belonging to an individual after they have used it for many years however there are no formal contracts or deeds. Male or female heirs can inherit communal land, but resettlement land cannot be sold. Land seekers in communal areas can go through Chiefs and Headmen. A Senior Headman in the Project Area noted that informal land transfer arrangements and sales of land between Village Heads and beneficiaries are rampant in Chidobe ward. Land in Hwange Rural District falls under all three categories. The vast majority of households live on communal land; only one household questioned as part of the household survey was reported to have title to the land that they occupied [18].

9.7 *LIVELIHOODS AND ECONOMY*

9.7.1 *Overview of National Economic Indicators - Zambia*

Zambia is considered to be a middle-income country (World Bank, 2019) and has sustained continued economic growth year on year since 2004 (averaging 7.4% per year). In 2018, The Gross Domestic Product (GDP) in Zambia was $ 26.72 billion (World Bank, 2018). As indicated in *Figure 9.10*, the wholesale sector accounted for 25.4% of GDP, followed by mining (13.4%) and finance and business services (11.6%). Mining continues to grow, albeit at a slower rate in Zambia and Zambia is Africa's largest copper producer and the fifth largest global producer (World Bank, 2018). However, the economy's growth slowed between 2015 and 2017 as a result of falling copper prices.

Figure 9.10 Sectorial Contribution to the GDP of Zambia 2016



Source: Zambia Economic Snapshot, 2016

(18) This information is based on the ERM 2014 Survey and has been used as secondary data

Zambia ranks among the countries with the highest level of inequality globally. 58% of Zambia's 2015 population earn below the poverty line ($1.90 per day). This exceeds the 41% total population living below the poverty line across Sub-Saharan Africa. Three quarters of the countries poor live in rural areas. Poverty levels in the Southern Province are significantly higher than the National average, with 67.9% of the population live in overall poverty and 47.3% in extreme poverty. Rural poverty is also higher, at 77.9% compared to 27.5% for urban areas (World Bank, 2018).

Unemployment is high in Zambia (estimated at 12.5% in 2018), particularly amongst youth, defined as those aged between 15 to 25 years (22.9%). Unemployment rates in the Southern Province are slightly below the National average at 7.5% (ZamStats, 2018). The majority of employment is within the informal sector, which is characterised by low pay and poor working conditions. Economic activity has been traditionally dominated by small-scale subsistence agriculture, which provides employment to just under two thirds of the population (ZamStats, 2018).

The Zambian Government has acknowledged this economic inequality and has outlined growth targets in Zambian Vision 2030 to promote inclusivity. The plan involves continued development of the historically dominant sectors, namely industry and tourism. In terms of tourism, the Southern Province is home to the Victoria Falls, which attracts thousands of visitors each year. Vision 2030 also places emphasis on modernising the agricultural sector, improving efficiency and productivity in the services sector and expanding the mining sector further.

The economy in the Southern Province (including in all of the Districts that fall within the Project Area) is largely centred on cattle rearing, sorghum, maize and cotton production, energy generation and the tourism sector. The District Situational Analysis Report for Zimba District notes that the shortage of agricultural extension personnel has severely affected the effectiveness of agricultural production. This has contributed to low yields and the continued adoption of inefficient farming methods (Zimba District KII, 2019). In order to enhance agricultural activities, which are also hampered by poor soils and lack of rainfall, the Government is supporting conservation agricultural programmes in all of the Project affected Districts. A USAID funded project has also been implemented to support fodder management.

NGOs and other organisations that support livelihood security active in the Project affected Districts include:

- **CARE International** - promotion of horticulture;
- **World Vision** - support farmers to purchase livestock, promotion of fish farming and support re-forestation efforts; and
- **The Zambian National Farmers Union** - facilitate market linkages and access to inputs.

In terms of tourism, the Province is home to the Victoria Falls, which attracts thousands of visitors each year (refer to Socio-economic Specialist Report attached as *Annex K*).

In 2015, the District Fisheries officer for Kazungula and Livingstone District reported that there were over 5,000 fishermen in the two Districts, with both commercial and artisanal fishing being undertaken in the District's river and lakes. The most popular place to fish however is reported to be the Upper Zambezi River, as well as Lake Kariba, Kalomo, Tambinka and Bombayu. Due to the number of fishermen and the use of inappropriate equipment (e.g. mosquito nets), it was reported that fish stocks are being depleted. To prevent overfishing, fishing is only permitted part of the year; from 1st March to 30th November and a license is required.

9.7.2 *Overview of National Economic Indicators – Zimbabwe*

Zimbabwe faces a number of challenges relating to financial consolidation and financial sector stabilization. This includes:

- Stimulating growth and investment to increase revenue collection and foreign exchange generation;
- Protecting social gains; and
- Improving governance outcomes through continued legislative and institutional reforms.

The recently announced Transitional Stabilization Programme 2018 to 2020 outlines the government's plans to ensure financial stabilization, stop current closing down of businesses challenges that have contributed to inflationary pressures, as well as attract foreign direct investment and improve the balance of trade to boost economic growth. The new dispensation that began in November 2017 started championing a "Zimbabwe is open for business" campaign as the start of its transition from a publicly led economy to a private sector-led economy to chart the way to "Vision 2030" (an upper middle-class income status by 2030) [19].

Zimbabwe's economy has one of the lowest Gross Domestic Product (GDP) per capita in the world. A breakdown of sectoral contribution to National GDP is provided in *Table 9.11*.

The main sources of government revenues are exports of nickel, platinum, diamond and tobacco. International sanctions placed on the previous government have resulted in extended hyperinflation and the suspension of the National currency up until recently (at the time of writing this social baseline, the Zimbabwean Dollar had been reintroduced as the National currency).

[19] World Bank 2019. The World Bank in Zimbabwe: Overview. [online] Available at: https://www.worldbank.org/en/country/zimbabwe/overview. [Accessed 22.08.2019].

Table 9.11 Share in GDP per Sector in Zimbabwe

Year	Sector		
	Agriculture, Forestry and fishing	Industry (Including mining and construction)	Services
2007	21.2	32.46	44.49
2008	19.02	30.48	48.55
2009	10.74	21.45	54.92
2010	9.61	20.69	57.83
2011	8.67	21.72	57.09
2012	8.04	25.33	55.09
2013	7.14	23.8	58.33
2014	8.75	23.72	57.59
2015	8.28	22.36	58.65
2016	7.87	22.12	60.41

Source: Pletcher H, 2019

Despite the challenges, the economy is projected to grow by 4.2% in 2019 and 4.4% in 2020 [(20)]. The agricultural sector and mining are expected to be the primary drivers of growth. Challenges to achieving this growth include:

- The high debt-to-GDP ratio;
- Cash shortages;
- Three-tier pricing;
- Limited availability of foreign exchange; and
- Shortage of essential goods, including fuel and consumer goods.

According to the Zimbabwe Poverty Atlas, the overall poverty prevalence within the Hwange District ranges between 36% to 72% (*Table 9.12*). The majority of the residents within these towns rely on the mining and tourism sectors for employment.

Table 9.12 Poverty Prevalence within the Hwange District

District	Poverty Prevalence	Source of Income/ Employment
Hwange Rural	68.5%	Safari lodges and Hwange National Park, these wards are in close proximity to the Hwange National Park
Hwange Urban	Ranges between 61% to 72%	Central Business District, which has Hwange Colliery Offices (the biggest coalmine in Zimbabwe).
Victoria Falls Urban	Ranges between 36% to 50.1%	Diverse sources of income, ranging from arts and crafts to game hunting in Victoria Falls.

Source: ZNSA, 2015

[(20)] World Bank 2019. The World Bank in Zimbabwe: Overview. [online] Available at: https://www.worldbank.org/en/country/zimbabwe/overview. [Accessed 22.08.2019].

9.7.3 *Economic and Livelihood Activities in the Local Area - Zambia*

Livestock Rearing

Across the Project Area, livestock rearing is the most popular livelihood activity. The majority of livestock are largely reared for income purposes, unlike crops, which are largely generated for subsistence. The most commonly owned livestock include poultry, goats, cattle, pigs and donkeys. Cattle and donkeys were observed to be primarily used for ploughing and ox cart transport purposes. Livestock are also an important form of bartering and are for a number of payments from dowries to traditional healer consultations. Livestock are also central to sacrifices in rituals.

In a number of 2019 community FGDs, members outlined how livestock became an important source of income during drought periods and served as an alternative livelihood strategy when crop harvests were inadequate. The income generated from the sale of livestock was largely used for subsistence; however, it is also used to fund children's education, family healthcare and other household requirements. Most villages reported that they did not use livestock for dairy production.

Livestock was sold in market centres including Livingstone, Kalomo, Zimba, Choma and across the border into the Democratic Republic of Congo (DRC). The exception was the Chibule cluster and Mukuni, where buyers travelled from Livingstone and beyond to Chibule and Mukuni to purchase livestock. Where households were able to, they would pay to rent small trucks, oxcarts and space on private vehicles to transport their livestock to market. Smaller livestock such as chickens were transported via taxi or hitchhiking vehicles, where people paid between Kwacha 20 and 100 one way. The majority of people walked their livestock to market themselves or paid others Kwacha 100 per animal to walk the livestock to market for them.

On average, the following amounts were received for livestock in good health:

- Juvenile cow (2 years old): Kwacha 1,500
- Adult cow: Kwacha 5,000
- Goat: Kwacha 150 to 200
- Chicken: Kwacha 30 to 40

The ownership of cattle, like in most of Africa is seen as a wealth status. The more cattle a household or individual owns, the more wealth and status they are perceived to have. A key concern in village clusters including the Valley was disease (including corridor disease) amongst livestock (particularly cattle and chickens), often-causing mass mortalities. Villagers were unable to dip and treat their animals due to a lack of water in the Project Area and because veterinary services, medication and subsidisation by the government was either unavailable or difficult to access remotely. Satellite veterinary centres were not often open according to FGDs and veterinary services were largely only available in centres including Livingstone, Zimba and Kalomo.

In the valley, livestock theft across the border with Zimbabwe was alleged to be a common problem. Interestingly, it was alleged that it was individuals from the Valley villages who were stealing livestock from Zimbabwean homesteads and villages on the other side of the valley.

Finding water for livestock was cited as a challenge, particularly under drought conditions currently being experienced in the majority of affected villages. Communities reported to use water sourced from boreholes, dams (where present) or water from streams and rivers.

Crop Farming and Gardening

Primary livelihoods in the Project Area are almost entirely agriculture based and all village clusters engaged in FGDs are engaged in the cultivation of crops, regardless of whether they consider it as their primary occupation. There is very little or no irrigation used and almost all crops are rain fed. The staple crop grown across the Project Area is maize, but millet, sorghum, cow peas, sunflowers and groundnuts are also cultivated. 2019 FGDs cited a lack of government support, inadequate mass water infrastructure and distance to maize depots as a primary reason crops were not used for commercial benefit. Cash crops including cotton and tobacco are farmed in the Project Area but by large commercial farmers with access to capital and resourcing.

Crop farming is focused in the rainy season across the Project Area. Crops are planted between November and January and harvested in April and May. Seeds are sourced from previous harvests or, when previous harvests are poor, they are bought at commercial seed outlets. Equipment used in the Project Area is basic e.g. (hoes, machetes, oxen and donkeys) because it is part of their culture and because they do not have the funds to invest in more efficient equipment. Communities use fertilisers, which are either brought at personal expense or accessed through the Government Funded Fertiliser Support Programme.

Figure 9.11 Typical Field Awaiting Preparation

Source: ERM FGDs, 2019

Vegetable gardening is undertaken in all communities throughout the year and used for both subsistence and economic purposes. Garden plots are cared for primarily by women and are often communal in nature. Commonly grown plants include tomato, cabbage, onion, butternut, peppers, eggplant, carrots and beans.

The communities within the Project Area rely heavily on agricultural activities for subsistence. The majority of produce (with the exception of sunflower and cotton) are consumed by the household or within the community. If food produce is sold, it is usually to community members within the villages. Often this may be done on a barter system, in exchange for other goods, as opposed to cash. Where produce is sold, it is transported to market centres including Kalomo, Zimba and Livingstone. Transport is usually rented and is costed according to the size of produce being transported (Kwacha10 per bag of produce).

Curio Trade

Curio making and selling is concentrated in the valley, Syamwamvwa and Ng'andu clusters of the Project Area. Curios are made by both men and women and sold in tourist hotspots including Livingstone town, within the vicinity of the Victoria Falls and at the Mukuni Curio Market in Mukuni Village.

Curios reported to be made by villagers as well as observed in the Project Area included carved goods such as wild animals, bowls, utensils and jewellery. Carving was undertaken by both men and women, but largely employs a number of male youths. The curios are made using locally sourced wood. Popular carving woods in the Project Area include Muzumina, Mopani, Ironwood, Ebony, Zebra wood and Mukamba. Seeds form the Mukamba tree are also used in making jewellery. Curio makers use hand axes fashioned from hard wood and steel to chop down selected trees. The tree branches are then left to dry before the curio is carved out. Woods used for curios are generally soft in nature, making them pliable and easier to shape. Carving is an age old tradition in the Mukuni and Valley clusters of the Project Area and the skills required are often passed down between father and son.

In Zambia, legislation requires that those who cut down the trees are in possession of a permit; however, the majority of 2019 FGDs with those engaged in curio making suggested this was not the case and most people operated without the permit. A KII with a curio maker found that whilst curio makers are aware of these restrictions, the curio trade is often their only income and therefore they "must' use the trees.

Figure 9.12 Wooden Carvings Created by a Chibule Resident

Source: ERM FGDs, 2019

Weaving is another important curio trade, usually undertaken by groups of women. Product include bags, floor mats and baskets. Elephant grass, which grows wildly on the Batoka gorge valley slopes is used, as well as riverine reeds from the Zambezi River and other streams in the Project Area. Weaving is undertaken for economic purposes and household consumption in the Valley and, Katapazi village clusters.

Curio prices varied greatly in the Project Area depending on the locality of sale. It was observed that more expensive curios were sold in the curio market outside the Victoria Falls National Park, while curios sold on the Victoria Falls Bridge, in Livingstone town and the Mukuni village were slightly cheaper. Curios were sold by both the curio makers themselves and by middlemen, who purchase the curios from the makers. Makers however prefer selling their own products directly as their profit margins are larger.

Wood Harvesting

All villages in the Project Area that attended FGDs in 2019 were found to be harvesting wood for a number of livelihood activities (including curios as described above). Wood is harvested by both men and women for firewood, livestock fencing, housing material (roof beams, wale poles etc.), furniture and charcoaling.

Other than Mukuni village and some others, none of the villages in the Project Area have access to electricity. As such, the vast majority rely on firewood for cooking, heating and lighting activities in their homes. Common trees including Mopani, Muvimba and Mululwe are all reportedly used for firewood; however, from field observation it is apparent that a number of other species are utilised as well. Firewood collection is a subsistence livelihood and only renders economic income for some households.

Trees including Mopani, Mululwe, Mukamba, and Mwanza are used to make poles for building and construction of houses, community facilities, granaries, fences and livestock enclosures. These poles are sold commercially by some but are largely made up for private use. Furniture making and carpentry are undertaken as economic activities in Lifalale and Syamwamvwa clusters. Furniture is reportedly sold in the villages and in market centres and is made using commercially valuable trees including Mukamba, Ebony wood, Zebra wood and others.

Although undertaken all year round, charcoal production was described as a particularly important drought time livelihood activity for 2018/19, and was undertaken to substitute normal livelihood activities hampered by drier conditions (crop farming and fishing most notably). Charcoaling was reported to be undertaken in the Katapazi and Ng'andu clusters, where both men and women harvested the wood and prepared the charcoal. The charcoal prices in the country have greatly increased (US $ 12 to US $ 16 for a 50 kg bag), particularly due to the dependence on hydropower and decreased dam levels in recent years. As such, charcoaling is becoming a popular economic activity in the Project Area. Charcoaling is discouraged by both Chiefs and government in the Project Area.

Typically, the charcoal manufacturing process starts with the felling of trees and cross-cutting of them into short logs. Tree species used in the Project Area include Mopani and Mululwe. These logs are then piled on one another in an earth kiln in a specific way to facilitate air flow and covered in soil. The kiln is then lit and left to burn for several hours or days (depending on the amount of wood), resulting in carbonisation. The solid residue left from the process (charcoal) is then harvested and packed into maize bags for distribution to market centres where it is sold.

Fishing

The Zambezi and other tributaries located downstream from the proposed BGHES are used by villagers from Mulola, Madyongo, Sikatali, Simanyonge, Posani, Siampondo and the Ng'andu cluster for fishing. Fishing is done by men only and is undertaken at fishing camps along the Zambezi River and other rivers in the Project Area where men stay between a few days and a week. These camps are located up to 15 km from the valley village cluster and beyond depending on the time of the year. The valley and Ng'andu village clusters said that fishermen came in season from as far as the DRC to make use of fishing camps in the Project Area. Fishermen reportedly catch a wide variety of species including bottle fish, tiger fish and Kariba bream. Fishing is undertaken in both the rainy and dry season; however, the catch is reported to be larger in the rainy season (between December and March). Fish are caught using both traditionally woven nets and baited fishing lines. Once caught, fish are commonly processed to preserve it, either through drying, frying or smoking.

Fish are sold at market in Mukuni village, Livingstone and as far as Kinshasa by men and women. They are transported to market by light vehicles rented by fishermen. Only some of the catch is used for household consumption.

Other

Ecosystem services provide significant livelihood activities to the Project Area, particularly in the more remote villages and subsistence-based households. Other notable livelihood activities discussed at FGDs include wild honey harvesting and beekeeping, brickmaking (using anthills) and wild fruit collection.

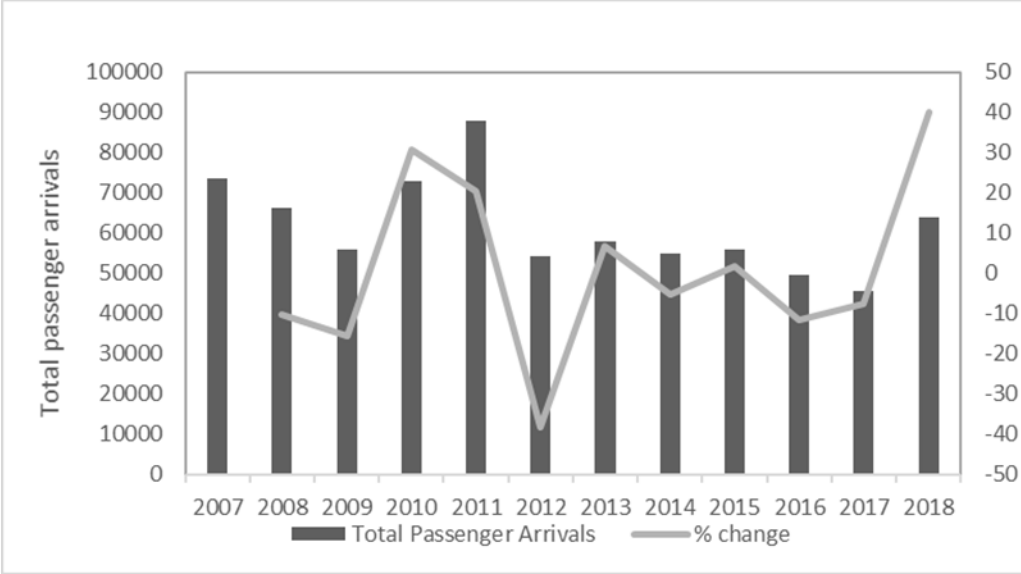
Tourism

Livingstone is considered the tourism capital of Zambia (Rogerson 2004). The town and surrounding communities (including those in the Project Area) rely extensively on the tourism industry, and any impacts on tourism are felt heavily. Although Livingstone has benefited from the political instability in Zimbabwe, interviews with tourism businesses indicated that numbers are now declining and that occupancy is falling as Zimbabwe becomes more attractive.

Tourist arrival statistics for Harry Mwanga Nkumbula International Airport (in Livingstone) indicate that arrival numbers have been declining steadily since 2013, apart from a sharp rise in 2018 (*Figure 9.13*). Interviews with tourism businesses indicated that, because flights into Harry Mwanga Nkumbula International Airport are relatively less expensive than flights into Victoria Falls, Livingstone is still a popular in-flight destination. However, foreign tourists are seen boarding busses at the airport en-route to Zimbabwe where accommodation and activities are relatively cheaper. The UNI VISA (21) system has made this affordable as tourists are no longer required to pay for two separate visas on arrival at either entry point.

(21) The Kaza UniVisa Zimbabwe Zambia allows unlimited entry into the two countries.

Figure 9.13 Total Tourist Arrivals to Harry Mwanga Nkumbula International Airport from 2007 – 2018



Source: Batoka Socio-economic Specialist Report, 2019

The Victoria Falls/Mosi-oa-Tunya is one of the world's greatest waterfalls and was listed as a World Heritage Site in 1989 (United Nations Educational, Scientific and Cultural Organization (UNESCO) 2019). It is the largest curtain of falling water in the world with up to 500 million litres of water per minute falling over the almost 100 m high steep wall. There are eight steep-sided gorges below the Falls that zigzag for a distance of approximately 150 km (UNESCO 2019).

On average just less than 154,200 visitors entered the Park in Zambia each year from 2010 to 2018. From 2012, visitor numbers increased to upwards of 150,000 and only dropping below that in 2015 and 2017.

During surveys and business interviews concerns about the delisting of Victoria Falls as a World Heritage Site were raised. A significant number of businesses believe that the delisting of the Falls would have a disastrous impact on tourism. Apart from the potential negative impact on tourism demand as a result of losing World Heritage Site status, stakeholders were concerned that, without the UNESCO World Heritage Site management and development criteria, Victoria Falls could become over-commercialised and lose the 'wildness' that attracts many of the tourists. It is important to note here that these concerns need to be addressed and that communication with UNESCO, if not already initiated, should take place.

In Livingstone the tourism activity providers reported that the high season was from June to October and the last two weeks in December. July and August are the busiest months with more than 70% of sales. During the high season months, businesses reported that they receive on average 70% of their annual turnover.

All businesses reported that February is their worst month for selling activities. This is due to a combination of not just decreased tourist numbers to the area over this time, but are also due to the availability of certain activities at that time of year. From January river water levels become too high and the availability and extent of some river activities become compromised. White water rafting and kayaking is only available for a half day from rapid 10, Livingstone Island (Devil's Pool) tours are not available and some hiking and angling activities in the gorge are suspended due to the high water levels. In most years from March to May the water levels become dangerously high and white-water rafting is closed completely for a few weeks.

The Batoka Gorge is a unique environment characterised by sheer cliffs and endemic flora and fauna. The steep cliffs and rapids of the Zambezi River below provide a rare setting for a number of activities. The proposed BGHES will inundate a large proportion of the gorge below Victoria Falls, having an impact on the tourist activities that are currently offered in the gorge. A number of tourist activities take place in the Batoka Gorge downstream of Victoria Falls. The scale of the gorge is an attraction in itself and the activities that take place appeal to both the adventure- and nature-based tourist.

White Water Rafting

White-water rafting has been a popular tourist activity below the Victoria Falls for more than 35 years. It is considered to be one of the best white water rafting experiences in the world because of the number of high grade rapids in succession over such a short stretch of river as well as the wild, untouched nature of the Zambezi River as it winds its way through the gorges. The rafting industry in Livingstone has played a vital role in establishing adventure tourism in the area (Rogerson 2004).

Rafting is not constant throughout the year and is dependent on annual flow conditions, which are dependent on the timing and quantity of catchment rainfall. The following is a summary of how the flow conditions influence rafting on the Zambezi:

- Rafting is able to run from rapid 1 when the water levels are at their lowest from August to early January.
- For the first half of January and the second half of July rafting can run from rapid 8 when flows are intermediate.
- From late January to the end of February and for the first half of July rafting runs from rapid 10.
- During March and June rafting runs from rapid 14 when flows are high, often called the "splash and dash" run.
- Usually during April and May, when flows are at their absolute highest, no rafting takes place.

Therefore, flow conditions play a major role in the operating of rafting on the Zambezi. These conditions change annually with some years having higher than average flows compared to other years dominated by low flows. The rafting trips offered are either a half-day, full-day, full day plus overnight or a 2 to 5 day trip throughout the main low water season from August to December. The half-day trip during low water involves rafting from rapid 1 to 10/11. The low water full day trip goes from rapid 1 to 24/25 and during high water from rapid 10 to 24/25. Excursions offer overnight camping in the gorge and 2 to 5 day rafting trips, which end, just above the start of Lake Kariba.

In 2015 there were a total of 11 rafting companies that operated on the Zambezi and in 2019 there were 10. Many more licenses have however been awarded. These range in size from small operators that only offer rafting, take fewer than 100 trips a year in hired boats, to the larger activity providers that offer a wide range of activities within the Project Area and sell more than 3,000 rafting trips per year and own their own boats and equipment. Most of these companies started out only offering rafting but have diversified over the years in order to remain competitive in the changing tourism market within the Project Area.

The rafting industry employs approximately 250 staff as river guides, porters, drivers and assistants. A large proportion of them are either part time or casual staff. This number also includes staff employed through other companies that are directly associated with rafting, such as media sales companies that film the daily rafting trips and take photographs.

Almost 100% of staff are from the local communities in the Project Area. Many of the rafting guides have been involved in the industry since it started and have over the years developed further into managerial and operational roles within the rafting companies. The villages along the gorge are well connected to the rafting industry and rely on the industry for employment opportunities. For example, local villagers who rely on agricultural crops for food and income are able to seek employment in the rafting industry when crops fail due to poor rains. These villagers are able to find casual or part time work as porters to supplement their income during times of hardship. This was emphasised during a conversation with one of the long-standing rafting guides in Livingstone. Through this, the rafting companies have formed good relationships with local communities and have worked with them through social and environmental development projects to improve community infrastructure and development. These projects include funding for schools and clinics, health-care and sanitation initiatives and scholarship programs within the community. Suich *et al.* (2005) reported in their study that 63% of tour operator and activity provider businesses made both financial and non-financial contributions to local communities.

Other Gorge Activities

Other activities in the gorge include birding, angling and hiking. Although these activities employ fewer people than the rafting industry, they are nonetheless very popular activities amongst nature- and adventure-based tourists.

Birding in the area is popular and birders travel considerable distances in order to see a number of endemic and rare raptors found in the Batoka Gorge. These include the Taita Falcon, Peregrine Falcon, Verreaux's (Black) Eagle and the Augur Buzzard. Many birding day trips are taken from Taita Falcon Lodge.

Fishing is a popular tourist activity both upstream and downstream of the Victoria Falls. However, the angling experience upstream of the Falls is very different to angling experience downstream in the Batoka Gorge. This activity involves hiking and sometimes camping in the Gorge in order to find the most productive fishing spots. Although most of the angling trips sold are upstream of the Falls, it is estimated that approximately 20% of the total angling trips sold are downstream of the Falls.

Hiking in the Batoka Gorge is often done in combination with another activity, such as birding, angling or local village tours. Hikers are attracted to the Gorge as it offers steep climbs and extensive scenic views of the river, rapids and sheer cliffs. Hiking is the best way to experience the vastness of the Gorge. Taita Falcon Lodge on the edge of the Gorge offers a range of hiking and walking trips. Hiking activities are usually a half day or full day trip but multi-day hiking trips can be organised from Livingstone.

9.7.4 Economic and Livelihood Activities in the Local Area – Zimbabwe

Crop Farming and Gardening

Subsistence crop farming and livestock rearing is the most important livelihood activity observed within the Project Area (22). The main crops cultivated include maize, sorghum and millet. Food security is a major concern in the area and food (in form of grain) is stored in granaries for use over the year, replaced by the harvest of the next season. There is very little or no irrigation used and almost all crops are rain fed. The rains in the area typically start from October and this is when ploughing and planting in the field takes place. Harvesting begins between March and May, depending on the crop being harvested. August is the month for threshing, treating and storage of food in the granaries.

Cash crop farming is only practiced by a small number of farmers, with maize, millet, sorghum and tobacco sold at within local markets and in Victoria Falls. To access markets, most villages reported having to walk, use private vehicles, donkey carts or pay for public transport to transport their produce. As such, the main challenge to selling cash-crops at market is lack of proper transportation means.

Based on the meeting held with the Hwange Ministry of Lands, Agriculture, Water and Climate, Livestock and Rural Resettlement, despite the fact that there are occasional rains during the year, the area is known to face perennial drought because of poor soil quality i.e. Kalahari soil type that is mainly acidic and dominated by sand. This is coupled with a shortage of agricultural inputs such as manure and agricultural equipment. 2019 FGDs with communities revealed that irrigation is one of the most urgent needs of the communities in the Project Area.

The average land allocation sizes and crop production capacities across the Project Area were given as follows:

- 0.5 ha per household;
- Crop field are between 2 ha to 2.5 ha per household; and

(22) Information obtained during the FGDs and KIIs conducted by ERM between June and July 2019 with the affected communities in the Project Area.

- Crops grown - maize average yield 2.5 tonnes per ha; sorghum 2 tonnes per ha; pearl millet 3 tonnes per ha.

Vegetable gardening is undertaken in all communities throughout the year and used for both subsistence and economic purposes. Garden plots are cared for primarily by women and are often communal in nature. Commonly grown plants include tomato, carrots and onions.

The communities within the area rely heavily on agricultural activities for subsistence. The majority of produce are consumed by the household or within the community. If food produce is sold, it is usually to community members within the villages, but like crops, some are sold at market in Victoria Falls town.

Livestock Rearing

Project Area livestock rearing is as important to livelihoods as crops and gardening (23). Livestock ownership (particularly cattle) in the Project Area represents wealth and are only sold or used for food during special occasions such as weddings, funerals, bride price payment, and traditional healer payment or in tough financial situations. Livestock are also used as draft animals (oxen or donkeys, to pull carts and plough fields). Goats and sheep are mainly used for meat and sold for money.

Women are mostly involved in poultry rearing because it is regarded as a less physically demanding job. The sale of poultry is regarded as an important income generating activity in the Project Area villages. Often, livestock are sold when schools are about to open to generate income that will be used to pay school fees.

Livestock are sold locally amongst communities and villages; however, larger livestock, including cattle, are sold at the main livestock market in Hwange called the Hwange Madumabizi cattle market. Cattle are walked to market by paid herders or transport by vehicle is organised and paid for.

The average households in the area owned between 5 to 10 cattle and 10 to 15 goats / sheep. On average, the following amounts (in US Dollars) were received for livestock in good health:

- Cow $ 427.85 to $ 513.42;
- Sheep $ 77.01 to $ 85.57;
- Goat $ 85.57 to $ 68.46; and
- Chicken $ 3.42 to $ 4.28.

A key community concern in villages including Batoka was disease amongst livestock. Villagers did not have access to facilities to dip and treat their livestock, resulting in mortalities.

(23) Information obtained during the FGDs and KIIs conducted by ERM between June and July 2019 with the affected communities in the Project Area.

Curio Trade

During the 2019 FGDs, the curio trade was reported to be a key livelihood activity in all of the villages in the Project Area. Stone sculptures, carved wooden figures and bowls, woven baskets and jewellery were made and sold by a number of community members in tourist hubs around Hwange and in Victoria Falls town (*Figure 9.14*). Weaving was done largely by women using elephant grass collected from the Batoka Valley. Men were largely involved in sculpting and carving.

Trees cut for curio production tend to be hardwood varieties such as Zimbabwean teak, known locally as mukusi (*Baikiaea plurijuga*); mopane, known locally also as mopani (*Colophospermum mopane*) and afrormosia; known locally as mubanga (*Pericopsis angolensis*). These trees take a long time to mature (about 100 years) and as a result, some species have been overexploited.

Curio prices varied greatly in the Project Area depending on the locality of sale. It was observed that more expensive curios were sold in the curio market outside the Victoria Falls National Park, while curios sold on the Victoria Falls Bridge and on the road to Hwange were slightly cheaper. Curios were sold by both the curio makers themselves and by middlemen, who purchase the curios from the makers. Makers however prefer selling their own products directly as their profit margins are larger.

Figure 9.14 Curios in the Project Area

Source: ERM Site Visit, 2019

Brickmaking

In the villages of Batoka, Jabula, Kachete, Vukuzenzele and Jembwe, brick making Figure 9.15) was an important livelihood activity that was used for household consumption but also as an income generating activity. Brick makers find clay soil deposits and mix these with water and sand (and at times, coal dust). Bricks are then shaped from moulded clay bricks and cured in the sun before being baked in in homemade kilns. Brickmaking serves as an important "piece job" for men and youth in the Project Area and is used to supplement failing agricultural income. There is a steady demand for the bricks all year round, with seven bricks selling for US$ 1.00.

Figure 9.15 Brick Making in the Project Area

Source: ERM Site Visit, 2019

Fishing

The Zambezi and other tributaries located in the Project Area are used by Sizindu, Jembwe, Batoka, Jabule and Kachete villages for fishing. Fishing is undertaken in the rainy season between Decembers to March. Fish are caught using both traditionally woven nets and baited fishing lines. Fish are sold at market in Victoria Falls and locally within villages.

Other

Ecosystem services provide significant livelihood activities to the Project Area, particularly in subsistence-based households. Other notable livelihood activities discussed at FGDs include construction, blacksmithing, informal labour, beer brewing, selling firewood and quarrying. Formal employment was mentioned in the tourism sector and included white river rafting, ecotourism and cultural village tours.

Piecework [24], including brick making is an important supplementary income generator when conventional livelihood activities (such as agriculture) are insufficient to support a household. Piecework is done in Victoria Falls and other tourist areas around the Project Area and include transport provision (e.g. taxis), construction work, cattle herding and gardening.

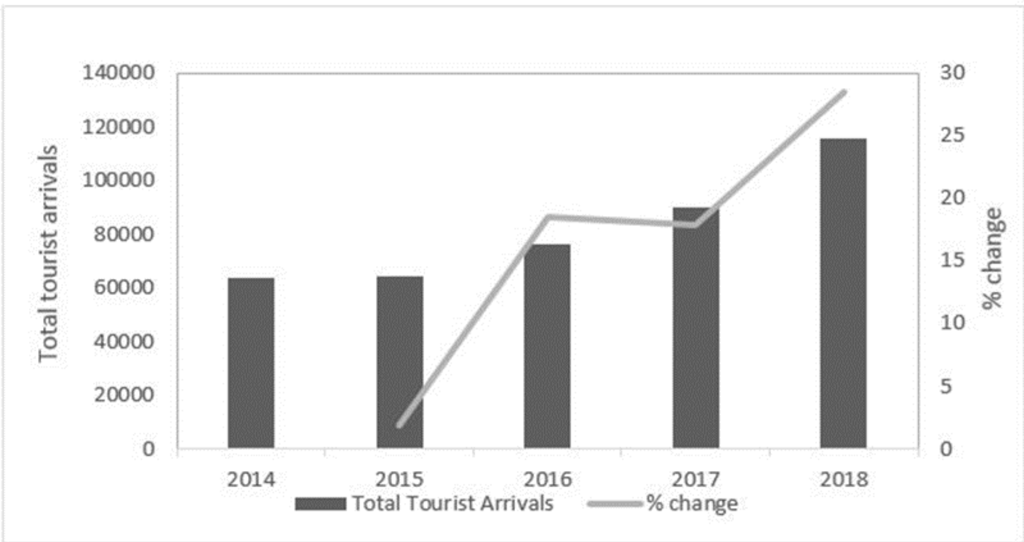
(24) Employment in which a worker is paid a fixed piece rate for each unit produced or action performed, regardless of time.

Tourism

The tourism industry in Zimbabwe has gone through a number of significant changes over the last few decades. During the period 1980 to 2000, tourism was amongst the fastest-growing sectors in the country, contributing significantly to GDP (25), and providing high quality reliable tourism products. However, political instability starting in 2001/02 and the global recession in 2008 saw tourism in Zimbabwe decrease substantially over this period, with travel bans and negative International media coverage impacting heavily on the tourism sector (Karambakuwa et al. 2011) (26). International arrivals started to recover in 2010; however, was slowed in 2012 by pre-election violence and instability, which resulted in a 25% reduction in total tourist arrivals.

Tourism is the main industry in Victoria Falls and contributes significantly to the local economy. The town has been the main gateway for exploring the area and a wide range of activities both above and below the Falls have been available to tourists for a number of decades. During interviews, businesses explained that the last decade had been a challenge for them. A large number of tourists wanting to view Victoria Falls and participate in activities in the area started to fly directly into Livingstone and for the most part avoided Zimbabwe altogether during the unstable periods. This impacted heavily on Victoria Falls' local tourism market and only over the last five years have tourist numbers to Victoria Falls started to increase again. In addition, there has now been a shift in sentiment where tourists are choosing the Zimbabwean side over the Zambian side as activities are cheaper and the new Kaza Uni-Visa allows tourists to visit both countries without paying double visa fees. Tourist arrival statistics from the Victoria Falls International Airport have shown increased arrivals over the period 2014 - 2018 (*Figure 9.16*).

Figure 9.16 Total Tourist Arrivals to Victoria Falls International Airport from 2014 to 2018



Source: ERM Socio-economic Survey, 2019

(25) Karambakuwa, R. T., Shonhiwa, T., Murombo, L., Mauchi, F. N., Gopo, N. R., Denhere, W., Tafirei, F., Chingarandem, A. & Mudavanhi, V. (2011). The impact of Zimbabwe Tourism Authority initiatives on tourist arrivals in Zimbabwe 2008 – 2009. *Journal of Sustainable Development in Africa* 13(6): 68-77.
(26) Ibid

The Victoria Falls/Mosi-oa-Tunya is considered a Natural Wonder of the World, and was listed as a World Heritage Site in 1989 (27). It is the largest curtain of falling water in the world with up to 500 million litres of water per minute falling over the almost 100 m high steep wall. There are eight steep-sided gorges below the Falls that zigzag for a distance of approximately 150 km (28).

During surveys and business interviews, concerns about the delisting of Victoria Falls as a World Heritage Site were raised. A significant number of businesses believe that the delisting of the Falls would have a disastrous impact on tourism. Apart from the potential negative impact on tourism demand as a result of losing World Heritage Site status, stakeholders were concerned that, without the United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site management and development criteria, Victoria Falls could become over-commercialised and lose the 'wildness' that attracts many of the tourists.

A number of tourist activities take place in the Batoka Gorge downstream of Victoria Falls. The scale of the gorge is an attraction in itself and the activities that take place appeal to both the adventure- and nature-based tourist. These include white water rafting, birdwatching, hiking and angling.

White -Water Rafting

White-water rafting has been a popular tourist activity on the Zambezi River downstream of Victoria Falls for more than 35 years. It is considered to be one of the best white water rafting experiences in the world due to the number of high-grade rapids in short succession, as well as the pristine nature of the Zambezi River. Rafting is dependent on annual flow conditions, which are dependent on the timing and quantity of catchment rainfall. The first section of rafting (rapids 1 to 8) is classified as "Grade 5" rapids characterised by steep gradients, big drops and pressure areas. The rapids decrease in size and difficulty as one moves further away from the falls.

Flow conditions play a major role in the operation of rafting on the Zambezi. These conditions change annually with some years having higher than average flows compared to other years dominated by low flows.

Other Gorge Activities

Other activities in the gorge include birding, angling, and hiking. Although these activities employ fewer people than the rafting industry, they are nonetheless very popular activities amongst nature- and adventure-based tourists that are visiting the area specifically for a high-quality birding, angling or hiking experience and contribute to direct tourism expenditure.

Birding in the area is popular and birders travel considerable distances in order to see a number of endemic and rare raptors found in the Batoka Gorge. These include the

(27) UNESCO. (2014). *Advisory Body Evaluation Report*. [online] Available at: http://whc.unesco.org/en/list/509/ [Accessed 22 Aug. 2019].
(28) Ibid

Taita Falcon, Peregrine Falcon, Verreaux's (Black) Eagle and the Augur Buzzard. A unique ecosystem exists within the Batoka Gorge. This interconnected food web is important for the birdlife in the gorge and any disruption along the food chain could have knock-on effects throughout the ecosystem.

Angling is a popular tourist activity both upstream and downstream of the Victoria Falls. However, the angling experience upstream of the Falls is very different to angling experience downstream in the Batoka Gorge. This activity involves hiking and sometimes camping in the Gorge in order to find the most productive fishing spots. Although most of the angling trips sold are upstream of the Falls, it is estimated that approximately 20% of the total angling trips sold are downstream of the Falls.

Hiking in the Batoka Gorge is often done in combination with another activity, such as birding, angling or local village tours. Hikers are attracted to the Gorge as it offers steep climbs and extensive scenic views of the river, rapids and sheer cliffs. Hiking is the best way to experience the vastness of the Gorge. Taita Falcon Lodge on the edge of the Gorge offers a range of hiking and walking trips. Hiking activities are usually a half-day or full day trip but multi-day hiking trips can be organised from Victoria Falls.

9.7.5 Household Income and Expenditure – Zambia

FGDs in 2019 found that the majority of communities earned a small household income, much of which was generated through agricultural activities. In the villages in the valley and Mukuni ward, curios are also significant income generators.

Where greater income to supplement education and healthcare is required, or where households traditional income sources are compromised, livestock sales become an important income generator. In the Katapazi and Ng'andu village clusters.

In the household survey undertaken by ERM in 2014, households reported that food was the largest expenditure, accounting for 48% of monthly spend (or Kwacha 431.75). Food purchased was typically that which cannot be grown (e.g. salt, sugar and oil), however maize was also brought when harvests have been eaten. Clothing was reported as another common household expenditure. In many cases households found it difficult to estimate monthly expenditure on key items as money tends to be spent as soon as it is obtained.

According to the 2014 ERM household survey, a number of communities in Zambia had small savings groups. However these schemes are very small with minimal funds.

9.7.6 Household Income and Expenditure – Zimbabwe

As derived from the 2014 ERM social survey, food is the major expenditure for all households, accounting for 48% to 52% of monthly spend (or US$ 67.78). Food purchased is typically that which cannot be grown (e.g. salt, sugar and oil); however, maize is also brought when harvests have been eaten. Clothing was reported as another common household expenditure. Household's income is spent on energy sources.

In many cases households found it difficult to estimate monthly expenditure on key items as money tends to be spent as soon as it is obtained.

As in Zambia, a number of communities have small savings groups with minimal funds.

9.8 HOUSING

9.8.1 National, Provincial and District - Zambia

According to the Centre for Affordable Housing Finances in Africa in 2016, Zambia had 2.5 million housing units, of which 64% is traditional housing and 36% (or about 800,000 units) is urban housing. At the time of writing this update, no recent data existed on housing at provincial and District level outside of the 2010 census of population and housing. The Southern Province had 292,179 households; 24.5% of which were headed by females. The majority of households (61%) lived in traditional huts, especially in rural areas (84%), which tended to have mud walls and thatched roofs. In urban areas, the majority of people lived in detached houses made from bricks (45.7% compared to 13.9 % in rural areas). In the Southern Province, 57.7% of households lived in traditional housing and 30.7% lived in detached house (ZamStats, 2010).

9.8.2 National, Provincial and District - Zimbabwe

Matabeleland North has 163,568 households that constitute a population of 744,841 persons with an average household size of 4.6 [(29)].

At the National level, 24.6% of the population live in traditional style housing (refer to *Table 9.13*). Matabeleland North Province and Hwange Rural District have a greater proportion with 60.1% and 69.1% of households respectively living in traditional style dwelling units made of pole and bricks with thatched roofs. Other housing compromises a mixture of traditional and modern housing made of brick and zinc/tile [(30)].

Table 9.13 Population by Number of Households and Size by Province

Province	Population	Number of Households	Average Household Size
Bulawayo	738 600	184 692	4.0
Manicaland	1 861 755	444 536	4.2
Mashonaland Central	1 441 944	338 369	4.3
Mashonaland East	1 366 522	339 654	4.0

(29) Ibid
(30) Zimbabwe Statistics. (2012). *Zimbabwe National Statistics Agency Census 2012 National Report*, Harare, Zimbabwe.

Province	Population	Number of Households	Average Household Size
Mashonaland West	1 567 449	366 325	4.3
Matabeleland North	744 841	163 568	4.6
Matabeleland South	810 074	192 666	4.2
Midlands	1 514 325	354 201	4.3
Masvingo	1 553 145	340 784	4.6
Harare	1 973 906	530 668	3.7
Total	**13 572 560**	**3 255 463**	**4.2**

Source: Zimbabwe ICDS 2017

9.8.3 *Local Level –Zambia*

Housing conditions across the Project Area varied, depending on the rurality of villages. Many structures were traditional and comprised mudbrick walls with thatched or corrugated iron roofs (refer to *Figure 9.17*). Structures were supported by wooden poles, with kitchen and sanitation facilities almost exclusively located outside the main residential structure. Business structures were largely located along the right of way of roads as pictured in *Figure 9.18*.

Figure 9.17 Typical Housing in the Project Area

Source: ERM FGDs, 2019

Figure 9.18 Typical Business Located Along the Road Right of Way

Source: ERM FGDs, 2019

9.8.4 Local Level –Zimbabwe

As observed during the site visit, most houses in rural settlements were constructed from mud walls and grass thatched roofs (*Figure 9.19)*. However, some houses were observed to be made from bricks and asbestos roofs, especially those located close to the Chief's residences. In the 2014 ERM household survey, most households own an average of three to five structures, including a main house for sleeping, a kitchen for preparing food and storing cooking utensils (*Figure 9.20*), a grain store and a kraal (31) to keep livestock in.

(31) An enclosure for livestock.

Figure 9.19 Traditional Homestead in the Project Area

Source: ERM Site Visit, 2019

Figure 9.20 Kitchen in the Project Area

Source: ERM Site Visit, 2019

9.9 EDUCATION

9.9.1 National, Provincial and District Education Infrastructure - Zambia

National Education Policy and Planning

The education system in Zambia is based on a three-tier system; seven years of primary school, two years of junior secondary school and three years of senior secondary school. Preschool education, which is optional, is open to children aged between three and six years old. Tertiary education follows senior secondary, and includes either university (four to seven years depending on the degree type) or training at a vocational or technical institute. The Government has identified improving access to and quality of education as a National priority and have set specific targets in the National Development Plan 2017 to 2021 (Republic of Zambia, 2016).

In 2002, the Ministry of Education enacted the Free Basic Education policy for grades 1 to 7. This has led to significant increases in student enrolments at the primary level, from 62.2% in 2000 to 74.0% in 2010 and 84.0% in 2017 (World Bank, 2018).

Educational Facilities and Provision

In 2016, Zambia had 9,674 schools; 1,246 of which were located in the Southern Province (ZamStats, 2016). 1,140 Of these schools were primary schools while only 106 were secondary schools. A summary of District level education facilities is provided in *Table 9.14*.

Table 9.14 District Education Facilities

District	Number of Schools	Summary
Choma	188	Choma District had the greatest number of schools in the Southern Province (188 in total).
Zimba	63	Zimba has the fewest schools in the Southern Province (63), including two secondary schools, 31 state primary schools and 30 community schools
Kazungula	103	Kazungula has 103 schools. 102 are basic schools (grades 1 to 9) and only one is a secondary school (grades 10 to 12)
Kalomo	159	Kalomo District has 159 schools, 92 of which are primary schools and four of which are secondary. Additionally the District has nine combined schools, eight private schools and 44 community schools
Livingstone	53	Livingstone District has 53 schools, 41 of which are basic (grades 1 to 9) and 12 of which are secondary (grades 10 to12)

Source: Southern Zambia, 2019

There is a continued focus on transforming a number of community schools in the District into formal secondary schools. The majority of schools (59%) in the Districts are state run; however, many rural communities sponsor community schools. As of 2015, 33% of schools in Zambia were community schools, 6.8% were private and 3.6% were grant aided (i.e. run by church missions through provision of government or donor grants). Community schools often use volunteer teachers; however, National government policy requires that these schools be provided with infrastructure support and eventually convert them to government schools.

Despite the National policy of free primary education, a number of children do not attend school because their parents or guardians cannot afford the additional costs of uniforms, food, transportation and books.

In all four Districts interviewed in the 2019 KIIs, educational budgets were reported to be inadequate and are blamed for poor delivery and quality of education. A shortage of teachers and learning materials, as well as inadequate infrastructure are major challenges to achieving universal education in the Project Area Districts.

There are a number of NGOs active in the Project Area Districts that support education provision. These include African Revival and Response Network who have constructed classrooms and provided sponsorship to girl children to enable them complete their high school or tertiary education. In Choma District, World Vision has provided bicycles to schoolchildren in order to improve access to education facilities. They have also offered support to orphans and other vulnerable children by paying for their school expenses.

9.9.2 National, Provincial and District Education Infrastructure - Zimbabwe

National Education Policy and Planning

In Zimbabwe, the education system provides for four years of Infant education that is comprised of 2 years of Early Childhood Development (ECD) and the first two years of formal primary education Grades one and two, followed by five years of junior education after which all students sit for the National grade seven examinations. There is a four year lower secondary education programme that concludes with students taking 'O' level examinations and then, for a small proportion, two further years of education in upper secondary schools after which students may sit for 'A' level examinations. Some of the 'O' level graduates join training institutions such as polytechnics, technical colleges, teacher's colleges, agricultural colleges and others, while the rest directly enter the labour market. 'A' level graduates may either enter universities or other training institutions or the world of work. The Zimbabwe School Examinations Council (ZIMSEC) and Cambridge sets all National examinations [32].

The Primary and Secondary Education Sector Plan 2016 to 2020 was prepared to follow on from the previous Medium Term Strategic Plan 2011 to 2015. During the previous plan period, significant progress was made in providing a quality and relevant education for all children in Zimbabwe. In particular, programmes were developed to raise the professional status of teachers and to enhance the quality of their teaching by setting professional standards and providing a range of professional development opportunities. A robust Education Management Information System was established during the 2011 to 2015 period and the education system now has credible data that provides for informed decision-making [33]. The Educational Sector Strategic Plan 2016-2020 is set up on the following four pillars:

(32) Education Sector Strategic Plan 2016-2020, Republic of Zimbabwe, Ministry of Primary and Secondary Education.
(33) Zimbabwe National statistics Agency, Education Report, December 2018

- **Access for all -** which will include providing adequate infrastructure, opportunity for Non-Formal Education (NFE); early identification of children at risk of not entering the system, dropping out or falling behind and strategies to support those unable to meet fee and levy charges;
- **Quality and relevant learning** - with the introduction of a competency-based curriculum that includes ICT, Science, Technology, Engineering, Arts and Mathematics (STEAM), Education for Sustainable Development (ESD) and in later years a strong life skills component;
- **Learner focus -** to be achieved by building, developing, monitoring and upgrading the professional skills of those teachers already in the profession and by working with the Ministry of Higher and Tertiary Education, Science and Technology Development (MoHTESTD) to have responsive pre-service curricula; and
- **Strong leadership, management and monitoring** - providing efficient and effective service delivery within an institution that has the right structural framework.

As GDP growth occurs in Zimbabwe, so does the size of the National budget, which is reflected in the primary and secondary education budget. In dollar terms, Ministry of Primary and Secondary Education (MoPSE) budget has increased four-fold since 2009 from $200 million to $800 million in 2014/15. MoPSE budget currently accounts for 22% of total government expenditure and an estimated 6% of GDP, shares that are high when compared to other countries. However, more than 97% of the government budget goes on teachers' salaries so when employment costs are excluded there has been a significant decline in expenditure on recurrent goods and services from 20% of the education budget in 2009 to less than 2% in 2014 and a decline from 4% to 1% in the capital budget.

In cash terms this is just over $8 million and under $5 million respectively, figures which are in fact much lower as the budget execution rates are low as a result of low and erratic cash releases from Treasury (34).

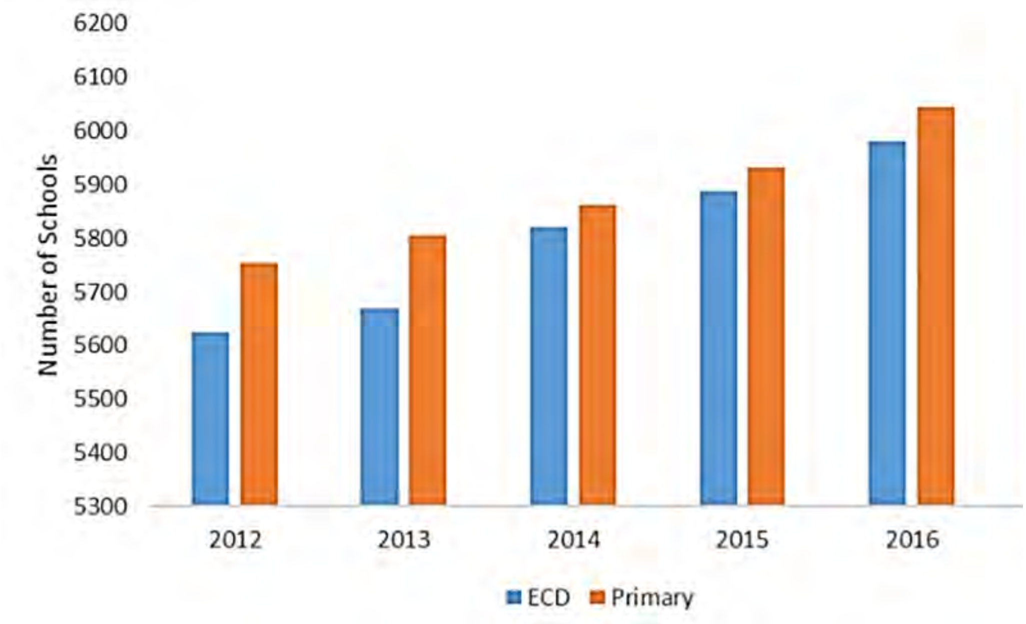
Educational Facilities and Provision

In 2012, 5,753 primary schools had been established in Zimbabwe with 5,625 of them offering ECD classes. In 2017, there were 6,123 primary schools of which 6,071 were offering ECD education. Refer to *Figure 9.21* (35).

Looking at the distribution of primary schools at Provincial level between 2001 and 2017 reveals that the number has been increasing over the years with the highest increase being noted in Mashonaland West Province. Between 2001 and 2017, a total of 270 primary schools were established in Mashonaland West Province signifying a 56% increase. At National level, the increase in the number of primary schools was about 28.7 % (36).

(34) Zimbabwe National statistics Agency, Education Report, December 2018
(35) Zimbabwe National statistics Agency, Education Report, December 2018
(36) Zimbabwe National statistics Agency, Education Report, December 2018

Figure 9.21 Number of Primary Schools with ECD Classes by Year, 2012 to 2017



Source: Zimbabwe Education Report, 2018.

Generally, the number of schools have been increasing signifying the Government's commitment to making secondary education accessible to all. As at 2017, there were 2830 secondary schools in Zimbabwe. *Table 9.15* shows the distribution of secondary schools at province level between 2006 and 2017. At National level, the number of schools has increased by almost 30% between 2006 and 2017 (37).

Table 9.15 Number of Secondary Schools by Province, 2006-2017

Province	Year					
	2006	2009	2010	2012	2016	2017
Manicaland	362	270	344	380	428	436
Mashonaland Central	129	125	135	202	241	245
Mashonaland East	355	250	264	312	366	372
Mashonaland West	303	168	219	330	377	379
Matabeleland North	120	106	107	152	191	198
Matabeleland South	144	120	127	149	161	162
Midlands	326	237	238	318	364	372
Masvingo	316	240	263	330	352	354
Harare	82	82	82	89	215	232
Bulawayo	45	46	46	50	80	80
Total	**2,182**	**1,644**	**1,825**	**2,312**	**2,775**	**2,830**

Source: Ministry of Primary and Secondary Education, 2017

(37) Zimbabwe National statistics Agency, Education Report, December 2018

In Hwange Rural District, it was reported that there is an insufficient number of primary and secondary schools to cater to the population. As a result, students have to walk long distances, of up to 10km one way to access them.

The problem is more acute with secondary schools and therefore in some areas satellite schools have been established to reduce the distances children have to travel. In Hwange Rural District, 3,273 children (1,716 males and 1,557 females) have benefited from the Basic Education Assistance Module (BEAM) that covers school fees for children whose families cannot afford to pay. The District also receives support from several multi-lateral and bi-lateral organisations to increase school attendance and enhance educational delivery. These include United Nations Children's Fund (UNICEF) who provide funds and textbooks, Environment Africa who pay schools fees for those who cannot afford them and World Vision, who have helped with the construction of schools (38). Zim Asset (2013 to2018) set the Government's goals to improve the quality and access to education, in order to enhance literacy levels and skills development (39).

9.9.3 *National Education Status - Zambia*

In 2018, the mean years of schooling per adult in Zambia was 7 years (World Bank, 2018). The literacy rate for those aged 15 years and older was 83.0% at the National in 2018 and 85.4% in the Southern Province. Younger generations are more likely to have received education than older generations and are therefore more literate. At the National level, literacy amongst youth (i.e. those aged 15 to 24 years) is 88.7% and 91.3% for the Southern Province.

Literacy rates are higher in urban than rural areas (94.1% and 74.4% respectively). Males also have a higher literacy rate (88.7%) than females (77.7%), this is likely due to their greater participation in the educational system; gross primary and secondary school attendance rate for males is 98% and 74.6% respectively, compared to 72.2% and 63.2% respectively for females (ZamStats, 2015).

9.9.4 *National Education Status - Zimbabwe*

The 2017 Inter-Censal Demographic Survey collected information on the highest level of education completed among the population aged three years and above. Out of the 11 million people aged three years and above, about 85% had completed either primary or secondary education. About 3% had completed short cycle tertiary education, which includes certificates and diplomas. Slightly over 1% had completed a Bachelor's degree while less than 1% had completed either a Master or a Doctoral qualification (40).

(38) Interview with Hwange Rural District Education Officer, September 2014
(39) Zimbabwe Agenda for Sustainable Socio-Economic Transformation. (2013). *Towards an Empowered Society and Growing Economy, Government of Zimbabwe, 2013.* [online] Available at: https://www.academia.edu/6906956/Government_Of_Zimbabwe_Zimbabwe_Agenda_for_Sustainable_Socio-Economic_Transformation_Zim_Asset_Towards_an_Empowered_Society_and_a_Growing_Economy_Contents [Accessed 10.08.2019].
(40) Zimbabwe National statistics Agency, Education Report, December 2018

Information presented in *Table 9.16* is on the population aged 15 years and above who completed at least a grade three (primary level of education). The table reveals that literacy rates decrease with an increase in age and are lower for females than for males especially in older age groups. Overall the literacy rates in 2017 for males and females were about 96 % and 93 %, respectively, yielding a literacy level of 94 % for the country[(41)].

Table 9.16 Literacy Rates by Age Group and Sex, 2017

Age Group	Male	Female	Total
15 - 19	98	98	98
20 - 24	97	98	98
25 - 29	98	98	98
30 - 34	98	98	98
35 - 39	98	96	97
40 - 44	98	97	97
45 - 49	98	93	95
50 - 54	96	89	92
55 - 59	93	80	85
60 - 64	91	79	84
65+	82	66	73
NS	72	63	67
Average Total	**96**	**93**	**94**

Source: ZIMSTAT, 2017 ICDS

The Zimbabwe Demographic and Health Survey (ZDHS) 2015 considered to be literate all persons who had more than secondary level of education. Persons with secondary education or less were asked to read a short sentence and were deemed to be literate if they read all or part of the sentence. *Table 9.16* shows that literacy levels were generally high for both males and females across all the age groups.

(41) Ibid

9.9.5 *Local Level Education Infrastructure – Zambia*

There is a shortage of schools in the Project area, particularly secondary schools, which are typically located in market centres of the District including Zimba, Choma, Livingstone and Kaloma. A summary of education facilities as derived from 201 FGDs in each village cluster is provided in *Table 9.17.*

Table 9.17 Education Infrastructure in the Zambia Project Area

Age Group	Male	Female	Total
Ng'andu	Chibule	Ng'andu Basic School (6km away)	Mukuni Secondary School Various Secondary schools in Livingstone
	Ng'andu	Ng'andu Basic School (2km away)	
Valley	Mulola Madyongo Sikatali Simanyonge Posani Siampondo	Mike McDonald funded school in Madyongo (10km away)	Not specified, but access is an issue
Katapazi	Katapazi	Six schools in the Katapazi village cluster (8km away)	Zimba High School Various Secondary schools in Livingstone

*Distance represents furthest distance travelled by learners
Source: ERM FGDs, 2019

Observed school infrastructure is generally in poor condition and inadequate for the number of students attending facilities. Buildings were in varying conditions; however, many were observed to have peeling walls, broken windows and damp. The majority of schools visited had between one and three classrooms; however, serviced five or more year groups. Classrooms typically had a blackboard and an insufficient number of desks and chairs; whereby students have to share chairs and desks or simply sit on the floor.

A number of outdoor classrooms were encountered while driving through the Project Area, many of which were located underneath large canopy trees (Figure 9.22, with no other shelter for bad weather days. Ventilated pit toilets were observed at most formalised schools with separate facilities for males, females and teachers. All schools in the Project Area baring the Mukuni Secondary school are not electrified.

Teacher accommodation is inadequate in Project Area villages, particularly in the more remote areas in the valley village cluster and along the transmission line. This acts as a barrier to teacher retention, with teachers preferring to work in Choma, Zimba, Kalomo and Livingstone where accommodation facilities are better.

Figure 9.22 Open-air classroom in Zambia Project Area

Source: ERM FGDs, 2019

The teacher to student ratio for schools in Mukuni ward (Kazungula) was noted to be one teacher to 75 – 80 students. For Zimba communities, it ranged from 1:35 for mission schools and up to 1:70 for schools located in rural areas and in Kalomo, 1:65. A summary of challenges associated with the provision of education is provide in Box 9.4 below.

Box 9.4 Challenges Associated with the Provision of Education

- Insufficient funding available at District level.
- Rurality of Project Area villages (i.e. distance for children to travel, distance for equipment, teachers and supplies to travel).
- Shortage of educators.
- Lack of accommodation for educators (i.e. staff housing).
- Educator to learner ratio.
- Insufficient infrastructure: classrooms.
- Shortage of Secondary Schools.
- Non-electrification of schools.

Source: ERM FGDs, 2019

9.9.6 *Local Level Education Infrastructure – Zimbabwe*

Schools in the Project Area include are listed in *Table 9.18* below.
On average, children have to walk five to 10 km to reach a primary school and up to 20 km to access a secondary school. In order to facilitate access, Lubancho (an NGO) has provided bicycles to 563 (*Figure 9.23*) schoolchildren in the area to ease the burden of such travel. Boarding schools are not a viable option or alternative for locals as they are unaffordable to the average family within the area. As a result, some children lodge with relatives or others who live closer to the school, sleep in the classrooms or do not access secondary education.

Table 9.18 Education Infrastructure in the Zimbabwe Project Area

Village	Nearest Primary School	Nearest Secondary School
Batoka	Shumbi Primary School (5km away)	Batoka Secondary School
Jabula	Jabula Primary School (4km away)	Batoka Secondary School (7km away) Vulindlele Secondary School
Sikumbi	Shumbi Primary School Jabula Primary School	Batoka Secondary School (10km away
Kachete	Jabula Primary School (4km away)	Batoka Secondary School (7km away) Vulindlele Secondary School
Vukuzenzele	Chisuma Primary School Simakade Primary School	Vulindlele Secondary School Sizinda Secondary School
Jembwe	Chisuma Primary School Simakade Primary School	Vulindlele Secondary School Sizinda Secondary School
Sizinda	Monde Primary School (5km away)	Sizinda Secondary School

Source: ERM FGDs, 2019

Figure 9.23 Lubancho (NGO) Provides Bicycles to School Children

Source: ERM Site Visit, 2019

A summary of the key challenges cited by communities during 2019 FGDs regarding about the access to and the provision of education services in the area are highlighted in *Box 9.5*.

Box 9.5 *Challenges Associated with the Provision of Education*

- Long distance required to access schools. Most students walk an average of 10km to access school.
- Inability to pay school fees.
- Shortage of trained teachers/inadequate training.
- High teacher-pupil ratio.
- Lack of uniforms and other essentials.
- Insufficient teaching resources and materials e.g. books.
- Lack of proper support from guardian/parents.

School infrastructure within the Project Area is generally of average to poor condition and inadequate for the number of students attending facilities. Buildings were in varying conditions. In FGDs held with communities in 2019, attendees listed school infrastructure upgrades and the provision of more secondary schools as one of the most urgent needs of communities.

9.9.7 Local Level Education Status - Zambia

All village clusters reported that learners walk to school, often covering great distances daily. There is no public transport in any of the villages to take learners to school. Some learners use bicycles to get to school as well. Learners travel to school on sand roads between villages or along established pathways through the veld.

Learners attending secondary school in Zimba, Kalomo, and Choma are required to board and if they cannot get into the school boarding houses, they rent accommodation, which they share with other students in the towns. Monthly room rental cost each student Kwacha 100 to 200. Access to secondary education is problematic in the Project area, as most students have to attend schools 40 km or more away from their home villages. This has financial implications for both accommodation and transport.

In general, people do not have access tertiary education. In Livingstone, there are branches of the Open University, the University of Zambia and Victoria Falls University. However, the lack of student housing associated with these facilities, as well as limited public transport mean that few people in the area access these establishments. FGDs revealed that there are no vocational training centres within the Project Area. There is a Catholic Missionaries Zimba Farmers Training Centre in Zimba and the Namianga Teachers College and Mukwela Farmers Training Institute in Kalomo.

Reasons preventing children from going to school in the Project Area are similar and the greatest constraint is cost. Fees, stationary, uniforms and other requirements are all expenses communities say they cannot afford, especially for those households who have multiple children of school going age. Teenage pregnancies are resulting in girls leaving school in all village clusters.

While some girls return to school to finish their education, many get married and replace their education with household responsibilities.

The majority of basic schools in the Project Area are community schools and thus paid for by the local villagers. Government provides only one teacher per community school and as such, communities have to pay for additional teachers and teacher accommodation.

Access as a result of distance and terrain is a significant problem, particularly in the Valley village cluster where one primary school services all six villages. Access in the rainy season is almost impossible as rivers make routes impassable and isolate settlements and public infrastructure.

As per data derived from the 2014 ERM Social Survey, literacy levels in the Project Area were below the National average with 26.7% of those surveyed aged 15 years being unable to read and write. Primary level schooling was the highest level of education attained by the majority of household survey respondents. Only 27% of people had been to secondary school and 3.8% had never received a formal education. None of the household representatives interviewed had received a tertiary education (42).

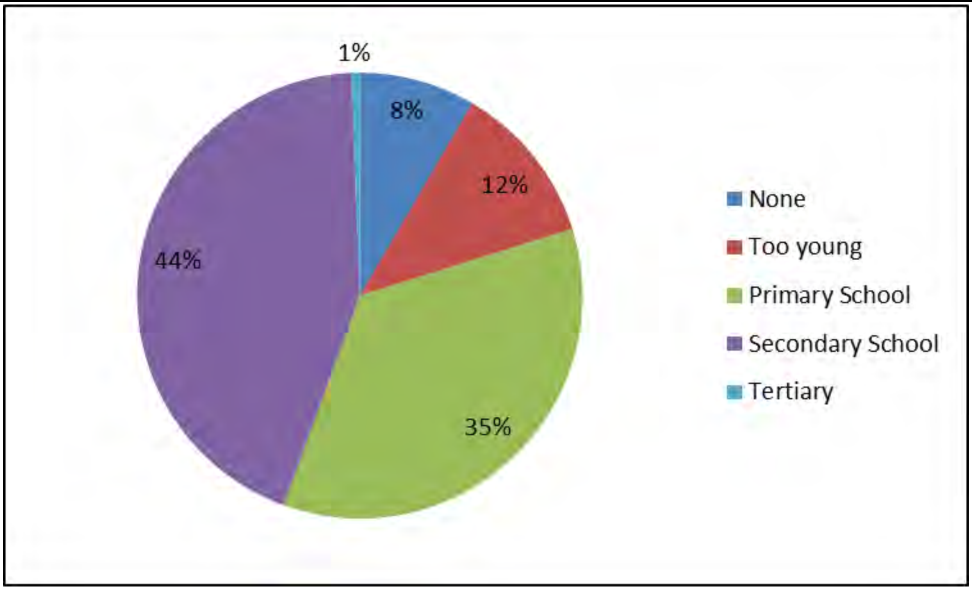
2019 FGDs with District officials and communities revealed that males had better access to and preferred educational opportunities compared to females. This (according to FGDs with women) is because households feel that men will benefit more from an education, as women's primary skills are household focused. As such, they seldom receive a secondary education due to early marriage, pregnancy and perceived household responsibilities.

9.9.8 *Local Level Education Status – Zimbabwe*

As demonstrated in *Figure 9.24* in 2014, almost half (44%) the number of household survey respondents and their families had received a secondary school education; however, a greater proportion of the population (8%) had never received a formal education. A small proportion (1%) had received a tertiary level education (43).

(42) Household surveys were not taken in communities located within Kalomo and Zimba Districts
(43) Based on the ERM Social Survey, October 2014

Figure 9.24 Education Levels within the Project Area [44]



Source: ERM Social Survey, October 2014

In 2019, FGDs with both village leaders and communities revealed that communities felt that the level education was not standardised in the Project Area and needed to be improved and aligned to National standards. It is anticipated that the education status within the Project Area has not changed significantly since the 2014 household surveys.

9.10 HEALTH

9.10.1 National, Provincial and District Health Infrastructure - Zambia

Healthcare System

Healthcare in Zambia is managed by Government departments, religious organisations, NGOs and CBOs. In addition, there is a growing private health sector, mainly in urban areas. Healthcare is overseen by the Ministry of Health, who are responsible for policy, regulation and standard setting. The Ministry is further supported by Provincial Health Offices, District Health Offices (responsible for coordination, planning and support at District level) and Neighbourhood Health Committees (NHCs) with responsibility for overseeing services at the community level). In addition, there are also National units that oversee specific health programmes, such as the National Malaria Control Centre and National Aids Council.

The National Health Policy outlines the country's commitment to realize health related human rights for all. Key health policies and strategies focus on ensuring equitable access to primary health care services while understanding social-economic determinants of health. The primary challenges faced by the Zambian health system include:

(44) This information has been used purely as secondary data and may not reflect the current trend changes over time.

- Inadequate funding;
- Shortages of health workers and poor distribution of health workers;
- Inadequate infrastructures and equipment; and
- Insufficient supply of drugs and other medical items.

These challenges affect rural communities in particular as well as vulnerable population groups (e.g. women, children, and the disabled). Primary Health Services in Zambia are free. (Global Health Observatory, 2017). *Box 9.6* shows the types of healthcare services available at the different levels (Republic of Zambia, 2012).

Box 9.6 Healthcare Services in Zambia

- Third Level Hospitals - also known as Specialist or Tertiary Hospitals are the highest referral hospitals in Zambia. They serve populations of approximately 800,000 and above, and have subspecialisations in internal medicine, surgery, paediatrics, obstetrics, gynaecology, intensive care, psychiatry, training and research.

- Second Level Hospitals - also known as Second level hospitals or Provincial or General Hospitals serve populations between 200,000 to 800,000 people. They provide services in internal medicine, general surgery, paediatrics, obstetrics and gynaecology, dental, psychiatry and intensive care services.

- First Level Hospitals - also known as District Hospitals serve a population of between 80,000 and 20,000 and provide services such as medical, surgical, obstetric and diagnostic services and all clinical in support of health centre referrals.

- Health Centres - urban health centres or clinics (UHC) serve populations of between 30,000 to 50,000 people. Rural Health Centres (RHCs) serve around 10,000 people.

- Health Posts – these are the lowest levels of health care and are built in communities far away from health centres. They cater for a catchment population of approximately 3,500 in rural areas and 1,000 to 7,000 in the urban settings and are set up within 5km radius for sparsely populated areas. The types of health services offered at this level are basic first aid rather than curative.

Source: ERM Social Baseline Study, 2014

National Health Facilities and Provision

As of 2012 (45), Zambia had a total of 1,956 health facilities, including six specialised hospitals, 19 General hospitals, 84 District hospitals, 409 Urban Health Centres, 1,31 Rural Health Centres and 307 Health Posts. After Lusaka Province, the Southern Province has the highest number of health facilities (253). The majority of healthcare facilities are state owned (88%) (Ministry of Health, 2013).

Health care services in Zambia are free to pregnant women and for those aged under five years or 65 years and older. In April 2006, the Government abolished user fees in all government and mission-run facilities in rural Districts.

(45) More recent information unavailable at time of reporting

However, patients are still required to pay a registration fee to open their medical file at these facilities.

District Health Facilities and Provision

With the exception of Zimba, all other Districts in the Project Area have a District hospital, including Livingstone.

Zimba

Zimba only has 10 health facilities in the entirety of the District.

Choma

According to the District Health Officer, Choma healthcare continues to improve and the District is focused on the delivery of quality healthcare. The District currently has 33 Health Centres/Post across the entire District with a number still under construction. Each facility has an average of 5 Neighbourhood Health Committee's (NHCs [(46)]), with approximately 160 NHCs operating in the District. An estimated 60% of the NHCs have been trained by the District, while the remaining 40% remain to be trained. Furthermore, the District has two health institution hospitals in the District i.e. Macha Mission and Choma General Hospitals.

Kazungula

Kazungula is the largest District in the Southern Province, and has a high population burden on healthcare. The District has one District Hospital and 22 Rural Health Centres (RHCs).

Kalomo

Kalomo District has 33 health facilities, including eight Health Posts, 24 RHCs and the Kalomo District Hospital).

Presence of Health NGOs

There are a number of NGOs active in health promotion in the Project area Districts, particularly in the field of HIV/AIDS. These include World Vision, UNICEF, Chreso Ministries and Corridors of Hope (who all work in the field of HIV/AIDS), NOTCAM (who run community based rehabilitation programmes to support the disabled, and Response Network (who concentrate on infrastructure development). The Butterfly Tree who are active in Mukuni ward (Kazungula) support health programmes that focus on mothers, as well as strengthening home based care services and facilities for people living with

(46) NHCs are community-based support groups formed under the guidance of health personnel to advocate for disease prevention and control through increased community participation in health care management and delivery. NHCs act as the

HIV/AIDS. They also undertake awareness raising campaigns and promote behaviour change to enhance health outcomes (ERM FGDs, 2019).

9.10.2 *National, Provincial and District Health Infrastructure - Zimbabwe*

Healthcare System

Healthcare in Zimbabwe is delivered by public bodies, not for profit and profit organisations, alternative providers and church organisations. Company operated clinics, for example from mining companies, are also in operation. The Ministry of Health and Child Welfare (MOHCW) oversees healthcare policy and is responsible for allocating funds, coordinating responses to National health issues and approving of staff hires at the Provincial and District levels. MOHWC are represented at the Provincial and District level by Provincial and District Health Offices [47].

Zimbabwe's healthcare sector was severely affected by the economic crisis and associated high levels of inflation that afflicted the country from 2000 to 2008. During this time, public spending on healthcare was dramatically reduced and as a result, healthcare delivery was affected, with funds to purchase medication and equipment, pay for wages, and support other activities that would allow for better health service provision being curtailed. Per capita spending on healthcare in 2010 was US$ 9, more than four times below the recommended amount of US$ 34 by the World Health Organisation (WHO) [48]. Accordingly, the healthcare sector in Zimbabwe is heavily reliant on International donors. In 2010, US$ 435 million was donated to Zimbabwe's health system for the years 2011 to 2015 by a group of International donors including UNICEF, the World Bank and World Health Organization (WHO) as part of the Health Transition Fund. The key objectives of the fund are to improve maternal and child health and nutrition and to increase the stock of essential medicines, vaccines and basic equipment for health care facilities. The fund is also being used to retain health workers. Zimbabwe suffers from a serious shortage of skilled and experienced health workers.

Zimbabwe's junior doctors have been on a National Strike since the beginning of March, protesting against poor remuneration and unsatisfactory working conditions, leading to the closure of almost all central hospitals, children's units, Provincial hospitals and the cessation of emergency lifesaving procedures throughout the country, according to their representative body, the Zimbabwe Hospital Doctors Association (Banya, N. 2019).

According to the association, there are 300 junior doctors working in Zimbabwe's health government institutions. Zimbabwe is a long way from the World Health Organisation's recommendation of the minimum threshold of 23

(47) Osika J et al. (2010). Zimbabwe Health System Assessment 2010. Bethesda, MD: Health Systems 20/20 Project, Abt Associates Inc

(48) UNICEF (2018) Zimbabwe Health Budget Brief. Available at: http://www.unicef.org/esaro/5440_investment_in_health.html. Accessed 12.12.2014.

doctors, nurses and midwives per 10 000 population. By 2015, Zimbabwe was at 1.6 physicians and 7.2 nurses per every 10 000 people (Banya, N. (2019).

National, Provincial and District Health Facilities and Provision

According to the Zimbabwe National Health Strategy (2016 to 2020), currently every District has at least two doctors, every primary health care centre has at least two qualified nurses, 59% of administrative wards are serviced by an Environmental Health Technician and 60% of villages have access to a village health worker. The Zimbabwe Service Availability and Readiness Assessment Report of 2015 says that health studies and surveys that have been carried out in the country all point towards inadequacies in the six WHO Health System Building Blocks – human resources, medical products, vaccines and technology including infrastructure, health financing, health information, service delivery, leadership and governance – that are prerequisites for a functional health delivery system (49). *Table 9.19* gives a summary of the health facilities in Zimbabwe based on the 2015 Zimbabwe Service Availability and Readiness Assessment survey (ZSARA). As of 2015, Zimbabwe had 1,848 hospitals and primary health care facilities.

The total fertility rate in Zimbabwe is estimated at 4.3 children per woman (15 to 49 years), with a population growth rate estimated at 2.7% per year. The population is served by hospitals and primary health care facilities owned by government (inclusive of security sector – army, police and prisons health care centres), NGOs, missions, private organisations and industry. The majority of the population is serviced by government, municipalities and mission care centres (50). The number of health facilities in Zimbabwe in 2005 is depicted in *Table 9.19*. With the exception of Bulwayo and Harare, which had central hospitals, provincial hospitals were located in all of Zimbabwe's provinces.

Table 9.19 Number of Healthcare Facilities

Facility Level/Managing Authority	All Facilities	Hospitals	Primary Health Facilities
Central Hospitals	6	6	0
Provincial Hospitals	8	8	0
District Hospitals	44	44	0
Mission Hospitals	62	62	0
Rural Hospitals	62	62	0
Private Hospitals	32	32	0
Clinics	1,122	0	1,122
Polyclinics	15	0	15
Private Clinics	69	0	69
Mission Clinics	25	0	25
Council/Municipal Clinics/FHS	96	0	96
Rural Health Centre	307	0	307
Totals	**1,848**	**214**	**1,634**

Source: ZSARA, 2015

(49) Banya, N. (2019). Zimbabwe's health delivery system: ZimFact. [online] Available at: https://zimfact.org/factsheet-zimbabwes-health-delivery-system. Accessed 12.08.2019.
(50) Zimbabwe National Health Strategy, 2016-2020

68% of the healthcare delivery in the rural areas is from mission hospitals and clinics. Nationally, the mission hospitals and clinics account for 35% of health care delivery. Of these, 22 mission hospitals have been designated District hospitals [51].

9.10.3 *National, Provincial and District Level Health Status - Zambia*

Despite significant progress in health status, Zambia continues to struggle with a high burden of infectious diseases and growing no communicable diseases (e.g. cervical cancer, diabetes, cardiovascular diseases). Life expectancy in 2016 at birth in Zambia was estimated at 61.87 years (World Bank 2016); 60.2 for males and 64.44 for females. In 2014, life expectancy in the Southern Province was the highest in the country at 56 years (ZamStats, 2014).

Mortality and Morbidity

The improvement in sexual and reproductive health service delivery has seen a decline in maternal morbidity and mortality, increased contraceptive prevalence rate, and increased skilled birth attendance. The infant mortality rate is 22.9 deaths per 1,000 live births while the maternal mortality ratio is 224 per 100,000 live births (Global Health Observatory, 2017).

The National fertility rate is high (5.3%), particularly in rural areas. Child survival has also improved. However, mortality remains high, particularly amongst new-born babies. Government immunization programmes are reaching more children with close to four fifths of Districts distributing the DPT3 and Measles-Rubella immunisation to 80% of the population.

According to the Ministry of Health, the leading causes of mortality and morbidity in Zambia are HIV/AIDS, Neonatal disorders, lower respiratory infections, TB, Diarrheal diseases, heart disease, malaria, strokes, congenital defects and cirrhosis (Ministry of Health, 2018).

Malnutrition

Malnutrition is of concern in Zambia, with more than 25% of children five or younger and 10% of women in the reproductive age groups undernourished. Reasoning for this includes inadequate feeding practices.

Malaria

Significant progress has been made in combating Malaria in the last ten years; however, pregnant women and children below five remain most vulnerable to infection Instances of severe malaria have decreased by an estimated 61%; with varying levels of prevalence across Provinces and Districts. (Global health Observatory, 2017). In 2014, Malaria accounted for 40% of visits to healthcare facilities (ZamStats, 2015).

(51) Zach (2019). *ZACH: Zimbabwe Association of Church-Related Hospitals.* [online] Available at: http://www.zach.org.zw [Accessed 12.08.2019].

The 2013 to 2014 Demographic Health survey showed that 72.9% of households own at least one mosquito net. However, ownership does not always imply use; only 43.3% of children under five years of age slept under a mosquito net the night before the survey (ZamStats, 2015).

HIV/AIDS and Communicable Disease

More than one million people are estimated to be living with HIV/AIDS in Zambia, with incidence gradually reducing. Nationally, woman are more likely to be infected, as well as urban populations. HIV/AIDS testing (using the UNAIDS Global 90-90-90 targets) is compromised by inadequate HIV/AIDS testing role out.

The Zambia National AIDS Strategic Framework (NASF) cited the key drivers of the HIV/AIDS epidemic as being multiple and concurrent sexual partners, low and inconsistent use of condoms, low levels of male circumcision, mother to child transmission and the presence of sex workers and mobility and labour migration (National AIDS Council, 2016). In order to respond to the HIV/AIDS crisis, District AIDS Task Forces (DATFs) have been established in Districts across the country to mobilise community-based organizations (CBOs) and other NGOs to respond to the needs of those affected by HIV/AIDS. District status and response to HIV/AIDS is summarised in *Table 9.20*.

Awareness of HIV/AIDS is reported to be high. The 2013 to 2014 Demographic Health Survey revealed that the majority of people (83.5%) are aware that the disease can be avoided by using condoms every time they have sexual intercourse and limiting sexual intercourse to one uninfected partner (93.5%). Males (89%) and females (86%) from the Southern Province had the highest levels of knowledge about how to prevent infection with HIV/AIDS than other Provinces (ZamStats, 2014).

Tuberculosis (TB) risk is five times higher amongst HIV positive persons; however two fifths of TB cases go undetected and untreated due to low diagnostic capacity and people not seeking medical attention. Hepatitis B is also higher amongst HIV positive people in Zambia. Annual cholera disease outbreaks tend to largely affect densely populated peri-urban areas where sanitation infrastructure is inadequate and hygiene practices are poor.

In a report developed by Corridors of Hope in 2012, patients in Kazungula and Livingstone Districts cited the following challenges experienced relating to HIV/AIDS treatment:

- *Access:* The distance between ART centres and residential areas was prohibitive for some people, mainly due to the cost of transportation. Clients without money to pay for transportation to the ART centre were not able to access services;

- *Understanding of HIV Care:* Counselling for people recently diagnosed with HIV did not adequately address issues such as the benefits of taking ART and risks of drug toxicity. Nor did they correct the inaccurate beliefs and myths that spread in the communities regarding HIV treatment.
- *Stigma:* Stigma and discrimination against people living with HIV/AIDS by family and friends remains a problem in many communities. As a result, some people would not provide contact information (or provide incorrect information), would deny the results of a positive HIV test, or would be reluctant to attend an ART center in their community for fear of being seen there. Some people would not disclose their HIV status to their family or partner out of fear, which contributed to their reluctance to visit ART centres.
- *Health System Barriers*: Issues that were beyond the control of the Wellness Centers include long waiting time, limited laboratory service, lack of integrated HIV service, and lack of patient follow-up at the ART centers.

Table 9.20 District Level HIV/AIDS Status

District	HIV/AIDS Prevalence	Risk Factors	Risk Behaviors	District response	Active HIV/AIDS NGO's
Zimba	12.8% (2019)	• HIV positive persons not knowing there status • High levels of poverty • Childhood marriages • High levels of illiteracy (particularly in rural areas) • Polygamy	• Cross border truckers: prostitution, promiscuity and drug abuse. • Alcohol abuse • Seasonal cross border traders engaging in illicit sex	• HIV/AIDS Testing • HIV/AIDS treatment and Start • Condom Distribution • Social Behavior Change through HIV/AIDS sensitization outreach programs (Ministry of Health, Department of Community Development and Department of Culture and Art • Provision of support to all known HIV/AIDS infected people in the community not yet linked to care	• University of Maryland(UOM) • Catholic Relief Service (CRS) • Churches Health Association of Zambia (CHAZ) • Kocebuka Community Based Organization
Kalomo	12.8% (2019)	• Poor ARV uptake • Harmful culture, traditional beliefs and practice • Inconsistent and incorrect condom use • Mother to child transmission • Drug and alcohol abuse • Multiple concurrent sexual partners • Negative religious teachings • Early and forced marriages	• -	• Intensifying the test and treat (90/90/90) • Conducting Social behavioral change communication through drama activities and radio programmes • Advertising the correct measures on the use of both male and female condoms programming and intensified distribution in workplaces. • Promoting and educating the community on the importance and benefits of male circumcision. • Discouraging some of the negative religious beliefs • Promoting avoidance of concurrent sexual partners and polygamous marriages	• NZP+ • University of Maryland • Planned Parenthood Association of Zambia
Kazungula	15.2% (2016)	• Multiple and Concurrent Sex Partners; • Low and inconsistent condom use; • Mobility and labor migration; • Early and forced marriages; unemployment and poverty; • Low levels of male circumcision; and • Mother to Child Transmission.	• Influx; • Harmful traditional and cultural practices; and • Alcohol and drug abuse	• Sensitization on the dangers of HIV/AIDS; • Condom distribution; • Voluntary counseling and testing • Prevention of Mother to Child Transmission of HIV is offered at the 22 RHCs; and • ART is provided at 15 RHCs (3 static, 12 mobiles).	• USAID • The Planned Parenthood Association of Zambia (PPAZ) • Chreso Ministries NZP+
Choma	15.7% (2016)	• Unemployment; • Migration and influx; • Poverty; and • Social status	• Multiple and Concurrent Sex Partners; • Stigma leading to decrease in testing and disclosure; • Unsafe sex practices; • Harmful traditional and cultural practices •	• Voluntary counseling and testing; • Condom social marketing programs; • Sex education and social mobilization interventions; • Interpersonal education programs; • Condom distribution; • Harm reduction interventions; • Selected interventions to mitigate barriers to prevention and negative social outcomes of HIV infection	• USAID; • Elizabeth Glaser Pediatric AIDS Foundation;

Source: ERM FGDs, 2019

9.10.4 National, Provincial and District Level Health Status - Zimbabwe

The 2015 Zimbabwe Service Availability and Readiness Assessment (ZSARA [52])) s shows that the health system has largely remained resilient enough to provide basic services to the majority of the people. However, challenges remain in terms of service gaps and more importantly quality of services to ensure effective coverage. The other key challenge affecting access is the question of direct payment for health services (Out Of Pocket (OOP) – formal or informal) which presents household hardships especially for those who are poor and vulnerable.

Furthermore, improving quality of services and equitable access means that health workers must be available when needed with the right attitudes and work ethics to meet user needs [53]. *Box 9.7* below gives a summary of the general service readiness on selected basic domains and specific tracer services such as HIV and AIDS, Maternal, New-born and Child Health (MNCH), tuberculosis (TB), malaria, diabetes and others [54].

Significant milestones in health have been achieved to date. These achievements include, reduced maternal mortality, and reduced HIV incidences. Furthermore, the country has entered malaria pre-elimination in Matabeleland South and Midlands. Although Zimbabwe has been able to improve their health systems, the progress has been significantly below the health Millennium Development Goals (MDGs). For instance under 5years mortality remains high among the poor and vulnerable households.

There has been significant increase in the allocation towards health care in 2018. The Ministry of Health and Children Care (MoHCC) was allocated a total of US$ 473.9 million in 2018, which is 68.1% higher than US$ 281.98 million allocated in 2017. This includes the additional US$ 65 million allocated following serious lobbying by the Parliament to increase the health budget. The total budget allocation to health represents 8.3% of total expenditure, some 1.4 percentage points up from 6.9% in 2017. The increased budget allocation is against a background of increased National budget, by 40.1% from US$ 4.1 billion in 2017 to US$ 5.7 billion in 2018 (UNICEF, 2019).

(52) Ncuwash.org. (2015). Zimbabwe Service Availability and Readiness Assessment 2015. [online] Available at: http://ncuwash.org/newfour/wp-content/uploads/2017/08/Zimbabwe-Service-Availability-and-Readiness-Assessment-Report.pdf [Accessed 27 Aug. 2019].
(53) The National Health Strategy for Zimbabwe 2016-2020
(54) Ibid

Box 9.7 Challenges associated with the Provision of Healthcare in Zimbabwe

- Basic amenities: Sanitation facilities were available in all facilities. 96% of all facilities had access to emergency transportation and an improved water source.
- Access to internet connected computers was 21%.
- Urban locations had a higher availability of basic amenities items compared to rural locations. Hospitals were more likely to have all basic amenities compared to primary care facilities.
- Basic equipment: Thermometers were available across all facilities. Items such as stethoscope, blood pressure apparatus, and adult scale were available in nine of ten facilities nationally. Light source had the lowest availability at 58%. Four in ten facilities had all six basic equipment items.
- Standard precautions: Auto disposable syringes were available in all facilities.
- Disinfectants, latex gloves and appropriate storage of sharps waste were available in nine out of ten facilities across provinces.
- Six in ten facilities had an appropriate storage for infectious waste. Only one in three facilities had all items for standard precautions.
- Capacity to conduct diagnostic tests on site was relatively high i.e. >70%. Nine in ten facilities conducted malaria rapid tests or HIV rapid tests on site.
- Eight in ten facilities conducted syphilis rapid test and urine dipstick for protein/glucose.
- Less than half (50%) of facilities had tests available blood glucose, urine test for pregnancy and haemoglobin.
- Only one in 10 facilities reported having all tests available. There were no major variations between hospitals and primary care facilities in diagnostic capacity.
- Essential medicines: Antibiotics such as oral Amoxicillin were available at almost all facilities (98%). Injectable antibiotics such as gentamycin, ceftriaxone, and ampicillin were the least available (31%)
- Magnesium sulphate and oxytocin were available at nine out of 10 facilities

.Source: ERM FGDs, 2019

Mortality and Morbidity

Table 9.21 below shows the National top twenty causes of mortality amongst Zimbabweans in 2014 according to the Ministry of Health and Child Care (MOHCC). The top five causes of death include Acute Respiratory Infection (ARI), conditions originating from perinatal period, TB, HIV and Meningitis [55].

Table 9.21 National Top Twenty Causes of Mortality, All Ages

Village	Nearest Primary School	Nearest Secondary School
1.	ARI	2,034
2.	Certain conditions originating in the perinatal period	1,812
3.	TB	1,134
4.	Human immunodeficiency virus (HIV) disease all complications, AIDS and AIDS Related Conditions	853
5.	Meningitis	823
6.	Diarrhoea and gastroenteritis due to other infectious diseases (bacterial, viral, protozoal)	560
7.	Heart failure (congestive and left ventricular)	510
8.	Symptoms, signs and abnormal clinical & laboratory findings, not elsewhere	462

(55) The National Health Strategy for Zimbabwe 2016-2020

Village	Nearest Primary School	Nearest Secondary School
9.	Other anaemias	455
10.	Malaria	441
11.	Renal failure	439
12.	Other endocrine, vitamin, nutrients and nutritional deficiencies, obesity and metabolic disorders	403
13.	Congenital infections and parasitic diseases, excluding HIV	402
14.	Other diseases of intestines, including peritoneum	337
15.	Cerebral infarction, Cerebrovascular accident (stroke) not specified as hemorrhage or infarction	270
16.	Mycoses, including candidiasis	249
17.	Intrauterine hypoxia and asphyxia	234
18.	Other diseases of liver	223
19.	Diabetes mellitus	206
20.	Other heart diseases	194

Source: MOHCC, 2014

Immunisation

Approximately 65% of Zimbabwean children age 12 to 23 months are fully immunised, i.e. received BCG and measles vaccinations, and three doses each of DPT and polio vaccines. Over a tenth (12.5 %) of children have received no vaccines at all (56).

Child immunization coverage increased from 25% to 80%, and together with increased coverage of other child health interventions, resulted in an under five mortality rate which dropped by more than 20%, from 104 per 1,000 live births to 81 per 1,000 live births (57).

Incidence of Disease

Although significant progress has been made over the last few years, the country still faces a double burden of communicable and non-communicable diseases.

HIV prevalence remains relatively high at 15% amongst adults, and gains achieved to date are threatened by sexual activity amongst youth and an increasing number of teenage pregnancies.

Deaths due to TB remain high due to its twin relationship with HIV and AIDS. Malaria remains a major cause of morbidity and mortality in the country and more so in some geographic areas. At the same time, non-communicable diseases are indeed emerging as major causes of morbidity and mortality amongst both rich and poor in the country. The nutrition status of children remains poor. Outbreaks of anthrax and rabies are not unusual. The challenges are compounded by health systems constraints related to shortages of critical

(56) Zimbabwe Statistics (2011). Zimbabwe Demographic and Health Survey 2010-11, Zimstat, Harare, Zimbabwe.
(57) UN Inter-agency Group for Child Mortality Estimation, 2010

health workforce and ageing infrastructure [58]. *Table 9.22* shows the top 10 diseases by all age groups (excluding STIs).

Table 9.22 Top Ten Out-patient General New Diseases and Conditions [59]

	Disease / Condition	Numbers	Percentage
1.	Acute Respiratory Infections	3,693,350	31.0
2.	Skin diseases	959,885	8.1
3.	Diarrhoea	763,136	6.4
4.	Burns and Other Injuries	570,841	4.8
5.	Malaria	535,931	4.5
6.	Diseases of the eye	421,620	3.5
7.	Dental conditions	178,948	1.5
8.	Bilharzia	74,916	0.6
9.	Dysentery	49,373	0.4
10.	Nutritional Deficiencies	22,648	0.2

Source: MOHCC, 2014

Sexual and Reproductive Health

The total fertility rate is estimated at 4.3 children per woman, and the age-specific fertility rate for women aged 15 to19 years is 120 births per 1000 women. The adolescent fertility rate in 2014 was estimated at 120 births per 1,000 women aged 15 to 19 years [60]. According to 2010/11 Zimbabwe Demographic Health Survey, 20.5% of women aged 20 to 24 years have had at least one live birth before the age of 18 years. The rural-urban differential in teenage fertility is significant, as rural girls under the age of 18 were twice as likely to become a mother as their urban counterparts. The decline of the Maternal Mortality Ratio among women of 15 to 19 years at 21% is much slower than the average decline of 43% for women of 15 to 49 [61].

9.10.5 Local Level Health Infrastructure - Zambia

Health Facilities

Health facilities in the Project Area are oversubscribed and inadequate in number. *Table 9.23* below provides a summary of available health facilities in the Project Area.

Table 9.23 Health facilities in the Zambia Project Area

Village Cluster	Village	Nearest Health Facility	Number of health personnel
Ng'andu	Chibule	Mukuni Clinic (15km away for furthest villages)	10 nurses 1 Medical Assistant
	Ng'andu		

(58) The National Health Strategy for Zimbabwe 2016-2020
(59) This list excludes STIs
(60) Zimbabwe Multiple Indicator Cluster Survey, 2014
(61) Ibid

Village Cluster	Village	Nearest Health Facility	Number of health personnel
			1 Co-medical Assistant 1 Doctor (once a week)
Valley	Mulola Madyongo Sikatali Simanyonge Posani Siampondo	There are no health posts in the valley village cluster.(Nearest health post 86 km away)	-
Katapazi	Katapazi	Katapazi Clinic (21km for furthest villages)	1 Clinical Officer 1 Environmental Health Technician 1 Nurse

*Demonstrates furthest distance travelled to health facility
Source: ERM FGDs, 2019

The greatest impediment to receiving healthcare in the Project Area is shortage of health facilities, drugs, personnel and equipment as well as the distance villagers are required to travel. The larger health centres, including Mukuni Clinic and Sipatunyana Health Centre are particularly overburdened and under resourced. Mukuni Clinic services a population of an estimated 10,000 people while Sipatunyana Health Centre reportedly services up to 30,000 people. In addition to health personnel available at health posts listed in *Table 9.23*. Community Health Workers (CHW) are located in every village. CHW are mainly involved in HIV/AIDS awareness campaigns and counselling and home visits. Once a month, CHW organise for health professionals to do rounds in each village in the Project Area to do inoculations and general check-ups. This is particularly beneficial to vulnerable groups including pregnant women, children and the elderly.

Both Mukuni Clinic and Sipatunyana Health Centre provide family planning, maternal and child health and antenatal care services, Sexually Transmitted Disease (STD) treatment, counselling, testing and care for those with HIV/AIDS and general treatment of diseases. Due to the two facilities large catchment area, people are required to walk long distances to access the facilities. In all 2019 FGDs, communities reported that health facilities were under staffed, have an inadequate supply of medication and have long waiting times. In instances where medicines are unavailable (which is often), patients are given subscriptions to go and purchase medication from pharmacies at their own expense.

Chronic drugs, including ARVs are available at all health facilities listed in *Table 9.23*; however, shortages occurred, particularly at the more rural clinics in the Project Area. In the rainy season for example, delivery of the medication from providers to healthcare facilities is occasionally impeded by trucks getting stuck in the mud. Few health centres accessed by communities across the Project Area have access to an electricity connection.

Livingstone Central Hospital offers preventive and treatment services to nearly 1.2 million people. Paediatric HIV treatment at Livingstone Central Hospital was initiated in 2003 and in 2006 the PCOE clinic was established through a collaborative agreement between the Ministry of Health in Zambia and the Centres for Diseases Control and prevention country office (Kankasa *et al*, 2009).

All facilities listed in *Table 9.23* had a delivery room; however, only Mukuni Clinic and Sipatunyana Health Centre had ward in which mothers could anticipate their labour and recover thereafter. As such, women are required to leave the same day they give birth and either have to walk or catch a lift back to their homes. Most women in the Project Area chose to give birth at village clinics; however, if births become complicated or local clinics are full, women travel to the centres of Livingstone and Zimba in order to access better maternity facilities. Women participating in the 2019 FGDs reported sleeping in the corridors of the Zimba Hospital and renting rooms in Zimba town a month prior to the birth to ensure that when they went into labour they could deliver safely. It is illegal to give birth at home and families are fined up to Kwacha 200 should home births occur.

All village clusters reported that although at a District level, NGOs were present, these NGOs and the benefits they offer are not being received by the villages in the Project Area specifically.

Traditional Medicine and Healers

Traditional healers are reported to be present in all the communities and are particularly important in the Valley village cluster because access to healthcare is extremely difficult. In all other villages, traditional medicine is used as an alternative to conventional medicine when patients cannot afford to pay for treatment, distances to health centres is too great or as a last resort when conventional medicine fails to have an effect.

Traditional healing methods are still used to treat non-tangible afflictions, for example to be successful in business, marriage and to strike down an enemy. FGDs with women and general community groups suggest that traditional medicine is used to treat a number of illnesses and afflictions (refer to *Table 9.24)* Men in 2019 FGDs revealed that traditional healers are approached by those suffering from STIs, as they were embarrassed to be treated at health centres for these diseases.

Witchcraft is reportedly active in the forested areas of Lifalale and Nsilele village clusters

Table 9.24 Diseases treated using Traditional Medicine in the Zambia Project Area

Village Cluster	Disease Ailments
Ng'andu	Diarrhoea, STDs, toothache, virility
Valley	Malaria
Katapazi	Diarrhoea, Respiratory infections, virility, STDs

Source: ERM FGDs, 2019

9.10.6 Local Level Health Infrastructure – Zimbabwe

Health Facilities

There are four hospitals that serve Hwange Rural District, including the hospital in Victoria Falls and a private hospital located at Hwange Colliery. Most households access community health posts for their health needs. There are a number of health facilities located in the Project Area including; Sacred Heart Mission, Chisuma clinic, Lukunyuni and Jambezi clinic. Few facilities have their own ambulance; they may however use an ambulance from the District hospital if the need arises. Communities have to travel 15 km or more to access health facilities (ERM FGDs, 2019).

Asides from visiting clinics, communities can also access health care services from Village Health Workers (VHWs). VHWs do follow ups with the sick in their homes. They treat minor alignments and also undertake malaria testing. VHWs report to clinics on a monthly basis. Family planning services are provided at health facilities, with the exception of the Sacred Heart Mission, which is a catholic run institution. Although condoms are available at the clinics, the distance that people have to travel in order to access them acts as a deterrent in collecting them from these. Condoms are also available at beer halls in some villages and VHWs may also distribute them to those who request them.

The cost of healthcare services is dependent upon the clinic accessed. Whilst healthcare services provided by state run facilities are free for those aged under five years and over 60 years in public health facilities, at Ndlovu clinic and the Scared Heart Mission patients falling outside of these age brackets have to pay between US$ 0.50 and US$ 1 for a consultation, whereas at Chisuma it is free. Health workers reported that people struggle to pay for healthcare. This has a domino effect on the clinics, who consequently find it difficult to pay for medication.

Based on KIIs and FGDs held with the communities in the area on June 2019, it was established that there are several NGOs that support health programmes in the area namely; World Vision that supports Nutrition, Zimbabwe AIDS Project that supports Nutrition and Anglican Church Isdell Flowers that supports Malaria. *Box 9.8* below highlights the main challenges reported by the communities in the Project Area.

Box 9.8 Challenges associated with the Provision of Health services

- Long distance to get to health facilities.
- Lack of adequate medical supplies.
- Lack of adequate medical equipment.
- Shortage of medical personnel.
- Lack of well-trained medical personnel.
- Shortage of ambulances.

Source: ERM FGDs, 2019

Traditional Medicine and Healers

In all villages, traditional medicine is used as an alternative to conventional medicine when patients cannot afford to pay for treatment, distances to health centres is too great or as a last resort when conventional medicine fails to have an effect.

Traditional healing methods are used to treat coughs, stomach ailments, flu and eye issues. Plants used in treatment included devils claw, isihaqa, ntolwane, gumtree and quava.

Some villages reported that if conventional and traditional medication failed to treat illness, they turned to the church for spiritual healing methods (e.g. prayer)

9.10.7 Local Level Health Status - Zambia

Health in the Project area village clusters was varied; however, common ailments included Malaria, Diarrhoea and HIV/AIDS.

Mortality and Morbidity

According to a Community Health Worker living in the Project Area, the most common illnesses treated at health facilities in the Project Area are respiratory infections, dental problems, eye disease, heart disease, trauma and injuries, and asthma. Diarrhoea was reported to be high in a number of village clusters, mainly due to poor sanitation and a scarcity of safe drinking water. The top 5 health issues in each village cluster are summarised in *Table 9.25*.

Table 9.25 Five Most Common Health Issues Experienced by Communities

Village Cluster	Top five Health Issues
Ng'andu	• HIV/AIDS • Malaria • Respiratory illness • Diarrhoea • Eye problems

Village Cluster	Top five Health Issues
Katapazi	• HIV/AIDS • Diarrhoea • Labour-related ailments (back ache, arthritis) • STDs • Malnutrition
Valley	• Malaria • Malnutrition • HIV/AIDS • Maternal death

Source: ERM FGDs, 2019

Malnutrition

Whilst malnutrition was not reported to be a significant issue by most villages, children were observed to demonstrate symptoms of malnutrition during FGDs and field work in 2019. Food shortages and concerns relating to failed rains and crops were discussed in all 2019 FGDs and as such, malnutrition was anticipated, if not thought to exist currently. Food shortages are particularly prevalent from September and February, when food harvested from the previous harvest has been depleted. It was reported by a CHW in the Project Area that villager did not necessarily recognise malnutrition when present and lacked knowledge about the nutritional content of food.

Malaria

According to communities, Malaria rates had significantly decreased in recent years due to the effectiveness of preventative measures such as spraying and use of mosquito nets. However, malaria is still a leading disease in the Project Area, particularly in the valley village cluster. This was attributed to spraying not being undertaken frequently as well as limited distribution of nets (nets are re-distributed every 5 years).

HIV/AIDS and Communicable Disease

Rates of HIV/AIDS were reported to be decreasing in village clusters due to sensitisation campaigns by USAID and the National government. Sensitisation includes campaigns such as the "ABC" approach where communities are taught the importance of 'Abstinence, Being Faithful and Using Condoms'. High prevalence of HIV/AIDS in the Project Area communities is attributed by communities to multiple sexual partners, unprotected sex and limited recreational and livelihood opportunities available to the youth.

Stigma around HIV/AIDS is reported to be much improved; however, it still exists. This is thought to be because of sensitization to the disease, its cause and how to live with it. Additionally, the high prevalence of HIV/AIDS in the Project Area means that many families have been affected by it in some way. As a result, people are a lot more open about their status now compared to the past. However, all village clusters reported that many HIV/AIDS patients still felt stigmatised and ashamed of their status and went to non-local clinics for treatment in order to avoid being "found out".

Transactional sex workers are noted to be in operation in Mukuni and Livingstone, as well as in communities in Zimba, Choma and Kalomo, especially at bars and truck stops. This is attributed to high levels of poverty and limited employment opportunities.

Women, as well as youth and businessmen are regarded as being particularly at risk of contracting HIV/AIDS. District health officers noted in 2014 that Tonga society is very patriarchal; women are taught to obey men and that they should not refuse to have sex with their husbands. Polygamy, which KIIs in 2014 reported to be as high as 30% in the Southern Province, also serves to increase the danger of contracting HIV/AIDS. Youth were noted as high risk due to being highly sexually active and businessmen, due to their mobility.

Livingstone General Hospital has over 7,000 patients enrolled for HIV care of whom 3,880 patients were on ARV treatment (Moomba *et al*, 2019). Economic factors such as poverty and unemployment and the lack of food were reported as major barriers to continuing ARV treatment at the hospital. In addition, social factors such as traditional medicine, religion, lack of family and partner support, and disclosure were also reported as reasons for not receiving treatment (Moomba *et al*, 2019).

1,039 Children aged less than 15 years undertook ARV treatment at Livingstone Central Hospital between January 2003 and June 2015. In total, 71 (7%) children were confirmed to have died after commencing treatment and 594 (56%) are still alive and active in care at the time of the study. A total of 164 (16%) were lost to follow-up and 210 (20%) transferred to other health care facilities (Mutanga *et al*, 2019).

9.10.8 Local Level Health Status - Zimbabwe

The most common illnesses and diseases reported in the Project Area as reported during the 2019 KIIs and FGDs are; HIV/AIDS, STIs, Upper Respiratory Tract Infections, Malaria, Diabetes, Diarrhoea, Cholera, Cancer, Hypertension, Tuberculosis and Bilharzia.

Mortality and Morbidity

HIV/AIDS and diarrhoea were cited as the most common cause of deaths. Although more females are affected with HIV/AIDS, it was reported that males are more likely to die from it at an earlier age as they are not as forthcoming in terms of getting tested.

Diarrhoea was attributed to poor sanitation. Malaria was reported to be under control as a result of the use of nets and indoor spraying. At the time of the social survey, teams of health workers were commencing with the indoor residual spraying (IRS) programme. Other vector borne diseases were reported not prevalent in the area.

Malnutrition

Whilst malnutrition was not reported to be a significant issue by communities at FGDs in 2019, children were observed to demonstrate symptoms of malnutrition during FGDs and field work in 2019. Food shortages and concerns relating to failed rains and crops were discussed in all 2019 FGDs and as such, malnutrition was anticipated, if not thought to exist currently. Food shortages are particularly prevalent from September and February, when food harvested from the previous harvest has been depleted. It was reported in the FGDs that people lack the knowledge to plant crops and gardens with plants that provide the highest nutritional value to sustain households.

Malaria

The According to communities, Malaria rates have significantly decreased in recent years due to the effectiveness of preventative measures such as spraying and use of mosquito nets. However, it is still reported as one of the most common health issues experienced by communities.

HIV/AIDS and Communicable Disease

Based on information obtained from the Hwange District Health Information Officer (62) for the sampled health facilities/centres on December 2018, about 8,452 people in the area are undergoing Antiretroviral (ARV) treatment at the various health. A significant number (8,307) are under the First Line Treatment i.e. the Initial treatment based on the 2015 World Health Organization (WHO) recommended consolidated guidelines on the use of ARV drugs for treating and preventing HIV infection (63). There were also about 145 people undergoing second Line Treatment (64).

About 3,734 people are seeking ARV treatment. A summary of the status of HIV/AIDS in the Project Area is provide in *Box 9.9*.

(62) Information was based on data collected from the various Health Centres and Facilities within Hwange District 2019.
(63) World Health Organization (2019). Updated recommendations on first-line and second-line antiretroviral regimens and post-exposure prophylaxis and recommendations on early infant diagnosis of HIV. [online] Available at: https://www.who.int/hiv/pub/guidelines/ARV2018update/en/ Accessed 13.08.2019.
(64) Treatment Initiated when the First Line Treatment has failed

Box 9.9 ***HIV / AIDS Status in the Project Area***

- There is a higher prevalence of new Sexually Transmitted Infection (STI) cases among males as compared to females
- More males than females presented cases of urethral/vaginal discharge and genital ulcers
- Repeat visits for treatment of STIs were slightly more prevalent among females as compared to males
- There appears to be a case of child abuse with one child between the ages of 0 and 9 years presenting STI symptoms.
- Among the elderly aged 50 and above there are also cases of STI with male cases (five) being slightly higher than female cases (four)

Source: ERM FGDs, 2019

9.11 SERVICES AND INFRASTRUCTURE

9.11.1 National, Provincial and District - Zambia

Transportation

Infrastructure development has been identified as a National development priority area by the Government of Zambia in the Sixth National Development Plan, as well as in the National Vision 2030. There are four international airports in the country, including one in Livingstone. The major urban centres in Zambia are connected via road. The country's road networks covers 38,763 km of which 6,173 km are bitumen, 8,592 km gravel and 23,998 km is unclassified (ZDA, 2018) . The main trunk roads include the Great North Road, which runs from Lusaka through the Central, Northern and Muchinga Provinces, up to the Tanzanian border town of Tunduma. The Great East Road runs from Lusaka through the Eastern Province up to the Malawian border. Other trunk roads include the Lusaka-Livingstone road and the Lusaka-Chirundu border post road. Road passenger transport is operated by private companies. The government of Zambia is currently planning to construct approximately 8,000 km of new roads across the country (RDA, 2018).

Zambia's railway infrastructure includes the Tanzania Zambia Railway Authority, (TAZARA) railroad, which runs from Kapiri Mposhi and traverses through Mkushi and Serenje, terminating at the port city of Dar-es-Salaam in Tanzania as well the Railway systems of Zambia. The National railways which are operated as a concession by Railway Systems of Zambia stretch from Livingstone in the Southern Province through Lusaka, to the Copperbelt town of Kitwe. Both the TAZARA and Railway Systems of Zambia operate freight and passenger trains.

Fuel / Electricity

Approximately 22% of the population has access to electricity (5% of the total rural population) (ZamStats, 2015). The state-owned ZESCO Limited is the main producer and distributor of electricity in the country. At the National level, most households (54%) used firewood as the main source of cooking energy. Charcoal is the second most commonly used energy source, used by 29%. Electricity is used by 16.8% of the population.

In the Southern Province, 69.3% use firewood, 17.8% use charcoal and 12.7 % use electricity (ZamStats, 2015). 16.7% of households use electricity as their main energy source for their lighting needs. Other sources of energy used for lighting is kerosene/paraffin (used by 27% of households), closely followed by candles (26 %).

Telecommunications

In 2017, Zambia had 78.6 mobile cellular subscriptions per 100 people. Fewer had access to the internet, with 15.4 per 100 people having a fixed broadband internet subscription (World Bank, 2017). This is attributed to the high cost of services and infrastructure (AfDB, 2015). A new fibre link has recently been completed, linking Lusaka and Livingstone, with the aim of increasing broadband connectivity in Southern Zambia. The main mobile phone networks in the country are Airtel, MTN and Zamtel.

Water

Nationally, 61.6% of households have access to improved (uncontaminated) water sources including a protected well, borehole or tap. Access is lower in rural areas at 49.2%. Households in the Southern Province have better access to such water sources compared to the National average at 72.5%. Nationally, 14% of households use water directly sourced from the river or stream as their main water source, and 19.8% obtain it from an unprotected well, considered unsafe for drinking, compared to 12.7% and 9.8% respectively in Southern Province. The proportion of people who have access to water from either a public tap or their own tap is 9.2% and 12.9% respectively for the Southern Province, slightly lower than National rates of 11.8% and 14.5%. Although water sourced from such taps are normally chlorinated and assumed safe for drinking, public health authorities encourage households to treat their water as a precaution. Nationally, only 35% of household treat their water; lower than that in Southern Province (51.2 %). Households in rural areas are less likely to treat water (25% compared to 53.1%) (ZamStats, 2010).

The Southern Water and Sewerage Company Limited (SWSC) is the primary supplier of water and sewerage services in all of the Districts. Water quality is reported to be good by Kazungula District Council and is reportedly supported by the apparent absence of frequent water related illnesses amongst users.

Sanitation

Nationally, only 33% of households have an improved toilet facility; 35.9% in the Southern Province. The majority of households use their own pit latrine without slab (44.3%). Access to improved facilities is significantly higher in urban than rural areas (66% versus 14.1 %). In the Southern Province there are more than two times the level of households (28% versus 12 %) that have no toilet facilities and instead, use a bush, stream or other public area (ZamStats, 2010).

Waste Removal

In Zambia, the majority of households dispose of their waste through pits, 34.5% dump it and 5.6% have it collected and 2% burn it. Those living in rural areas are more likely to dump waste (41.2% compared to 22.3% in urban areas) and are less likely to have it collected (0.6% compared to 14.6 %). In the Southern Province, 55.6% of households dispose of waste in a pit, 39.1% dump it, 2% burn their waste and 1.7% is collected (ZamStats, 2010).

9.11.2 National, Provincial and District - Zimbabwe

Transportation

Zimbabwe has an extensive road network with 88,100 km of classified roads; 19.8 % (17,400 km) are paved, 71.98% gravelled and 8.6% are earth (65). The main highways extend out from Harare to neighbouring countries Mozambique, South Africa and Zambia. The general condition of roads has deteriorated due to inadequate funding for regular maintenance.

ZIM ASSET (2013 to 2018) recognised the poor state of transport infrastructure in the country as an impediment to growth and set targets to improve rail, road and air networks to catalyse development in this sector. Zimbabwe has a rail network that covers an estimated 3,077 km; of which 318 km is belonging to Bulawayo-Beitbridge Railway (Private) Limited. Of the 2,759 km maintained by the public sector through the National Railways of Zimbabwe, only 313 km (Dabuka to Harare) was originally electrified, but it has been vandalized and is in a state of disrepair. This, coupled with reduced economic activity has negatively impacted the ability to utilise the railway network at its full capacity.

Fuel / Electricity

Approximately 41% of households in Zimbabwe have access to electricity (66). Access is significantly higher in urban areas than rural areas, at 83% and 13% respectively (67). In Matabeleland North, only 22.6% of household have an electricity connection (68). The main electricity provider in the country is the state owned Zimbabwe Electricity Transmission and Distribution Company (ZEDTC). However, due to high demand and insufficient supply, the country suffers from frequent load shedding.

The main source of energy used for cooking at the National level is wood (62.6%), followed by electricity (30.9%) and paraffin (2.1%). Only 0.3% use gas

(65) Timothy, M., Mark, M., & Kudzanai, K. (2012). Dodging the Potholes: The spatio-distribution and socio-economic impacts of potholes in the residential areas of Gweru, Zimbabwe. Journal of Environmental Science and Engineering. B, 1(7B), 874.
(66) Zimbabwe Statistics (Zimstat), (2012), Census Preliminary Report, Zimstat, Harare, Zimbabwe.
(67) The government of Zimbabwe's National Energy Policy of 2012
(68) Zimbabwe Statistics (Zimstat), (2012), Census Preliminary Report, Zimstat, Harare, Zimbabwe.

and 0.1% coal. Households in Matabeleland North have a greater dependence on wood to fulfil their energy needs, at 78.4% (69).

Telecommunications

In 2017, it was estimated that there were 85 mobile cellular subscriptions per 100 people and those with a subscription to a fixed broadband internet totalled 1.13 per 100 people (70).The main mobile phone networks in the country are Econet, Netone and Telecel.

Water

Zimbabwe is primarily dependent on surface storage for its water needs. All of its major rivers are shared with other members of the Southern African Development Community (SADC). There is active cooperation with other members of SADC on the shared management of the region's river systems, and it is a signatory to the Shared Water Course Systems Protocol, which provides the basis for management of the International rivers in the SADC countries. It is also an active member of the Limpopo and Zambezi basin communities, which oversee joint management of these International rivers (71).

The largest user of water in Zimbabwe is the agricultural sector and while agriculture can consume about 82% of the country's water resources, water being used currently is estimated to be at approximately 20%. It is a major National resource and, up until the economic uncertainty of the past decade, it was a crucial factor in Zimbabwe's agricultural and industrial competitive advantage in the region. Access to improved water and sanitation has a direct positive impact on health in Zimbabwe, particularly among children. It also tends to raise school attendance rates, particularly for girls, and the ability of children to learn. Improvements in such areas in turn may have a high payoff in the long term in terms of productivity (72).

Sanitation

The Zimbabwean Rural Livelihoods Assessment, undertaken in 2013, reported that 48% of households in the country use improved sanitation facilities. Matabeleland North province however, has one of the poorest levels of access to such facilitates, with 70% of residents practicing open-air defecation compared to the National average of 39% (73).

Waste Removal

Sanitary disposal of waste is typically a service that is only available in urban areas. In communal settlements and resettlement areas, households are

(69) Ibid
(70) World bank (2019). The World Bank. [online] Available at: https://data.worldbank.org/indicator/IT.CEL.SETS.P2?locations=ZW&view=chart [Accessed 20.08.2019]
(71) Zimbabwe Infrastructure Report 2019
(72) Ibid
(73) ZimVac (2013), Zimbabwe Vulnerability Assessment Committee, 'ZimVAC Draft Report', ZVAC, Harare, Zimbabwe.

responsible for managing their own waste disposal. Typically, a pit is dug and household waste is thrown therein, sometimes incinerated by a fire.

9.11.3 Local Level Context - Zambia

Transportation

The Project area Districts are primarily connected by the tarred T1 road (Livingstone to Kalomo to Zimba to Choma) to the North. Access to amenities, larger settlements and service infrastructure not located along the T1 road is via secondary, graded roads while the majority of settlements are accessed by sand and gravel roads. A large number of these roads are in poor condition and are impassable in the wet season. Along the proposed transmission line route, the road is made impassable by a number of "donga" river crossings.

Public transport is generally available in the larger market towns of Zimba, Livingstone, Kalomo and Choma. However, public transport within the villages in the Project Area is virtually non-existent. As such, the majority of villagers explained in the FGDs that they walked, rode bicycles or motorbikes and caught lifts with villagers who had access to private vehicles. Private taxis are available in the Project Area; however, they are costly and cost Kwacha 250 one way.

Oxcarts were used to transport goods and services as well as donkeys, which were observed to be important pack animals in a number of communities.

Figure 9.25 Donkeys on Mukuni Road to Chibule

Source: ERM FGDs, 2019

Water

All communities that participated in the 2019 FGDs accessed water from wells/boreholes and rivers. Wells and boreholes were the most popular source of water in all clusters. In villages where mechanised wells were available, they were hand pumps and water from wells was used not only for household use but also for watering of cattle, gardening and brick making. Each village cluster reported to have between two and four boreholes per village; however, the Valley cluster reported to rely more on surface water than wells and boreholes. Water collection is primarily undertaken by women and children and distances travelled to collect water varied from 500 m to 10 km.

Access to water was reported as an issue in all village clusters except the valley village cluster. This was particularly true of the dry season, when FGDs reported that many water sources dry out and distance to collect water increases. Reason for water issues included drought, damming of rivers by upstream agricultural users and damaged/non-maintained infrastructure.

Figure 9.26 Manual Hand Pump (left) and Pan used to Water Cattle (right)

Source: ERM FGDs, 2019

Sources of Power

None of the villages in the Project Area besides parts of the Mukuni Village have access to the National electricity grid. In FGDs in 2019, communities described that firewood was the most important fuel source and used for cooking, heating and lighting. This was particularly the case in villages located more remotely along the transmission line route. Popular sources of power included solar home systems, batteries and, where households could afford it, generators. Paraffin lamps, candles and torches are all used for lighting.

Sanitation

Formalised sanitation was unavailable throughout the Project Area. All FGDs with village clusters described non ventilated pit latrines as the most popular sanitation facility, followed by bush defecation. Formal facilities including clinics and schools had ventilated pit latrines.

Waste Removal

Waste removal services are not available in any of the villages in the Project Area. Waste is generally buried, burnt or left in the environment.

Telecommunications

Most people who attended the village FGDs owned mobile phones and used them as their primary means of communicating. Telephone reception however is poor in the majority of the communities, particularly those more isolated villages.

Recreational Facilities

Sport is an important social activity in all the villages that participated in the 2019 FGDs, and all except one village participated in inter-village football and netball leagues. Each village has at least one field/court; however, equipment including balls were not always available. Some schools also have courts and fields on which children played against one another within the village and against other villages.

9.11.4 Local Level Context – Zimbabwe

Transportation

The Project Area is primarily connected by the tarred A8 (Victoria Falls to Hwange) to the Southeast. Access to amenities, larger settlements and service infrastructure not located along the A8 is via secondary, graded roads while the majority of settlements are accessed by sand and gravel roads. A large number of these roads are in poor condition and are impassable in the wet season. In Chisuma, Jabula Sizinda and Dibu Dibu improvement of the road network was cited as a key community development need. Public transport is generally available in the larger market towns of Victoria Falls and Hwange. Public transport is virtually non-existent within the Project Area villages; however, and the majority of community members either walk, cycle or rely on private taxis for transport.

As on the Zambian side, oxcarts are used to transport goods and services in the Zimbabwe Project Area.

Water

In the 2014 ERM household survey, the majority (90%) of households obtain water for their drinking, cooking and washing purposes from wells with pumps/boreholes and take on average 20 minutes to collect it. Water collection is primarily undertaken by women and children. A small number (3%) use water sourced from rivers and streams and approximately 4% of households, most of whom are located in Sizinda, use piped water (*Figure 9.27*). In Kasikiri and Dibu Dibi it was reported that some households also use water sourced from unprotected wells. Water for livestock is normally obtained from rivers and dams.

Access to water was reported as an issue in a number of villages in the 2019 FGDs.

Figure 9.27 Piped Water in the Project Area

Source: ERM Site Visit, 2019

Boreholes in the Project Area have been constructed by NGOs such as UNICEF and ORAP, and also by the Government Agency, the District Development Fund (DDF). DDF is located within the Ministry of Rural Resources and Water Development and is tasked with the responsibility of providing and maintaining rural infrastructure. The DDF has trained 'pump minders' in the Project Area to maintain the pumps however in some villages e.g. Jabula, it was reported that they did not always adequately fulfil these responsibilities. With the exception of Mununa where water from hand pumps/boreholes was reported to be salty, the quality of water was generally noted to be good. Availability is variable in the dry season; however, and in a number of villages (eg Mununa, Kasibo, Borehole 126 and Chisuma), it was reported that boreholes were not that accessible and were unevenly distributed. In Borehole 126, the borehole was noted to be heavy too pump and suffers from constant breakdowns (74).

Sources of Power

Wood is the most popular source of energy for cooking and is used by all households. The majority collect it from the wooded areas surrounding the villages. Households often use more than one energy source, and paraffin is also commonly used for cooking purposes. Candles are used most commonly for lighting needs, utilised by three quarters of households. Other forms of energy for lighting are used including torches (51%) and paraffin lamps (45%).

(74) Based on the ERM Social Survey, October 2014

Approximately 65% of households reported to own solar panels. They are also used for lighting and cooking needs, to power radios and televisions and to charge mobile phones. Female adults are most likely to collect firewood and males are responsible for collecting or paying for lighting sources [75].

Sanitation

Over half the household survey respondents noted that they had access to a latrine; 43% to a built latrine and 15% to an improved latrine. However, in the 2019 FGDs, Village Heads reported that few households actually have their own toilets and most use the bush. In Dibu Dibu and in Borehole 126, Mvuramanzi, an NGO has donated bags of cement for the construction of toilets. NGOs helping other villages in this regard include DANIDA and CADEC.

Waste Removal

In 2014, the majority of households (97%) dump their waste, generally in pits, which are covered when they get full. A very small percentage (2%) of households burns it. The situation remains the same in 2019 and waste removal services are not available in any of the villages in the Project Area. Waste is generally buried, burnt or left in the environment.

Telecommunications

In 2014, the majority of households (82%) own at least one mobile phone however; telephone reception was reported to be poor in all communities. At FGDs in 2019, most people who attended the village FGDs owned mobile phones and used them as their primary means of communicating. Telephone reception is however poor in the majority of the communities, particularly more isolated villages.

Recreational Facilities

Sport is an important social activity in all the villages that participated in the 2019 FGDs and all participated in netball and football activities.

9.12 *VULNERABLE GROUPS*

According to the World Bank Environmental and Social Framework (2017), "Disadvantaged or vulnerable refers to those who may be more likely to be adversely affected by the project impacts and/or more limited than others in their ability to take advantage of a project's benefits. Such an individual/group is also more likely to be excluded from/unable to participate fully in the mainstream consultation process and as such may require specific measures and/ or assistance to do so. This will take into account considerations relating to age, including the elderly and minors, and including in circumstances where

(75) Ibid

they may be separated from their family, the community or other individuals upon whom they depend".

Poverty is a major contributor to vulnerability, and in light of drought conditions, reliance on rain-fed agriculture, and general poverty in the Project Area, it is reasonable to conclude that the area is demographically vulnerable (see the National Vulnerability Assessments for Zambia and Zimbabwe in *Figure 9.28* and *Figure 9.29*).

Rapid population growth is expected to be further stimulated by the presence of the BGHES, which may increase vulnerability, more so, if it is coupled with reduced water availability and degradation and loss of land (whether Project-induced or not). The increase in the number of child dependents relative to the working age population may continue to contribute to food shortages in the Project Area. In addition, limited education facilities and access may underpin inadequate employment readiness in the future.

Population growth in all Project Districts has been rapid. Continued growth with no change in economic opportunities and livelihood conditions will likely perpetuate existing levels of poverty in the Project Area.

Like Zambia and Zimbabwe themselves, the population of the Project Area has a low resilience to demographic, economic and environmental resources shocks, making timely and effective mitigation all the more important.

Taking this into consideration the following groups have been identified as potentially vulnerable in the proposed Project Area:

- *Women / Female Headed-Households:* Due to the nature of domestic relations and traditional practices, women's access to resources (physical and financial) is more restricted in the Project Area. Female headed households can be identified as particularly vulnerable as they face reduced access to income generating opportunities and typically suffer from higher levels of food insecurity. FGDs with women suggested that there were a large number of female headed households in the Project Area. In 2010, 22.2% of households nationally were headed by females. Pregnant women were also reported to be vulnerable as access to maternal healthcare was inadequate. In addition, it was reported that teenage pregnancy was as significant issue in all participating villages. In many cases, these girls were made to marry young, drop out of school or support themselves and their children.

  FGDs revealed that there are a number of widows in the Project Area. According to traditional laws, women can inherit or own land; however, it was stressed that when woman are widowed, they can only allowed to inherit and keep their land provided they do not remarry. Additionally, women play a limited role in decision-making at community level. Although they may occasionally participate in village councils and other traditionally constructed forums, the position of women in village affairs is largely limited. Women noted that they had lower levels of human development compared to men when measured in terms of literacy and education.

- *Youth* (15 – 24 years old): The youth are physically capable but faced with future uncertainties, largely driven by stagnant, subsistence based economies and poverty. The youth are disempowered by an inability to bridge the gap between dependence and independence because they do not have access to the resources or support systems available to those living in better socio-economic conditions. The majority of the population in the Project Area is made up of the youth, and as such, they are disproportionately vulnerable and not resilient.

- *Elderly:* The elderly within a village are less likely to receive an income and are reliant upon other members of their families to support them, both financially and otherwise. Thus, their ability to adapt to potential changes in their environment is reduced. Within this group, women are identified to be more vulnerable. Elder men within the village play a more prominent role in village level decision making. It was observed that elderly men constituted a large number of those attending FGDs, demonstrating levels of dependency. The elderly are deeply respected by traditional structures; however, once they become dependent on younger members of the community, they lose their social status. Where they are opposed to social and technological changes, they may clash with the youth and their ideas. Their potential conservatism may lead to relative marginalization, with reduced access to potential benefits associated with BGHES.

- *People with Physical / Mental Health Illnesses and Disabilities, including those with HIV/AIDS*: People that lack physical mobility or who have mental health issues are typically less able to adapt to changes within their environment. In addition, people with disabilities are less able to generate income for themselves and rely on others to provide for them. Like the elderly, disabled and ill people may be unable to access Project benefits, in this case due to health conditions. People living with chronic illness, including HIV/AIDS and tuberculosis (TB) are often unable to maintain their livelihoods because their health is compromised. Malnourished people, especially young children and pregnant women are severely vulnerable and prevalent in the Project Area because of food insecurity and available food does not contain the nutrients required to sustain a healthy body. There are insufficient facilities available to treat and diagnose these illnesses and disabilities in the Project Area. HIV/AIDS was noted by both District officials and community members to be widespread. Those suffering from HIV/AIDS are particularly vulnerable due to the stigma associated with the disease in rural communities. However, this stigma was said to be improving in the communities due to information drives in local communities by National government.

- *Households Dependent on Subsistence Activities:* These households generally have lower income, making them more vulnerable to shocks and change. Results from community FGDs indicated that a large portion of households are reliant on subsistence activities, particularly rain fed agriculture. Drought conditions, fueled by disappointing 2018/2019 rains render these households particularly vulnerable.

- *Households on Low Income:* Lower income households are more vulnerable to shocks (such as death, illness or natural disaster) and change (such as inflation) with fewer resources to rely on.

- *Child Orphans:* Orphans are less likely to access education and find it harder to meet their food needs. It is not clear how many child orphans there are in the Project Area; however, in FGDs held with women, most attendants indicated that they had one or more orphans living in their households.

Figure 9.28 Zambia National Vulnerability Assessment, 2018

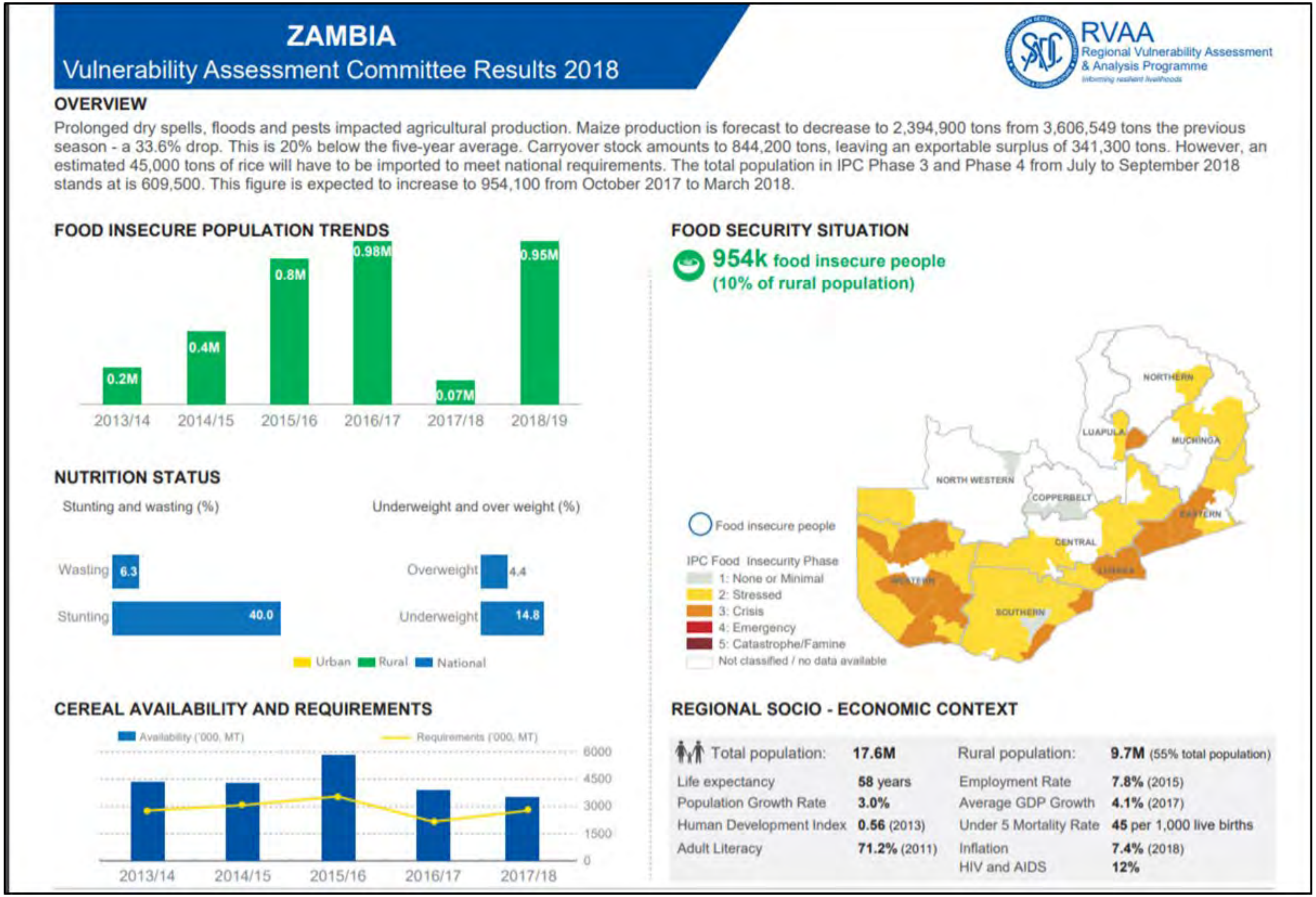
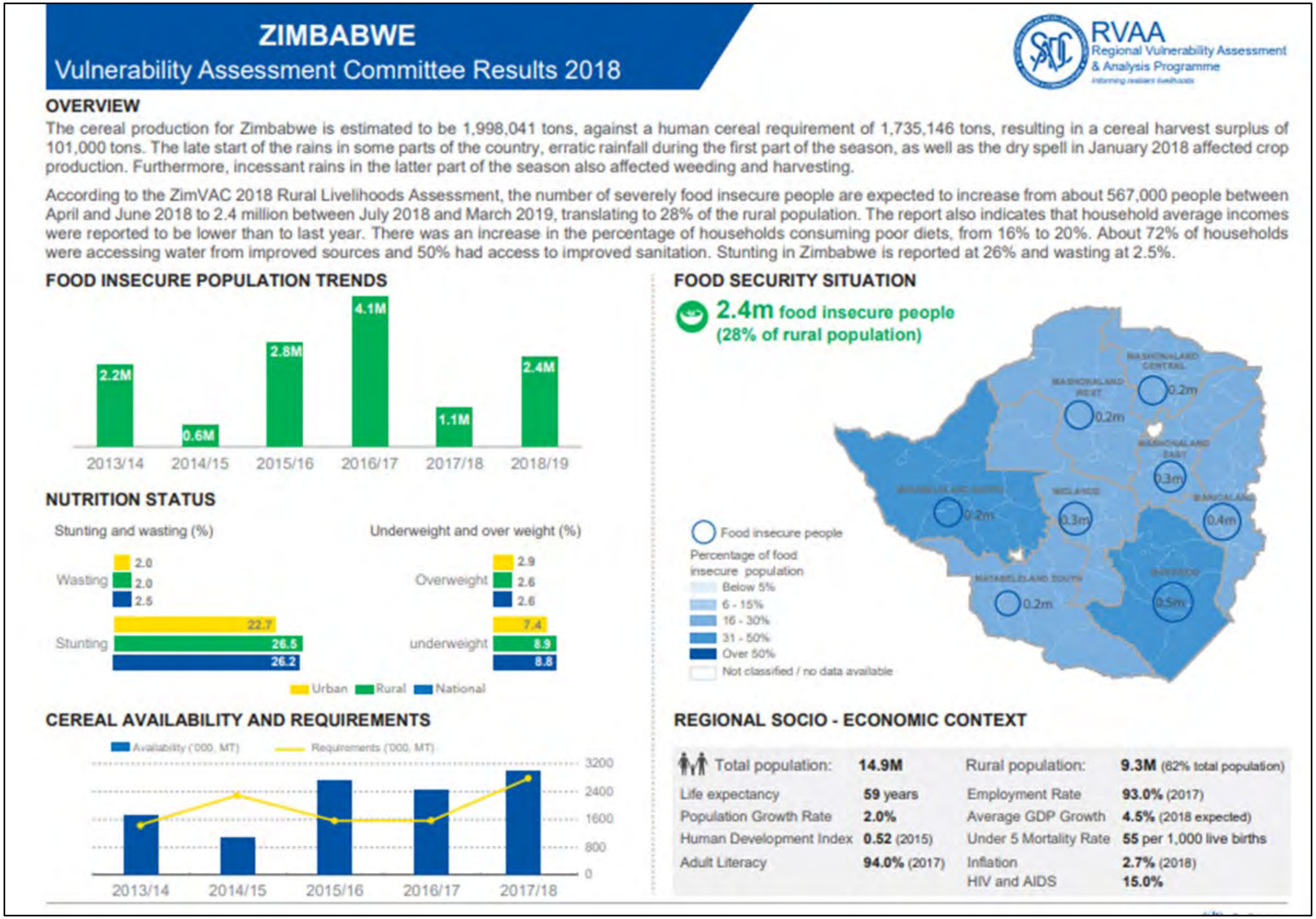


Figure 9.29 Zimbabwe National Vulnerability Assessment, 2018



9.13 PERCEPTIONS OF THE PROJECT

The potential development of the BGHES Project has been known to many communities for a number of years. As such, people have developed both good and bad perceptions about the Project. It is important to understand these concerns and expectations in order to properly manage community perceptions and expectations should the Project go ahead.

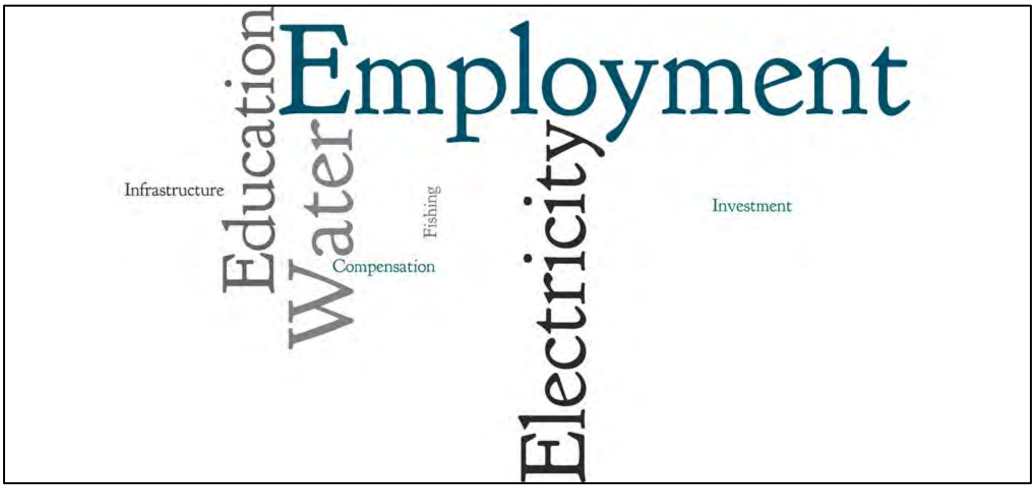
9.13.1 *Zambia*

The concerns voiced most by participants included physical and economic displacement, nepotism and discriminatory employment practices and unfair compensation. Other concerns raised included promiscuity and unsafe sexual practices resulting from the presence of contractors, harm to animals and children resulting from speeding and increased theft.

Figure 9.30 Key Community Concerns Relating to the Project

Affected communities harboured much hope in the Project and the benefits it would offer, particularly regarding employment opportunities for the local population. People also felt that the presence of the Project would promote investment in the area, and improve infrastructure and access to education and water. The Katapazi FGD members also felt that they would benefit from a temporary increase in household income resulting from displacement compensation received as a result of the transmission line.

Figure 9.31 Key Community Expectations Relating to the Project



9.13.2 *Zimbabwe*

The majority of FGD attendees felt that the Project would offer more benefits than negative impacts on communities. However, most common concerns voiced by participants included non-hire of local people, accidents (relating to roads and transmission lines) resettlement, unfair compensation and a rise in HIV/AIDS and other STIs. Other concerns raised included the community not benefitting from the Project and impacts to water and graves.

Figure 9.32 Key Community Concerns Relating to the Project

As in Zambia, affected communities were optimistic about the Project and the benefits it would offer, particularly regarding employment opportunities for the local population. People also felt that the presence of the Project would promote business and development in the area, and improve transport infrastructure and access to electricity.

Figure 9.33 Key Community Expectations Relating to the Project

9.14 CULTURAL HERITAGE

The Batoka Gorge area has an exceptionally rich and wide-ranging cultural heritage, ranging from Stone Age sites to farming community sites and rain-making shrines of more recent populations. This *Chapter* provides an overview of the cultural heritage baseline within the footprint of the proposed BGHES infrastructure. The information in this chapter was sourced from several Cultural Heritage Assessments that were conducted on both the Zimbabwean and Zambian sides of the project (ZRA 1993 & 1998, Burrett 2014, Mbewe 2015, van der Walt & Mbewe 2016). These studies focused on the areas expected to be inundated as well as ancillary infrastructure, proposed settlement alternatives, proposed quarry sites and access routes. In addition to these studies, archaeological research into the Stone Age and Iron Age of the area (e.g. Clark 1950, 1952 and Vogel 1971 a, b, 1975a & b) was consulted, providing an accurate characterisation of heritage resources in the larger geographical area.

9.14.1 Previous Studies

Intensive archaeological exploration was carried out in the vicinity of Victoria Falls in the early and mid-twentieth century. This focused on evidence for early human settlement preserved in Pleistocene river terraces of the Zambezi. Much of this work was conducted by Desmond Clarke who published the seminal study on the subject, *The Stone Age Cultures of Northern Rhodesia*, in 1950. In the context of this assessment, Clarke's work provides relatively limited directly relevant information as it concentrates strongly on the valley to the north and south of Victoria Falls (Figure 0.01). However, the analysis contained within it of the development of the Zambezi in the Pleistocene and Holocene (i.e. the past 2.5 million years) and the associated evidence for early human settlement provides essential context for understanding the nature and distribution of prehistoric archaeological remains in the vicinity of the proposed HES development.

Clarke (1950) also discussed the formation of the Batoka Gorge between the Falls and Chimamba Rapids in considerable detail. However, he conducted relatively little survey work along the banks of the Zambezi to the east of the confluence with the Songwe. As a consequence, this area, including the plateau to the north and south of the gorge, has remained relatively little explored or understood until recently. In terms of the Iron Age of the area the most comprehensive work was conducted on the Zambian side of the river out of the Livingstone Museum from the 1960's onwards (Vogel 1971a, 1971b, 1975a, 1975b).

A preliminary heritage assessment of the project was conducted in 1981 and reported on in 1982. The author based his assessment on secondary sources and provided generalised statements on the regional occurrence of stone tools in the alluvial gravels of the Zambezi River (Du Toit 1982 in Burrett 2014).

Following this assessment an International Union for the Conservation of Nature (IUCN) workshop called for detailed heritage surveys to be undertaken for the project. An intermediate assessment was conducted in 1992/3 with the aim to expand on the baseline study of 1982. This study recorded eleven new sites, including intangible sites, and most importantly, the site of Chemapoto Hill in Zimbabwe.

This was followed by a more detailed survey in 1997, reported on in 1998, carried out by archaeologists from the History Department of the University of Zimbabwe (Harare) and National Museums and Monuments of Zimbabwe (NMMZ) based on the recommendations for more detailed fieldwork of infrastructure associated with the project. This identified a further 31 sites on Zimbabwean side and 24 sites on the Zambian side. During these early assessments 55 previously unrecognised sites were identified on the Zimbabwean side of the river and 36 on the Zambian side.

More recently, a Tangible Cultural Heritage Study (Burrett 2014) was carried out focussing on the dam site and some ancillary infrastructure (i.e., the dam wall, powerhouses, spillway, inundation area, construction camp, permanent villages, switchyard and access roads) on the Zimbabwe site. He consolidated the work conducted on the Zimbabwean side and addressed certain gaps (mostly in site recording) arising from the 1998 report. He conducted a field visit to confirm and adequately document these sites as well as potential new sites located during the field visit.

Similarly, an Archaeological and Intangible Heritage Assessment was conducted for the same infrastructure on the Zambian side (Mbewe 2015). The aim of the study was also to update the 1998 Heritage Assessments in accordance with guidelines from the Zambia Environmental Management Agency (ZEMA), EIA Regulations and the Zambian National Heritage Conservation Commission Act CAP 173. Recently, an Archaeological Impact Assessment was conducted for the proposed alternative settlement areas and access routes on the Zambian side not covered by previous assessments (van der Walt & Mbewe 2016). The combined assessments recorded 95 sites in Zimbabwe, while 75 sites were recorded in Zambia (*Figure 9.35*).There are, however, certain limitations to these studies:

- The gorge itself was not covered.

- Sites from the 1998 report were not all revisited mainly due to difficulties in locating these sites based on their location reading. (These sites were given as 6-figure grid references).

- Dense vegetation hampered archaeological visibility.

- Inaccessibility to study areas due to steep topography and, in the case of Zimbabwe, landmines.

- Some of the previous studies on the Zambian side of the project did not provide heritage significance ratings. The significance ratings have been deducted from the site descriptions in the reports and must be treated as tentative significance ratings.

- Power line corridors were assessed at desk top level only.

- Limited community consultation was conducted on the Zimbabwe side by the archaeologist during the 2014 assessment and only communities close to Chemapato hill (Site 93) were consulted. A more comprehensive engagement process was followed for the 1998 report but assessed to be lacking and biased during the 2015 Assessment.

Figure 9.34 Clarke's Map of Archaeological Sites and Geomorphology of the Victoria Falls Area

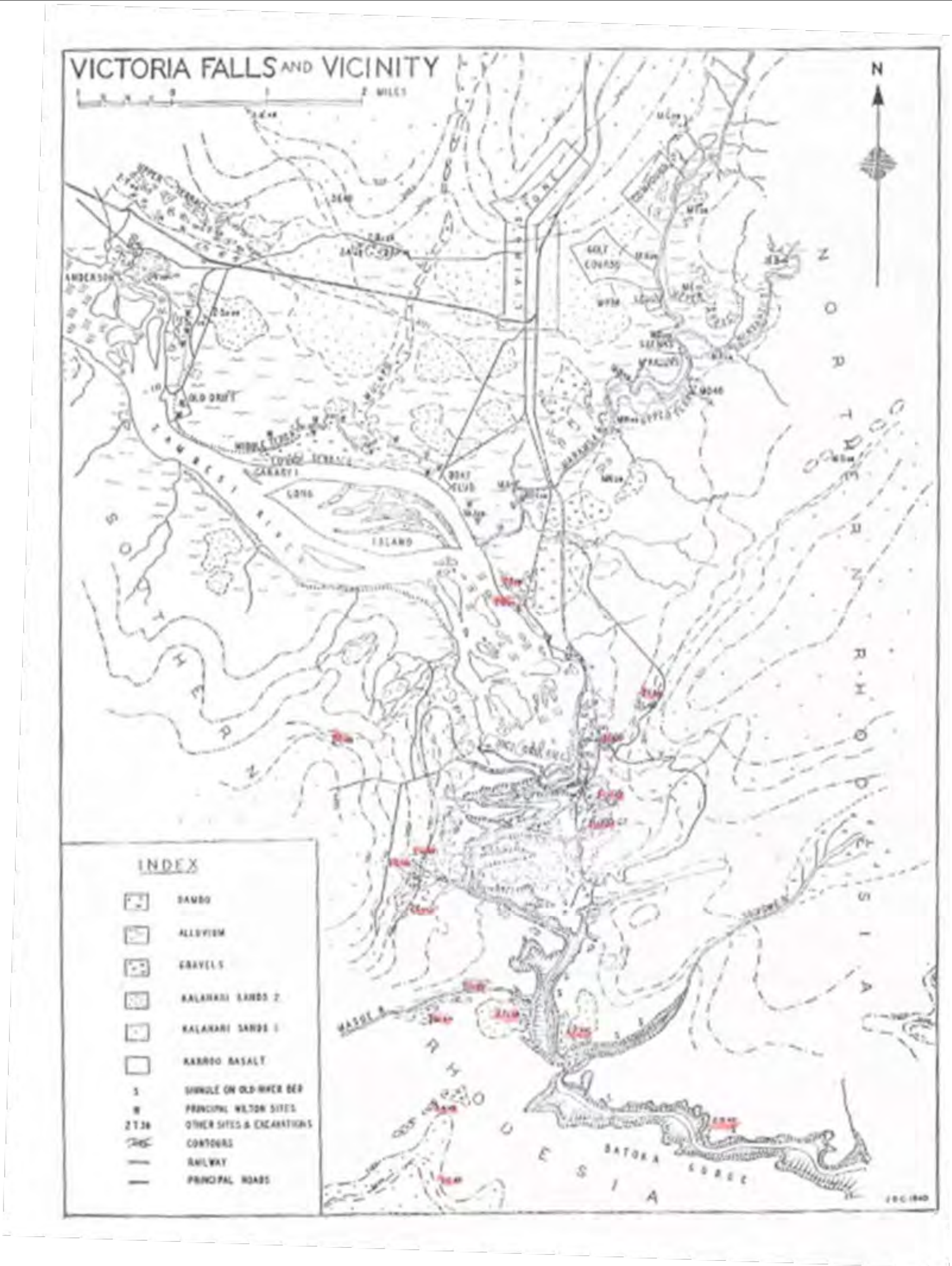
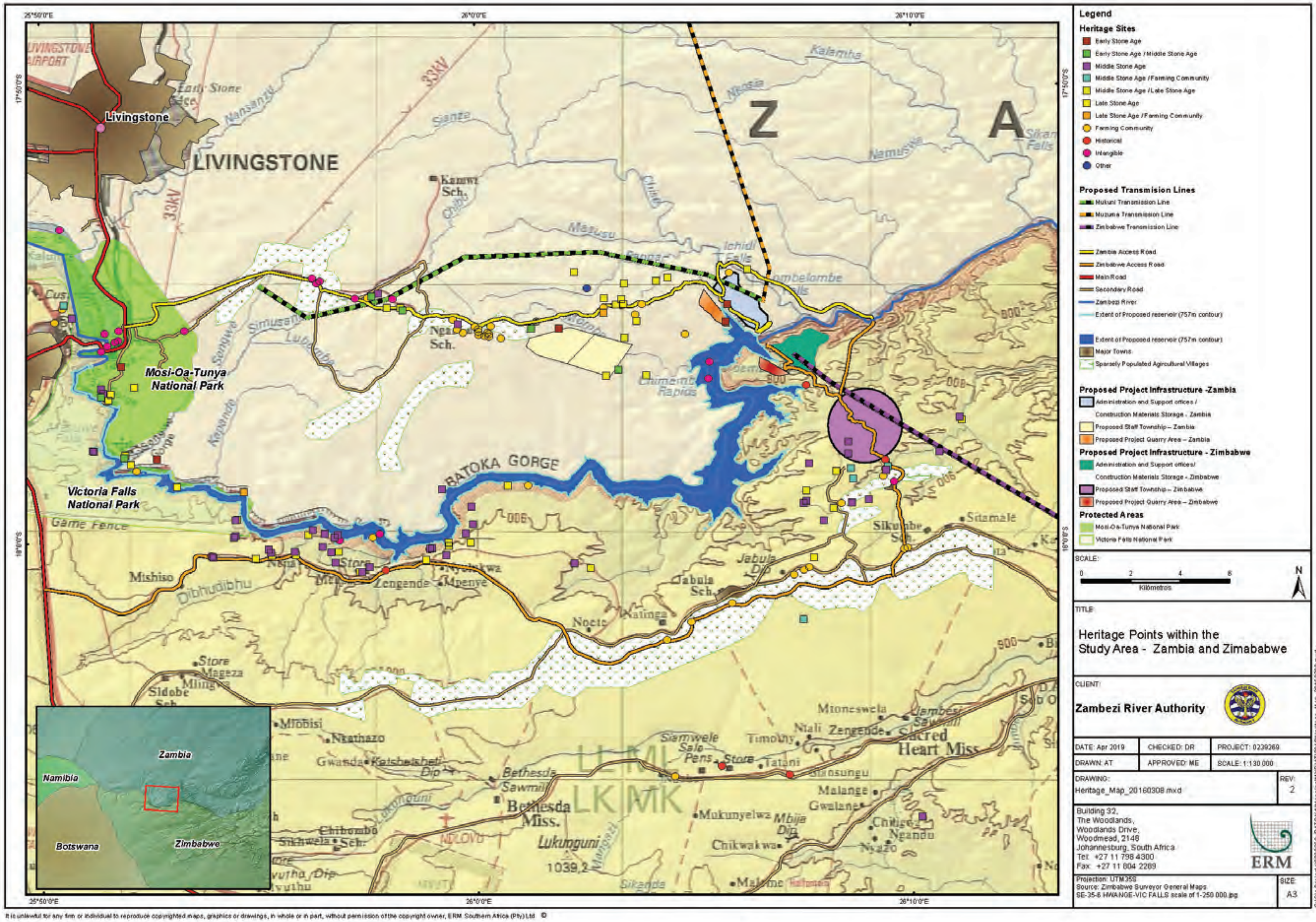


Figure 9.35 Distribution of Recorded Heritage Sites



9.14.2 Geomorphological and Topographical Context

The Batoka Gorge and Victoria Falls are indivisibly connected – the one being the result of the long-term effects of the other. The basic geology of the area has a direct bearing on the heritage signature and landscape use in antiquity and is summarised below:

- The underlying rock through which the gorge has been cut is Karoo Basalt, the result of volcanic eruptions c.180 million years ago. Across much of the project area, the ground surface is either, where erosion has washed away the oil, basalt bedrock or basaltic soils. The effect of weathering on the latter mean that buried archaeological material (e.g. Stone Age stone artefacts) tends to get churned up and loses its contextual integrity;

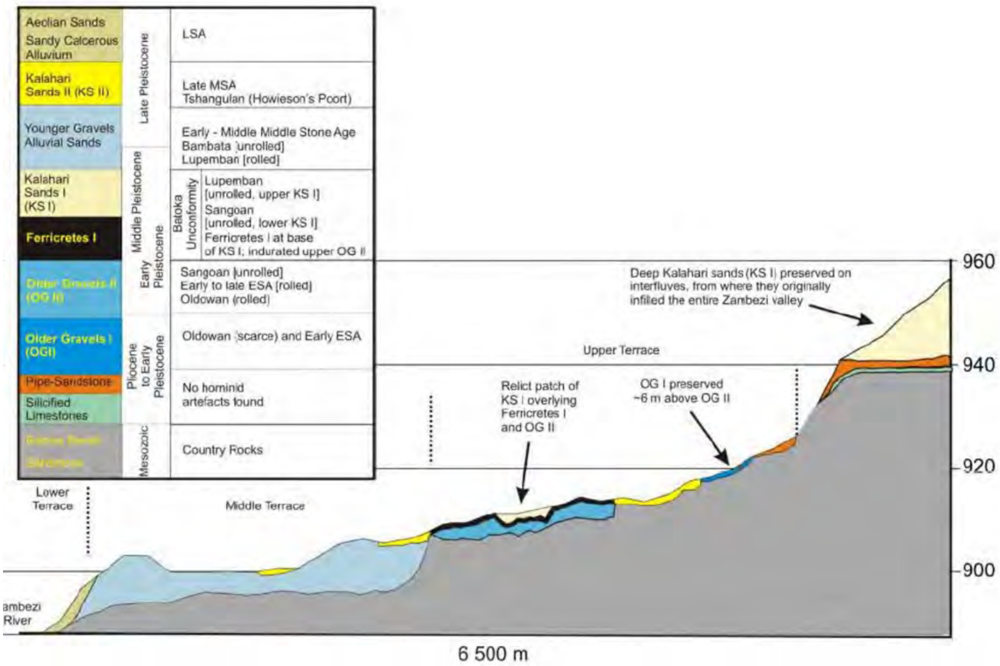
- Above this a thin layer of silicified limestone – often transformed to chalcedony – is differentially preserved, particularly under later Kalahari Sand deposits. This was the main source material for stone Age tool makers;

- Lying above the chalcedony/limestone is layer of 'pipe' sandstone, known as such because of its unusual internal structure characterised by vertical cylindrical voids. Its ferruginous character means that it was used a source of iron by historic populations;

- The Kalahari Sands which sit on top of the pipe sandstone are a defining element of the regional landscape, forming large palaeodunes on both sides of the Zambezi. The scarps which define the edges of these deposits to the north and south of the river are the result of erosion by the river before the creation of the gorge. The palaeodunes show little internal structure, as the result of redeposition by natural processes. Many Stone Age artefacts recovered from gravel terraces within the valley show traces of having been polished by the movement of these sands. Some of the most important Middle Stone Age sites in the project vicinity occur on buried ground surfaces at the base of these palaeodunes.

- Subsequent geological deposits comprise Pleistocene gravels laid down by the ancient river. These appear to extend along the length of the Batoka Gorge, although they have only been mapped in detail around Victoria Falls itself. Clarke identified three terraces of fluvial material: the older and younger gravel terraces and the alluvial terrace. The older terrace has only been identified to the north side of the river because it is eroding slowly southwards. Redeposited Early Stone Age material, dating from as early as 1.7 million years ago through to c.200,000 years ago, has been identified within these gravels in a number of locations. The younger gravels, which are found on both sides of the river, contain numerous Middle Stone Age lithics (dated to c.200,000-35,000 years ago). These terraces are frequently found close to the edge of the gorge on islands of higher ground, where erosion has had less effect. The lower lying alluvium is generally associated with Late Stone Age assemblages (dating from c.35,000 years ago onwards).

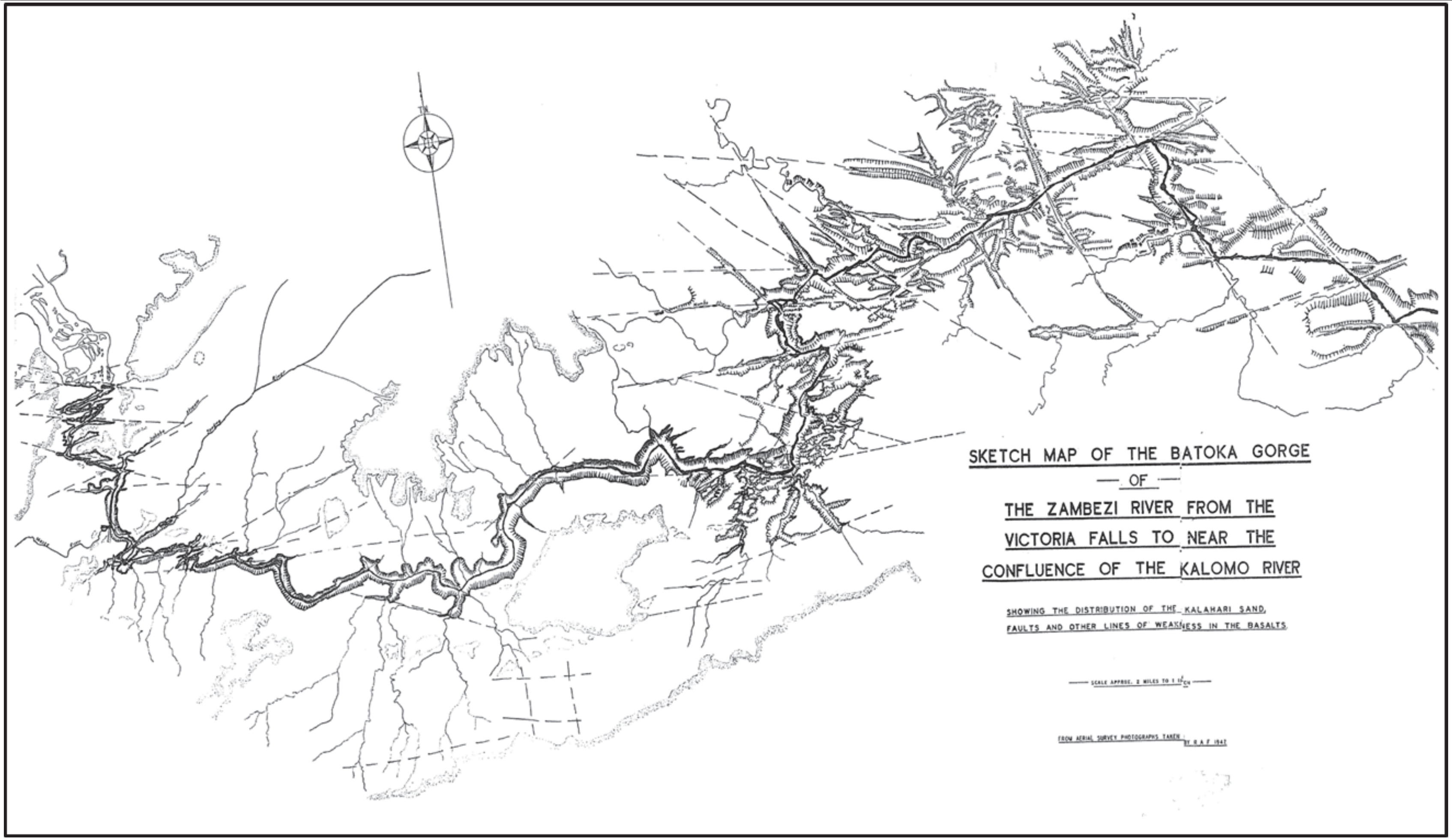
Figure 9-36 ***Cross-section of the Main Geological Units associated with the Zambezi River in the Victoria Falls Region (Adapted from Moore 2013)***



The development of the Batoka Gorge is the result of the interaction between the river and the underlying Karoo Basalt. This contains a series of vertical 'joints' – deep cracks in the basalt containing softer fill – which, as weak points in the much harder basalt, have eroded out from east to west to form a series of waterfalls of which Victoria Falls is just the most recent. The seven gorges to the south of the current falls mark successively older lines of waterfalls. After c.10km, at the confluence with the Songwe River that runs in from the north-east, the gorge turns to the east. At its greatest extent, the new reservoir is expected to reach a point c.5km east of the Songwe confluence.

The main physical impacts of the proposed scheme are focussed around the dam wall site, c.2.5 km to the east of Chimamba Rapids and c.47km downstream of Victoria Falls (27 km in a direct line). Victoria Falls marks the transition from the wide, mature river valley to the relatively recent deep, steep-sided Batoka Gorge.

Figure 9.37 Clark's Map of the Batoka Gorge showing Former 'Joints'/Lines of Waterfalls



The early development of the Zambezi is generally believed to have involved multiple changes of course, with the river being captured by different catchments on a number of occasions (Moore *et al* 2007). The point at which these diversions took place - 'nick points' – are generally marked by sudden changes in the river's direction. Chimamba Rapids is one such point, with the valley upstream and downstream of it having significantly different character and gradient. Based on a variety of observations, Clarke estimated that the Batoka Gorge between approximately the proposed location of the dam and fourth gorge below Victoria Falls was eroded during the Upper Pleistocene (i.e. between c.125,000 and 12,000 years ago). That is to say that c.125,000 years ago this entire length of the Zambezi was a broad, braided stream of the kind that can be seen today to the north and west of Victoria Falls. Over that period, the power of the water has cut the gorge gradually westwards, forming a set of lateral falls comparable to Victoria Falls every time it hit a transverse joint in the basalt.

In his extensive surveys of the region, Clark identified Pleistocene gravel terraces containing Middle Stone Age tools as far as 20 km downstream from the Falls, but failed to identify to find them after 30 km. These findings have been broadly confirmed by the surveys carried out in support of this assessment. It is likely that there are surviving Pleistocene gravels associated with tributary rivers that flow into the Zambezi. The most significant, in terms of their proximity to the Batoka HES proposals, are as follows:

- the Dibudibu (Zimbabwe), which flows from the south-west to join the Zambezi approximately half way between Victoria Falls and Chimamba Rapids;

- The Songwe (Zambia), which flows north-east to south-west to its confluence meet the Zambezi to the south of Victoria Falls at the point where it turns to the east (an areas where numerous significance Stone Age sites have been found);

- The Momba (Zambia), flowing west to east to join the main river close to the Chimamba Falls;

- The Chibonga (Zambia), which joins the Zambezi immediately west of the proposed location of the dam.

The drainage for the Songwe and the Momba runs in a curving linear depression through the Kalahari Sands running between the contemporary settlements of Mukuni to the north and Machenje and Ngandu to the south. A significant number of early and Middle Stone Age sites have been identified in this area, indicating the presence of artefact-bearing deposits, perhaps fluvial gravels, in this area. Options for project settlement and new access roads run across this area. The main impacts to the south of the river lie in broken country to the south of the proposed dam site and east of Chimamba Rapids. The potential settlement areas and access roads extend southwards onto large Kalahari Sands palaeodunes.

The effect on past human settlement from the unique geographical character of the region varies across each of the topographic zones within it. It is possible to identify at least four such zones:

- The Gorge itself has generally been written off as having low cultural sensitivity owing to the destructive scouring effect of flooding and water flow. This will undoubtedly have destroyed or redeposited any in situ evidence for past human settlement in the lower parts of the gorge up to Chimamba Rapids. However, as pointed out by Clark, from this point onwards, the gentler profile of the valley has allowed the accumulation of degradation terraces of the kind that might contain evidence for Middle of Upper Stone Age activity (Clarke 1950). There are also some known rock shelters/caves within the Gorge, although none are easily accessible. It is possible that some could contain prehistoric remains, or even rock art. In addition, certain key points in the affected sections of the Gorge – most notably Chemapoto Hill, Chimamba Rapids and Moemba Falls – have been the focus of historic social and ritual significance to local communities;

- The tributary valleys. These have their own associated deposits of Pleistocene and Holocene alluvium and gravel that remain little explored and may (as in the case of the Chibonga River) contain Stone Age remains;

- The dissected plateau on either side of the Gorge, generally uncongenial to human settlement, except in areas – often at the head of local drainage systems - where rainfall has led to the accumulation of more fertile, silty soils. Patches of Pleistocene gravels scattered across the plateau preserve reworked scatters of largely Middle Stone Age artefacts;

- The Kalahari sand dunes generally have little historic settlement on them. By contrast evidence prehistoric and historic settlement frequently is widespread at the base of the dunes, particularly closeto sources of water.

9.14.3 Archaeological Baseline

The Stone Age

Stone Age Archaeology is well represented in the Zambezi Valley especially the Zambian side of the river. This is a result of intensive studies carried out in and around the Victoria Falls area and Livingstone in general. These studies have revealed a rich and long antiquity of human settlement in the Zambezi Valley. The earliest evidence in the area is found in the older gravels in the rocks of the Kalahari sands. The chalcedony, quartzite and sandstone provided early man in the Falls area with raw materials for the manufacture of his implements.

The Stone Age sequence is traditionally broken down as follows:

- Later Stone Age; associated with Khoi and San societies and their immediate predecessors. Recently to ~30 thousand years ago
- Middle Stone Age; associated with Homo sapiens and archaic modern humans. 30-300 thousand years ago.

- Earlier Stone Age; associated with early Homo groups such as Homo habilis and Homo erectus. 400 000-> 2 million years ago.

Each of these phases contains sub-phases or industrial complexes, and within these, we can expect regional variation regarding characteristics and time ranges. For Cultural Resources Management (CRM) purposes it is often only expected/ possible to identify the presence of the three main phases. In some cases, nonetheless, the recognition of cultural groups, affinities or trends in technology and/or subsistence practices, as represented by the sub-phases or industrial complexes, is achievable (Lombard 2011).

Early Stone Age (ESA)

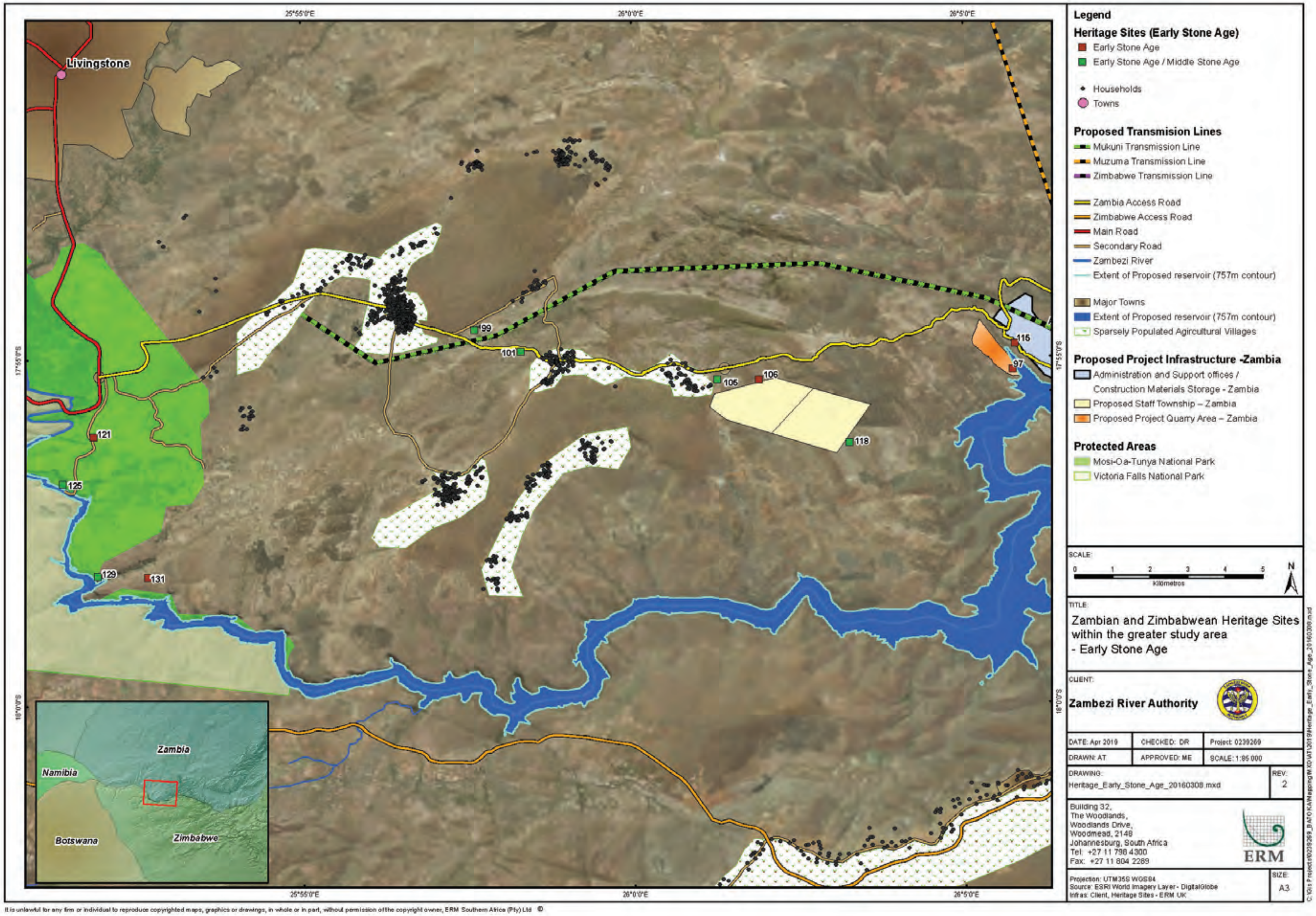
The only ESA sites identified in the vicinity of the proposals occur on the north side of the Zambezi. Substantial numbers of these sites, with Oldowan and Acheulian stone tools (Burrett 2014), have been found on the 'older gravels' around Victoria Falls in adjacent to the gorges immediately to the south. Clarke excavated an important site, which produced tools of this period at Songwe Point, at the confluence of the Songwe and Zambezi.

In addition to these well-known sites around Victoria Falls, the 1998 EIA survey identified a series of ESA sites around the fringes of the valleys of the Songwe and Momba (Figure 5; sites 99, 101, 105, 106 and 118) most of these are found in association with MSA material.

The 1998 report provides very little detail about these sites. More geomorphological studies need to be undertaken of their context in order to elucidate their full significance. One possibility may be that there could have been a diversion of the Zambezi along this alignment at some point in the Pleistocene. Two scatters of heavily weathered ESA tools were identified in 1998 close to the proposed location of the Batoka Dam, on the plateau edge overlooking the Chibonga (sites 97 & 115). Site 115 is close but outside of the footprint of Alternative B Township in Zambia. Most of these sites are located in the power line corridor.

While it appears that none of these sites are *in situ* (*in situ* ESA sites are extremely rare) they are sufficiently unusual to be of interest.

Figure 9.38 Map showing the Location of Early Stone Age Sites



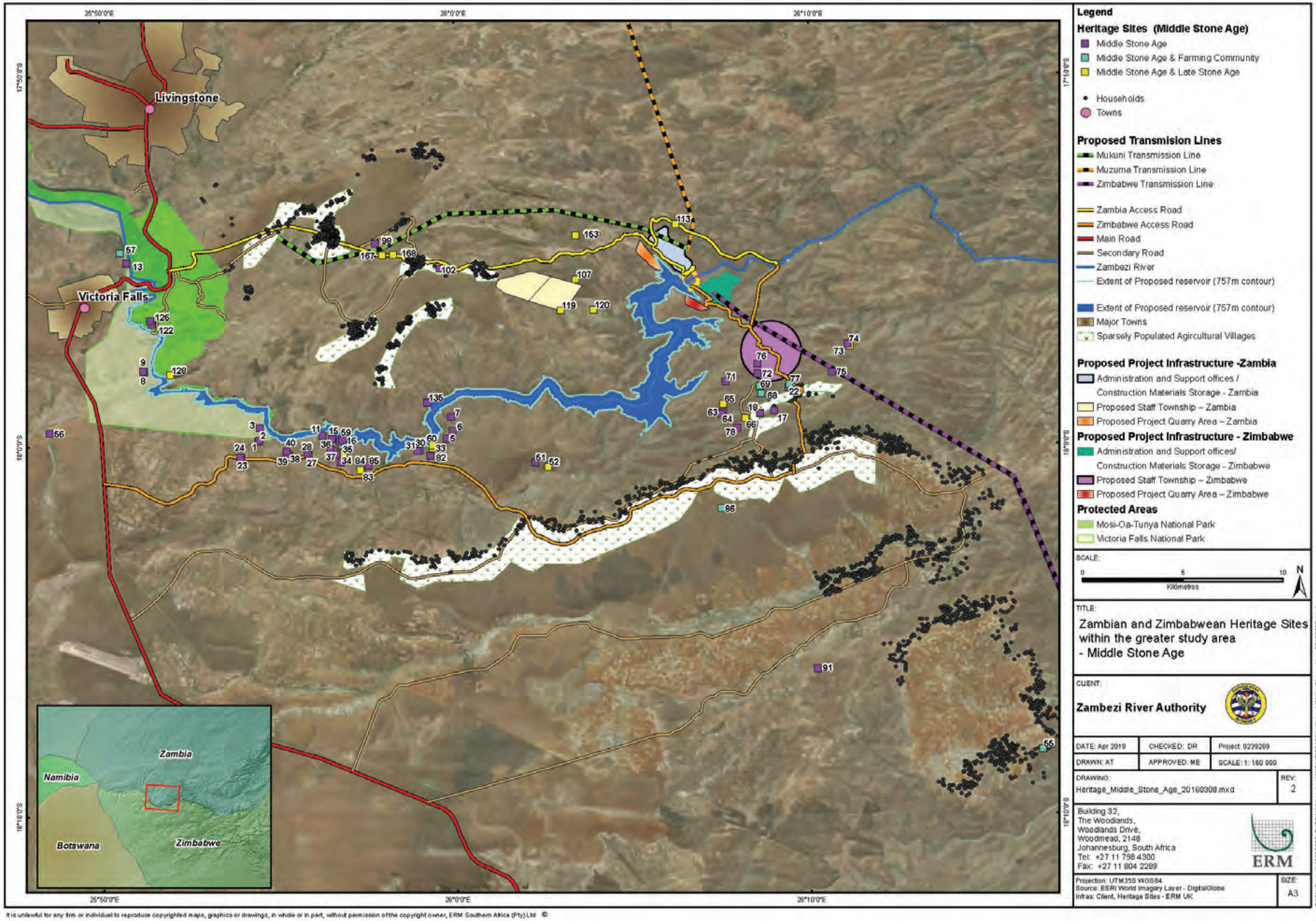
Middle Stone Age (MSA)

There were more MSA sites than of any other period found during the various surveys carried out in support of the Batoka HES. In total 75 sites with MSA material were identified by the various surveys. Of these, six sites were found mixed with ESA material, while 15 were mixed with LSA tools. A substantial portion of these sites were found on the plateau edge on either side of the Gorge running eastwards from Batoka Gorge for at least 28km. These are largely associated with Clarke's 'younger gravels' and represent evidence for riverside settlement on the margins of the pre-gorge wide Pleistocene river. It appears that these deposits do not, therefore, extend along the gorge as far east as Chimamba Rapids or the proposed dam site (pending detailed surveys within the gorge itself). There seem to be a hiatus of MSA sites directly to the north of the Zambezi where raw material is absent or where systematic surveys were not done yet. This is not the case on the southern side closer to the Falls where marked clusters of MSA sites are recorded next to the gorge.

On the Zambian side of the river, several sites could be impacted on by the proposed project (Figure 6; sites 98, 102, 107, 113, 153, 167 & 168). Most of these are scatters of weathered/rolled tools. There is a significant concentration of sites at the base of the Kalahari sands palaeodunes forming the northern and southern sides of this depression. Some of these may represent MSA quarrying or knapping sites, associated with the silicified limestone/chalcedony deposit that underlies the Kalahari Sands.

A further group of MSA sites was identified during the 2014 survey to the south of the river in the area of low, dissected basalt ridges to the north of Kasikiri village (Figure 6: sites 63-66, 68-69 & 71-78). Several of these sites are located in the proposed footprint of Alternative Township A (Zimbabwe). These are largely deflated scatters of weathered tools, which may indicate a true distribution of ancient settlement or may simply be redeposited from eroded Pleistocene gravel terraces. Similar sites were also identified in similar terrain on the northern side of the river (sites 107, 119-120).

Figure 9.39. Map showing the Location of Middle Stone Age Sites



Late Stone Age (LSA)

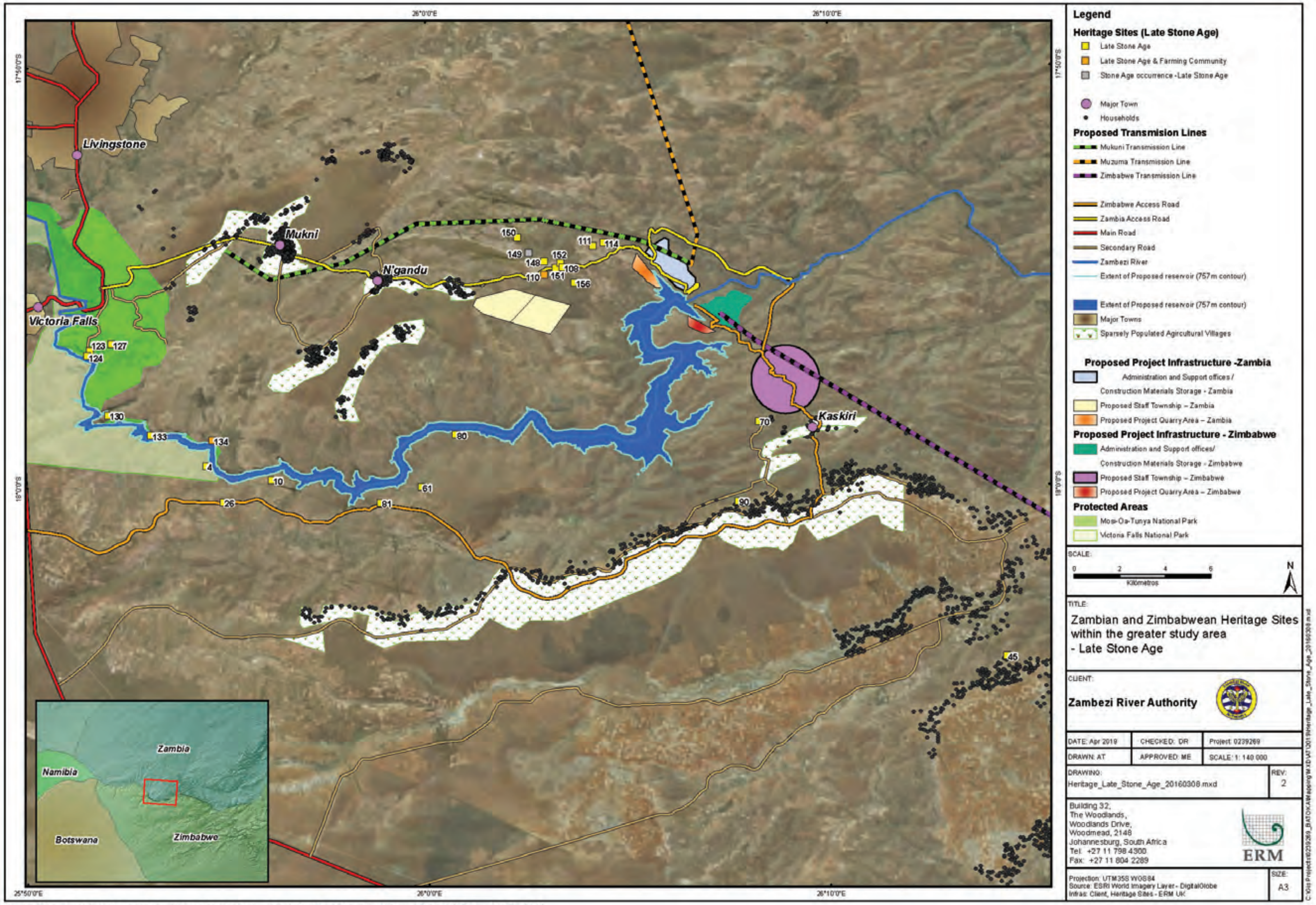
The stone technology of the LSA represents a tradition of mobile hunter-gatherer bands, which can be traced from c.35,000 to as little as 1,000 years ago. Some 43 Late Stone Age sites were identified by the Batoka HES heritage surveys, more than half the number of MSA sites, albeit these represent settlement over a much longer timespan. This does not include the many LSA sites found on the banks of the Zambezi above Victoria Falls by Clark.

Due to the ephemeral nature of LSA sites, LSA artefact clusters might mark settlements rather than isolated finds, especially where there is some sort of spatial or temporal integrity. Therefor LSA scatters are generally being considered to be of higher significance.

A large number of LSA sites were recorded during the 2016 survey and are located in Alternative Township A on the Zambian side. This area is marked by a dissecting basalt plateau with various valleys and several perennial drainage systems. Clay soils cover large areas with Pleistocene gravels being exposed by sheet erosion, mostly on higher lying areas on basalt ridges. These were utilised by LSA communities for raw material in the manufacturing of tools. In some instances LSA material was recorded with thin walled ceramics (site 152). Similar to the MSA sites, there are numerous groups of LSA material found in gravel and alluvium on the edges of the gorge extending south and eastwards from Victoria Falls.

A single LSA site (site 70) is located in the footprint of Alternative Township A on the Zimbabwean side. The site was assessed as being of no heritage significance and no further mitigation is necessary for this site.

Figure 9.40. Map showing the Location of Late Stone Age Sites



Iron Age/ Farming Community

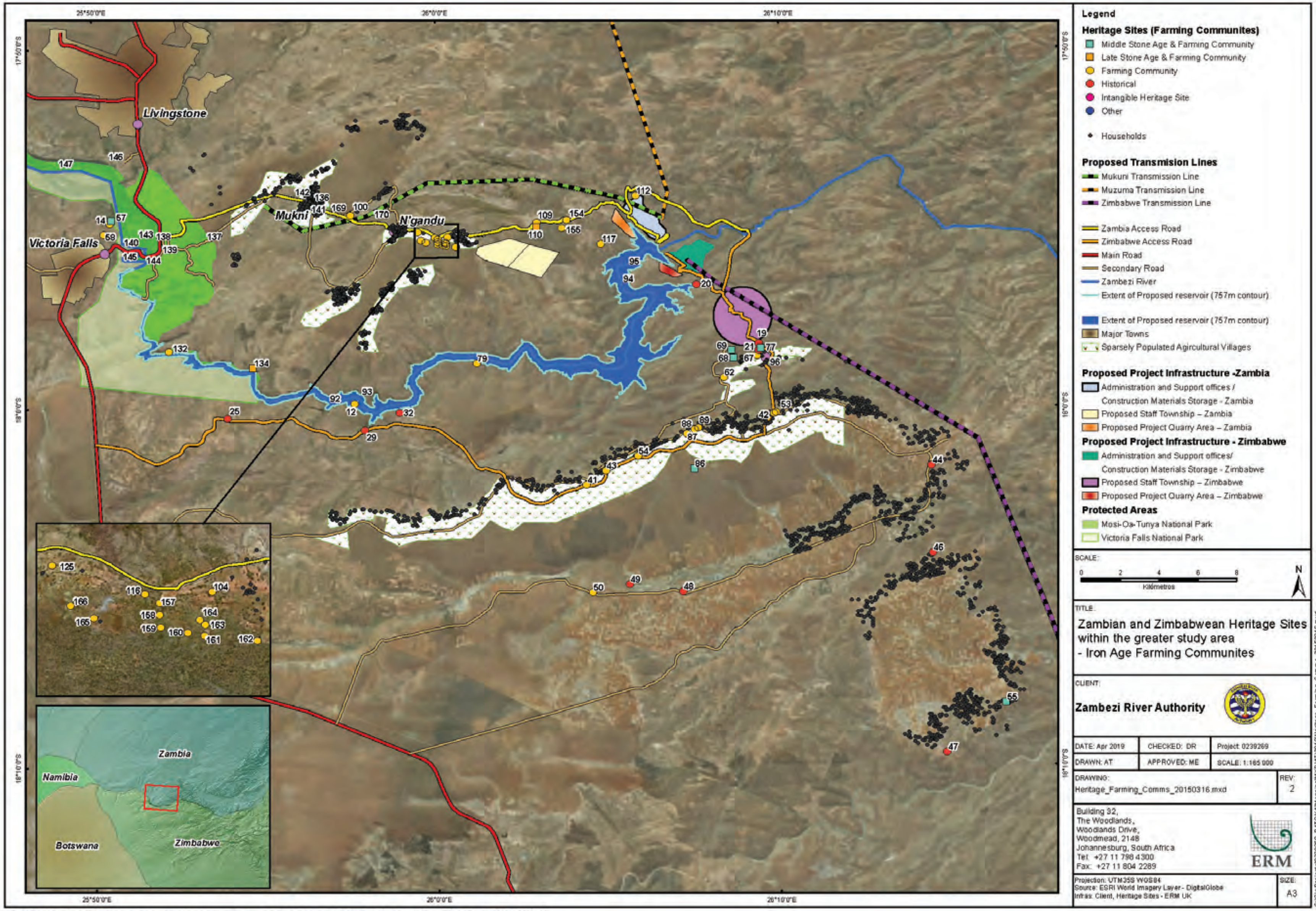
The first Iron Age settlement sites date to around AD200. The Early Iron Age is known as the Shongwe culture in this region. By the twelfth century, Tonga speakers, still dominant across much of south and central Zambia, had settled the region. In the sixteenth century, the Toka/Tonga Leya people, now the dominant community in the region, began to appear in the archaeological record.

The archaeology of the Iron Age, farming cultures in the region received intensive study by archaeologists based in Livingstone Museum during the 1950's and 1960's (Vogel 1971). As a result, knowledge of archaeological sites of the period is better on the Zambian side of the Zambezi. The *dambos* – seasonal wetlands - of southern Zambia were a key focus of early Iron Age culture in the region, with the better known examples lying north and west of Victoria Falls. The historic settlements between Livingstone and the Chimamba Rapids – Mukuni, Machenje, Ngandu and Chibule – all lie at the base of Kalahari Sands palaeodunes close to water sources. All have produced evidence of earlier Iron Age settlement.

The distribution of Iron Age sites is similar on both sides of the river and quite distinct from what had gone before. Iron Age settlement sites are strongly concentrated at the north-facing base of Kalahari Sands palaeodunes, meaning that they do not occur close to the edges of the Gorge (Figure 8). A site of particular note, identified by the 1998 survey, is a Shongwe site to the east of the contemporary settlement at Ngandu adjacent to the proposed Alternative Township C (Figure 8; site 104). This site produced evidence for iron production as well as settlement. Several other sites with evidence of iron working (possibly smithing) was recorded within the footprint of Alternative Township C. Based on interviews with Mr Philemon Syasai, senior headman of the area, and combined with the evidence of decorated ceramics found in association with these sites, they could be associated with Historic Tonga communities. This corroborates the findings of the 1998 report that indicates that iron working occurred in the area until the 1950's.

In the past 300 years there have been a number of waves of immigration and conquest in this region, notably the establishment of a state on the south side of the river by the Nambya – a Shona group – in the eighteenth century. They were followed by the Ndebele, a group of Zulu origin who moved north into modern Zimbabwe in the nineteenth century. The Toka Leya has remained the dominant group to the north of the Gorge, centred on the Mukuni kingdom.

Figure 9.41. Map showing the Location of Farming Community/Iron Age Sites



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Intangible and Living Heritage

The region of Victoria Falls and the gorge itself is rich in traditional heritage, much of which is the subject of ritual and belief, particularly for the Toka Leya communities on the north bank of the river. The local Leya people, under chiefs Mukuni, based in the settlement of the same name, have numerous annual shrines and rituals focussed around the Falls area. The objects of these rituals were deities believed to inhabit the river and the Falls themselves, and their intent was frequently to ensure rains.

The key Mukuni rituals, carried out at a number of sacred locations to the east of the Falls, persist to the present (see detailed discussion in *Annex B* and *C*). Most of the important intangible sites are located outside of the proposed impact areas, close to the Falls. Within and to the east of Mukuni Village and within the proposed powerline corridors several intangible sites are known and include amongst others Kaanda Ka Leza (Site 136), Nanjina Palace and Mukuni Palace (Site 141 and 142). Boabab trees are frequently places of ritual significance, as well as being the focus of a number of the settlements in this area. Two additional sites to the east of Mukuni village (sites 169 & 170) were pointed out by the royal advisor to Chief Mukuni, located within the power line corridor and close to the proposed access route to Alternative Township C. He indicated that no development should occur close to these sites.

The traditional reverence for the falls and the river is expressed by the fact that different parts of the falls as well as the different sections of the Gorge have different names. It is likely that there were legends associated with these different parts of the river, and these were reflected by rituals and shrines. The most important of these, perhaps, were the rituals associated with the Silent Pool, just below Victoria Falls, where the Toka-Leya worshipped a river goddess, Nyaminyami, in the form of a snake until the construction of the ZESCO hydro-electric plant at this location in 1937.

Interviews with local communities indicate that Chimamba Rapids and Moemba Falls are also viewed as places of traditional importance. These areas were not visited during any of the studies conducted so far. As with other ritual sites in the area, the precise nature of this significance is not clear. Whether this is because the old traditions of worship and ritual are dwindling – or whether it reflects a reticence on the part of the local population to speak in detail about such issues – is also unclear.

Moemba Falls, which are accessed from the Zambian side of the Gorge, are renowned as an excellent location for fishing, so can be presumed to have seen continuous human activity across a long period. Chimamba Rapids, the section of white water before Moemba Falls, is generally accessed from the Zimbabwean side. Desmond Clark recorded the use of the stretch of the Gorge beside the Rapids as a place of refuge used by the local population in the nineteenth century when sheltering from raids on their villages by the Ndebele. In describing a similar refuge on the promontory between two of the gorges at Victoria Falls he explained that locals stored large pots for food and water there.

It seems likely, therefore, that a site of this sort – probably marked by the presence of numerous vessels - could exist at the base of the Gorge on the Zimbabwean side in the vicinity of Chimamba Rapids or in caves and shelters within the gorge.

It may be that such 'refuges' were seen as places of both physical and spiritual protection. The presence of numerous vessels in a hidden and protected location is also a key characteristic of Chemapoto Hill (site 93), a very significant site of established tangible and intangible value. It is flat-topped hill on the edge of the Zimbabwean side of the Batoka Gorge, roughly half way between Victoria Falls and Chimamba Rapids. It was clearly once part of the same upper land surface but has been separated by erosion along a prominent fault line that has created the gap. Access to the site is difficult as the slopes are steep and covered in loose basalt gravel. This site is documented in some detail in the 1998 heritage study, including interviews with a wide range of local headmen and spiritual leaders (ZRA 1998). The surveys revealed the presence of 61 large and small vessels, mostly globular pots, at that time. 52 were counted during the 2014 survey. The form and decoration of these vessels is typically Tonga, the Iron Age culture dominant in the area from the twelfth to sixteenth centuries.

Figure 9.42 Chemapato Hill Viewed from the South

The interviews indicated that it was used for rainmaking ceremonies involving the construction of a ritual hut, animal sacrifice and beer libations. Other oral accounts reinforce the idea that Chemapoto was a place of high ritual importance for the Tonga (Toka Leya) population, that have now largely been replaced by the modern populations of Dombe Leya, Nambya and Ndebele.

Figure 9.43 Whole Pots on Chemapato Hill

Away from the river, sites of intangible value most likely to be affected by the proposals are those associated with existing village settlements that lie close to proposed access roads and/or new settlement areas. In Zambia these include Chibule, Ngandu and Machenje and in Zimbabwe Kasikiri.

Sensitive sacred/traditional sites around these settlements are likely to include:

- Boabab trees;
- Rocks and other notable landmarks and features;
- Graves and cemeteries;
- Places of worship.

Funerary traditions in the region vary. In most villages, burials are placed in communal cemeteries. In traditional Tonga communities, on the other hand, burials are placed in plots near the family homestead. This can make them particularly difficult to identify.

Two sites of significance will be inundated (Site 94 and 95). Intangible sites will require extensive mitigation.

Quarry Sites

Archaeological assessments were undertaken in January 2019 for the proposed quarry sites located in Zambia and Zimbabwe as addendums to the archaeological impact assessments conducted in 2014 and 2016. The assessment for the propose quarry site located in Zambia consisted of primary data collection walk through and a desktop study, while the assessment for the quarry located in Zimbabwe was primarily desktop based.

There were no archaeological or other cultural heritage resources identified in the proposed quarry area in Zambia. Furthermore, no fossils, graves, sacred or traditional sites were discovered in the study area. This is largely attributed to the fact that the proposed quarry site has not been inhabited by the Leya or any other ethnic group in the past or at present as the area in question is generally hilly, rocky and rugged and therefore unsuitable for human settlement.

The area of the proposed quarry on the Zimbabwe side is rough, inaccessible country. The underlying basalt is deeply dissected and the countryside comprises of steep sided valleys and razor-backed ridges and dry plateaux. The area is not suitable for agriculture, is of low biomass productivity and has a limited ecological carrying capacity. The area is therefore unlikely to have attached past human habitation and hence there is little chance of finding cultural heritage remains.

Conclusion

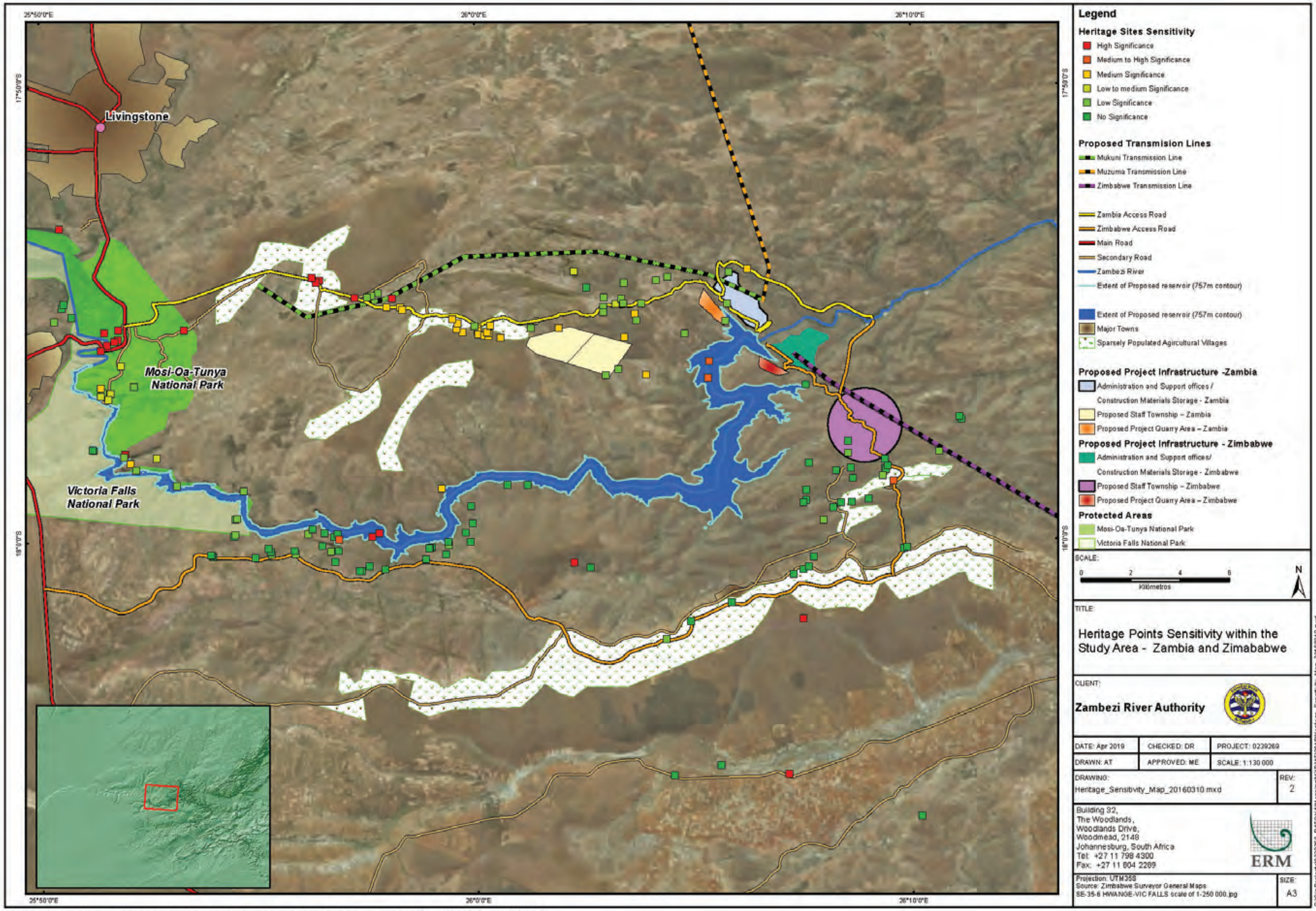
From the various archaeological surveys conducted for the Batoka HHS, the cultural sequence and settlement patterns was adequately characterised with a total of 170 sites recorded on both sides of the Zambezi River. Not all of these sites have research potential. Most of the sites directly impacted by the development footprints are of low to medium significance apart from two intangible sites of medium to high significance (Figure 13).

Areas of steep and broken relief and the dissecting basalt plateaus close to the proposed BGHES dam wall and Alternative Township B in both Zimbabwe and Zambia appear to have been void of significant archaeological sites. Today these areas are still sparsely occupied

The vast majority of sites recorded date from the Stone Age, in particular the Middle Stone Age (MSA) and Later Stone Age (LSA). Most of the Stone Age sites are located in the open basalt plains and low ridges. In most cases palaeo gravels consisting of chalcedony were utilised at these locations for raw material to manufacture stone tools. No diagnostic Early Stone Age (ESA) artefacts have been recorded during recent surveys. Farming Community sites are all clustered along paleo dunes where there is cultivatable soil.

From a heritage perspective, the proposed project is viable as no sites of outstanding value occur in impact areas and impacts on heritage resources can be mitigated. Alternative Township B in both Zimbabwe and Zambia are preferred from a heritage perspective as the least impact on heritage sites will occur. Alternative Township C in Zimbabwe is also acceptable.

Figure 9.44 Heritage Sensitivity Map



9.15 CONCLUSION

This *Chapter* presents the social baseline study undertaken by ERM for ZRA in 2014 and updated in 2019. This document in turn informs the overall BGHES ESIA. Apart from legal and regulatory compliance, the overarching purpose of the social baseline study is to provide a foundation on which to develop social performance management and mitigation in a way that is appropriate to the receiving social environment.

Based on the baseline information provided above, key social characteristics for Zambia are:

- The majority of the local population are from the Tonga or Toka Leya ethnic group.
- The most commonly spoken language in the Project Area is Tonga; however, Toka Leya is spoken in villages in the Mukuni Chiefdom. The majority of the Project Area are Christian.
- Regarding land and building ownership, the majority of land is owned and managed by the Chiefs and their Headmen.
- Main residential buildings are largely made of mudbrick, thatch roofs and corrugated iron. Subsidiary structures are made of fibers, wooden poles and thatching grass.
- A key driver for in-migration to the area is the potential for job and livelihood opportunities associated with the BGHES.
- People who have moved into the Project Area have also moved in due to displacement, fertile land and peaceful community status.
- Availability of food and land, and family cohesion are key effects of migration
- Animal husbandry and crops served as primary livelihood activities. Other activities included curio making, charcoal burning, gardening and fishing.
- Maize, sorghum, sunflowers, millet and groundnuts are the most important crops for both subsistence.
- Livestock important for livelihoods were cattle, chickens, goats and pigs.
- Health, education and service infrastructure is generally poor and access remains limited in the Project Area.
- The main source of water is boreholes and dams, and villages did not have access to National grid electricity.
- Pit latrines are the most common sanitation service

Based on the baseline information provided above, key social characteristics for Zimbabwe are:

- The most commonly spoken language in the Project Area is Shona and Ndebele.
- The majority of the Project Area are Christian.

- Communal land is held under the custodianship of the state and is managed under both local and decentralised government arrangements, as well as traditional leadership of Chiefs, Headmen and Village Heads.
- Crops and gardening, animal husbandry and curio trade serve as primary livelihood activities. Other activities included fishing and brick making.
- Main residential buildings are largely made of mudwalls, thatch roofs and corrugated iron. People who have moved into the Project Area have moved in to access economic activities in the tourism sector, fertile land and grazing land.
- The main source of water is boreholes and rivers, and most villages did not have access to National grid electricity.
- Wood is the most commonly used source of energy for cooking and is used by all households. The majority collect it from the areas surrounding the villages.
- Health, education and service infrastructure is average to poor and there is a shortage of secondary schools.
- Pit latrines are the most common sanitation service.

All large infrastructure projects have the potential to deliver a net positive social and developmental outcome to receiving communities and other stakeholders. It is hoped that this social baseline study will contribute to this ideal in the case of ZRA and the BGHES.

10 BIOPHYSICAL ENVIRONMENT IMPACT ASSESSMENT

10.1 INTRODUCTION

This *Chapter* presents the predicted impacts to the physical and biological environment as a result of the proposed BGHES. More specifically, this *Chapter* presents those biophysical impacts for the following Project components:

- Dam wall and impoundment, including a spillway;
- Surface power houses, one on each side of the river; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching areas).

Potential impacts to the socio-economic environment as a result of the aforementioned Project components are described in *Chapter 11*.

As mentioned in *Chapter 1*, separate ESIA reports have been compiled for 1) Access Roads in Zambia and Zimbabwe; and 2) Transmission Lines in Zambia and Zimbabwe.

10.1.1 Impact Assessment Layout

The ESIA methodology followed in this *Chapter* and in *Chapter 11* is provided in *Chapter 5* of this report. In this *Chapter*, the impact assessment is laid out as follows:

- Background information relating to the impact is provided. This includes a description of the baseline environment that will be affected, the Project aspect or activities that will cause the impact and a description of the effected receptors.

- The significance of the impact pre-mitigation is then assessed and rated through use of a rating table;

- Following the pre-mitigation rating tables a section describing the recommendations and mitigation/management measures proposed are provided; and

- Once the recommended mitigation/management measures are provided a residual impact (post-mitigation) is rated through use of a less detailed rating table.

Descriptions of impact assessment terminology are given in *Chapter 5*.

10.2 *PHYSICAL ENVIRONMENT IMPACTS*

The predicted impacts on the physical environment are presented as follows:

- Impacts on air quality and noise during the construction phase;

- Impacts on flow (water level and velocity) conditions in the Zambezi River upstream of the reservoir impoundment, including potential effects on the Victoria Falls power station and river users in the gorge.

- Impacts relating to water quality conditions in the reservoir formed by the proposed BGHES, including potential eutrophication.

- Impacts on flow and water quality conditions in the Zambezi River and affected receptors downstream of the dam wall due to reservoir conditions and dam operating procedures.

- Impacts on the proposed BGHES in terms of potential changes to Zambezi River flows and resulting power generation capacity due to climate change and/or changes in upstream water resource use.

- Impacts on water and soil resources relating to construction of the proposed BGHES, including localised (i.e. non Zambezi River related) impacts on water supplies, drainage conditions and soil erosion associated with the construction of access roads, ancillary infrastructure and transmission lines etc.

As described in *Chapter 2* (Project Description), the proposed BGHES base case design has been taken for assessment purposes to be a FSL 757 masl dam structure that is operated as a peaking scheme. Alternative full supply levels and operating conditions are also assessed as variants to this, including for mitigation purposes.

The analysis is supported by a detailed annex containing the results of the reservoir water quality modelling studies (*Annex I*) and downstream Environmental Flow Assessment (*Annex J*). In addition, it is difficult to describe water flow or quality related impacts without referring to the ecological and/or social receptors that are affected. However, the physical assessment defers to the relevant report sections for a more detailed discussion of these issues where relevant.

10.2.1 *Impact Assessment associated with Greenhouse Gas (GHG) Emissions*

Introduction

This *Section* provides an estimate of the emissions contributing to climate change from the BGHES, during its construction and operation phases.

Note – this GHG assessment is for the BGHES as a whole. The study has not been separated out for specific Project components (i.e. – for the dam and associated infrastructure; for access roads and for transmission lines).

The objectives of this assessment are to –

- To present the construction and operational carbon footprint of the BGHES through an impact assessment.
- To determine whether expected GHG emissions are deemed to be 'significant'.
- To present viable mitigation measures and management actions that are designed to reduce any significant GHG emissions.
- Assuming the implementation of the suggested mitigation measures and management actions, to present the residual impact assessment.

The GHG assessment looks at the emissions associated with the BGHES during its construction and operation phases. These can be described as follows:

- During construction, GHG emissions are linked with the clearance of vegetation in the construction sites, as well as typical activities associated with construction such as the transportation of raw materials, use of heavy vehicles and on-site power generation (1).
- Emissions associated with the BGHES during its operation are related to the decay of biomass in the reservoir and additionally very limited vehicle transport and power generating requirements expected at and around the site.

It is not possible to link emissions from a single source, such as the BGHES, to particular impacts in the broader study area. This assessment, therefore, looks at the potential impact of the BGHES on Zimbabwe and Zambia's National GHG Inventory (as presented in *Chapter 8*) and the likely implications of this rather than the potential physical impacts of climate change.

Note – the full GHG Assessment Report is provided as a standalone in *Annex R*. The following Section presents the GHG Impact Assessment as is included in Section 4 of the GHG Assessment Report. Limited detail around BGHES construction and operation was available at the time of this assessment. Calculations have therefore been undertaken on the basis of limited data, assumptions and experience of previous hydro-electric projects.

(1) Scope 3 emissions associated with the mining/manufacture of the raw materials used for construction of the BGHES (e.g. cement and steel) are considered to be outside the scope of this Assessment. Emissions associated with transportation of these raw materials to the project site have however been included within the scope of work.

Construction Impacts (Pre-mitigation)

Transport of Materials Emissions

Emissions are associated with the transport required to deliver materials, predominantly cement, fly ash and steel to and around the BGHES construction areas. It has been assumed that the vehicles used for delivery of raw materials to and around the site will be owned and operated by BGHES and therefore sit within the scope 1 emissions category.

The base data provided by SP for undertaking the calculation estimates is shown in *Table 10.1*. According to SP, there will not be any aggregate transportation to the site, as it is intended that excavated material will be used as an aggregate in the concrete required for construction. If the aggregate is of insufficient quality, it is intended that alternative aggregate will be extracted from the on-site quarry. In the absence of certainty on data around the potential quarry sites, emissions associated with this activity (quarrying and transportation) have been excluded from the GHG assessment.

In the absence of data, transportation of materials associated with construction of the two project townships has been excluded from the assessment, as has emissions around transportation of generation equipment.

Table 10.1 Materials requiring Transportation

Construction Location	Item	Volume	Unit
Dam and associated generation areas	Cement	65,143	tonnes
Dam and associated generation areas	Reinforcing Steel	8,571	tonnes
Transmission lines	Steel lattice towers	1,517	tonnes
Transmission lines	Cement	150	tonnes
Road	Construction material	67,168	tonnes

In the absence of data, a range of assumptions were made around the transportation vehicles used and distance travelled to the collection points. Based on estimated volumes (set out in *Table 10.1*), number of trips /total distance were calculated and the estimated tCO_2e calculated (set out in *Table 10.2*).

Table 10.2 Emissions Associated with Transportation of Materials

Part of Journey	Total Journeys (number)	Total Distance (km)	Conversion	Total
Full Leg	6,480	259,181	0.89125 kg CO_2e/km	231 tCO_2e
Empty (return) leg	6,480	259,181	0.67174 kg CO_2e/km	174 tCO_2e

Part of Journey	Total Journeys (number)	Total Distance (km)	Conversion	Total
Total				405 tCO_2e

Construction emissions associated with materials transport were estimated as an average 57.9 tonnes CO_2e per year over the construction period [(1)], equating to 405 tCO_2e over the whole construction period. On the basis of the estimations set out above, annual construction emissions associated with transport of materials therefore amount to less than 1% of Construction Activity Fuel Use Emissions.

Construction emissions associated with materials transport are classified as having a **Low** magnitude according to the EBRD GHG emission reporting categories (refer to *Table 5.8* in *Chapter 5*) and emissions likelihood is considered to be **Likely** (refer to *Table 5.10* in *Chapter 5*). As a result, the average annual emissions and are considered to be **Minor**, as set out within the GHG Impact Significance Rating matrix (*Table 5.11* in *Chapter 5*).

On-site Fuel Use Emissions

There will be demand for fuel for excavation and construction machinery and on-site power generation (including power generation for the project townships). *Table 10.3* shows fuel demands associated with the BGHES. The calculation is based on an estimated daily consumption of mineral diesel over a 7 day working week, provided by SP.

Table 10.3 On-Site Fuel Use for Construction Activities

Area	Item	Value	Conversion	Annual Emissions
Fuel use for excavation & construction machinery and on-site power generation	1,274,000 Mineral diesel	litres per year	2.688 kg CO2e/litre	3,424 tCO2e

Construction emissions associated with the excavation and construction machinery and on-site power generation have been estimated as 3,424 tCO_2e/year, equating to 23,970 tCO_2e over the whole construction period (7 years). On the basis of the estimations set out above, annual fuel use emissions are estimated to be less than 5% of average annual construction emissions.

Construction emissions associated with on-site fuel use are classified as having a **Low** magnitude according to the EBRD GHG emission reporting categories (refer to *Table 5.8 in Chapter 5*) and emissions likelihood is considered to be **Likely** (refer to *Table 5.10* in *Chapter 5*). As a result, the average annual

[(1)] Distribution of materials transport within the construction period is unknown. In order to provide an average annual emissions figure, the total construction emissions associated with materials transport, it has been assumed that transport is spread evenly across the 7 year construction period.

emissions and are considered to be **Minor**, as set out within the GHG Impact Significance Rating matrix (*Table 5.11* in *Chapter 5*).

Land Use Change Emissions

GHG emissions will result from land clearance in the areas required for construction of BGHES infrastructure and inundation following construction of the dam. GHGs resulting from clearance will be determined by the current use of the land, and how much carbon is estimated to be stored within it. The different land uses and their associated areas for BGHES are shown in *Table 10.4.* The area totals for each of the land use types has been calculated from data provided within the BGHES documentation or estimated, based on likely areas. It is understood that the reservoir area will not be cleared of vegetation extensively before inundation.

SP have indicated that in the first instance excavation materials from BGHES will be used as aggregate for the BGHES construction. Should this aggregate be of insufficient quality or quantity, it is understood that aggregate will be taken from the proposed quarry sites. According to SP, there is still uncertainty on data around the potential quarry sites. As a result of this uncertainty, emissions associated with land use change across the potential quarry areas has been excluded from the calculations.

Table 10.4 Land Use Types and Total Areas of Land Use Change

Current land use	Area	Units	Existing land use	Conversion	Units
Transmission lines	0.44	ha	Wooded Grassland	165	tCO_2e/ha
Roads	178.00	ha	Wooded Grassland	165	tCO_2e/ha
Project townships	420.00	ha	Wooded Grassland	165	tCO_2e/ha
Impoundment area	2,200.00	ha	Wooded Grassland	165	tCO_2e/ha
Surface power plants, switch yards and batching areas	0.30	ha	Wooded Grassland	165	tCO_2e/ha
Total land area changed	**2,799.00**	**ha**	**Wooded Grassland**		
Converted totals	**461,835.00**	**tCO_2e**			

Construction emissions associated with the land use change have been estimated at 461,835 tCO_2e. The majority of emissions associated with land use change will occur at the time of the disturbance, which is likely to occur towards the beginning of the construction phase. In the absence of detailed information around construction schedules, land use change emissions have been spread across the 7 year construction period, equating to an estimated annual emission of 65,976 tCO_2e/year.

Whether land use change emissions occur within year 1 or split to provide an average annual emissions across the 7 year constriction period, these emissions account for 99% (emissions occurring within year 1) or 94.9% of average annual construction emissions.

Construction emissions associated with land use change are classified as having a **Medium-High** (emissions occurring within year 1) or **Medium-Low** magnitude (spread equally across the 7 year construction period) according to the EBRD GHG emission reporting categories (refer to *Table 5.8 in Chapter 5*) and emissions likelihood is considered to be **Likely** (refer to *Table 5.10* in *Chapter 5*). As a result, the average annual emissions (years 1 to 7) are considered to be **Major** as set out within the GHG Impact Significance Rating matrix (*Table 5.11* in *Chapter 5*).

Summary of Impacts during the Construction Phase

The total expected GHG emissions for the 7 year BGHES construction period and associated GHG emission impact significance is summarised in *Table 10.5.*

Table 10.5 Total Expected Construction GHG Emissions

Item	Estimated annual emissions	Estimated total construction phase emissions	Magnitude Rating	Likelihood	GHG Impact Significance Rating
Transport of materials	57.90	405.1	Low	Likely	**Minor**
Excavation and construction activity	3,424.00	23,970	Low	Likely	**Minor**
Land use change	65,976.00 (1)	461,835	Medium-High to Medium-Low	Likely	**Major**
Total Construction	**69,459 tCO_2e**	**486,210 tCO2e**			**Major**

(1) The majority of emissions associated with land use change will occur at the time of the disturbance, which is likely to occur towards the beginning of the construction phase. In the absence of detailed information around construction schedules, land use change emissions have been spread across the 7 year construction period.

Operational Impacts (Pre-mitigation)

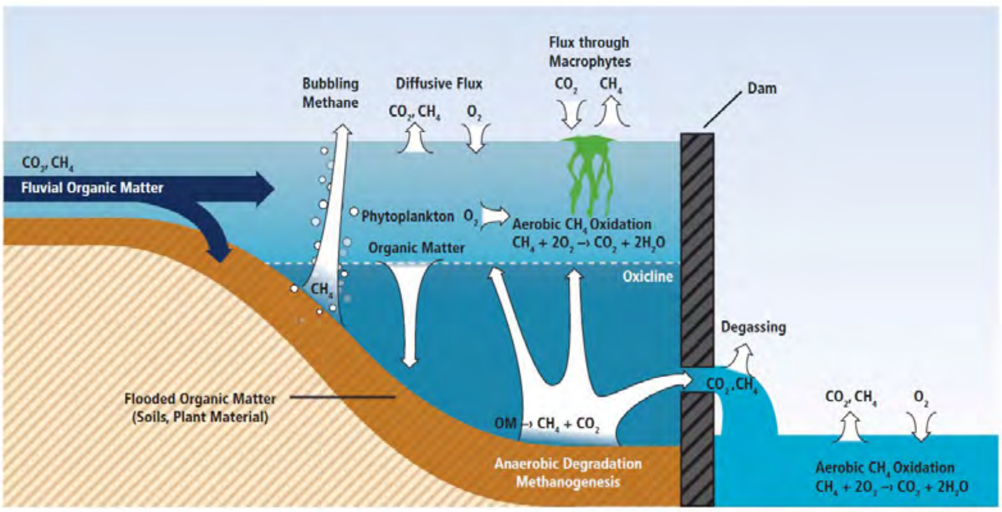
Decay of Reservoir Biomass Material

Best available research (IPCC) suggests that decay of biomass material in inundated reservoirs leads to emissions of both CO_2 and CH_4 with the main impact occurring during the first 10 years of relevant projects [(1)]. The IPCC has suggested an approach to calculating these emissions, which takes the total area to be inundated, the climate in which it is situated and multiplies it by estimated daily GHG emissions produced.

It should be noted that in 2017, the International Hydropower Association (IHA) and the UNESCO launched a web based tool (the GHG Reservoir (G-res) Tool) [(2)], to estimate and report net GHG emissions from planned and existing reservoirs.

In this instance, the IPCC approach was used because the data constraints from a proposed development allows for a high-level 'Tier-1' estimation of GHG emissions. This only accounts for the diffusive flux emissions across the air-water interface as shown in *Figure 10.1.*

Figure 10.1 Carbon dioxide and Methane Pathways in a Freshwater [(3)]

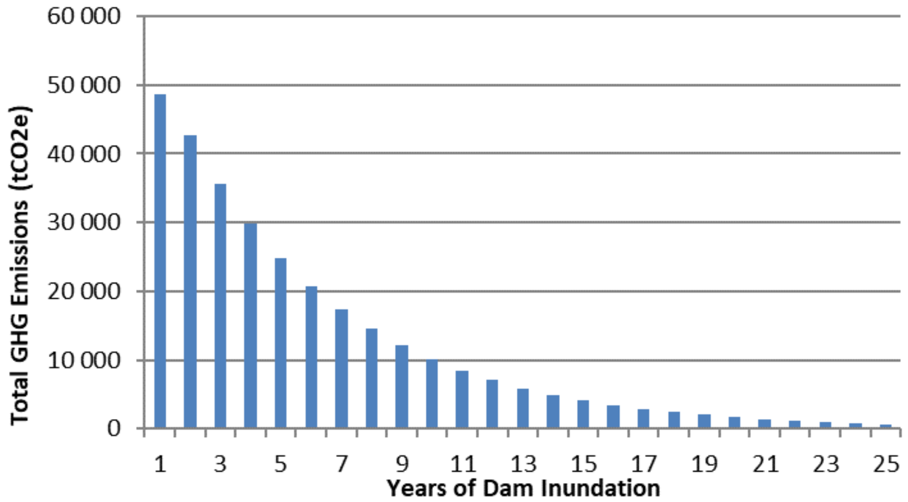


BGHES is expected to create an inundated area with a surface area of 2,200 ha. Inundation is expected to take approximately four months, leading to 100% inundation at the end of the four month period.

(1) IPCC research indicates that emissions are associated with decay of organic matter in the first 10 years following inundation of a previously vegetated area. The best available research indicates that these emissions do not remain beyond this initial period.
Source:http://www.ipccnggip.iges.or.jp/public/2006gl/pdf/4_Volume4/V4_p_Ap2_WetlandsCO2.pdf
(2) Available online at: https://g-res.hydropower.org/
(3) Source: Figure 5.16, Chapter 5; Kumar, A., T. Schei, A. Ahenkorah, R. Caceres Rodriguez, J.-M. Devernay, M. Freitas, D. Hall, Å. Killingtveit, Z. Liu, 2011: Hydropower. In IPCC Special Report on Renewable Energy Sources and Climate Change

Figure 10.2 shows the estimated emissions throughout the whole 25 year period. Over 25 years, it is estimated that the total GHG emissions emitted from the decay of biomass is 304,594tCO_2e, of which 256,718 tCO_2e (84.3%) occurs during the first 10 years. This is primarily from CO_2 emissions, which account for approximately 74% of the total and 26% is from CH_4.

Figure 10.2 GHG Emissions from Decay of Biomass Material in the BGHES Reservoir



Research by the IHA [(1)] suggests that emissions will decrease in the years following full inundation, falling to 50% of peak emissions by year 8 following inundation; and less than 25% of peak emissions by Year 10 following inundation. The average annual operational emissions are equivalent to 12,184 tCO_2e over a 25 -year period. After 25 years annual operational emissions associated with decaying vegetation are approximately 2% of peak emissions and would continue to decline thereafter.

GHG emissions associated with the decay of biomass material in the BGHES reservoir over the 25 year period amounts to 304,594 tCO_2e, of which 256,718 tCO_2e (84.3%) occurs during the first 10 years.

Operational emissions associated with the decay of biomass material in the BGHES reservoir are classified as having a **Medium-Low** magnitude during the first 6 years of operation and a **Low** magnitude thereafter, according to the EBRD GHG emission reporting categories (refer to *Table 5.8 in Chapter 5*) and emissions likelihood is considered to be **Likely** (refer to *Table 5.10* in *Chapter 5*). As a result, the average annual emissions and are considered to be **Major** during the first 6 years and **Minor** thereafter, as set out within the GHG Impact Significance Rating matrix (*Table 5.11* in *Chapter 5*).

(1) International Hydropower Association, 2010. 'GHG Measurement Guidelines for Freshwater Reservoirs'. Calculation Manual, pp121

BGHES Site Operation Emissions

SP were unable to provide any data around O&M (Operations and Maintenance) vehicle movements or on-site fuel consumption during the operational phase of the BGHES at the time of this assessment. As a result, vehicles emissions have been estimated based on an assumed number and length of on-site journeys, multiplied by GHG conversion factors for vehicle emissions per km. In the absence of data, it has been assumed that the O&M vehicle type is a 'van' (1). Calculations are based on an average van (2). A total of 75 return journeys, each covering a one-way distance of 10 km per year, (a total of 1,500 km per year) is assumed for the O&M vehicle emissions. On-site fuel consumption has been based on our experience of previous hydro-electric projects. Estimated annual operational emissions are set out in *Table 10.6.*

It is not clear whether the two project townships will remain in the direct control of BGHES following construction; however, in the absence of data, operational emissions associated with the two project townships (likely to comprise fuel and electricity consumption) has been excluded from the assessment.

Sulphur hexafluoride (SF_6) and many refrigerants, including Hydrofluorocarbons (HFCs) are potent GHG's. No information on the possible use SF_6 within electrical circuit breakers or refrigerants within air cooling units was available and therefore potential fugitive emissions from these sources have been excluded from the assessment.

Table 10.6 Annual Expected Emissions from Site Operations

Item	Estimated Annual Emissions (tCO_2e)
O&M vehicles	0.39
Operations activity, including machinery fuel use, on-site power generation (no imported electricity)	0.40
Total	**0.79**

Operational emissions associated with O&M vehicles and all other operational activity (excluding decay of biomass material) has been estimated as 0.79 tCO_2e/year.

Construction emissions associated with site operations (excluding decay of biomass) are classified as having a **Low** magnitude according to the EBRD GHG emission reporting categories (refer to *Table 5.8 in Chapter 5*) and emissions likelihood is considered to be **Likely** (refer to *Table 5.10* in *Chapter 5*). As a result, the average annual emissions and are considered to be **Minor**, as set out within the GHG Impact Significance Rating matrix (*Table 5.11* in *Chapter 5*).

(1) a van can be defined as a multipurpose, enclosed boxlike motor vehicle.
(2) Factor taken from UK Government GHG Conversion Factors for Company Reporting 2018 (version 1.01)

Summary of Impacts during the Operational Phase

The GHG emission impact significance for during the operational phase of the BGHES is summarised in *Table 10.7*.

Table 10.7 Operational Phase Impact Rating

Operational Phase Annual Impact	Estimated annual emissions	Estimated total operational phase emissions [1]	Magnitude Rating	Likelihood	Significance
Emissions associated with the decay of reservoir biomass material within the inundated area	Variable	304,594tCO_2e	Medium-Low	Likely	**Major**
Emissions associated with onsite fuel or energy use (O&M transport and Operational Activity)	0.79 tCO_2e	19.75 tCO_2e	Low	Likely	**Minor**

[1] Note – this assumes a period of 25 years.

Based on the data in *Chapter 8*. Zimbabwe and Zambia emitted an estimated 72.1 and 320 million tCO_2e (respectively) in 2012, excluding the emissions from land use, land use change and forestry. The countries were therefore responsible for 0.13% and 0.59% (respectively) of global emissions in 2012, and are considered to be low emitters. However, between 1990 and 2012, national emissions grew by 105% in Zimbabwe and 53% in Zambia, whilst global emissions increased by 41% over the same period.

During the first year of operation, it is estimated that the BGHES emissions, including those from decay of biomass, will increase the national inventory of Zimbabwe (excluding LULUCF) by 0.03% and Zambia by 0.008%, based on 2012 emissions levels (assuming 50/50 split of BGHES emissions by country). It will gradually decrease down to 0.0005 and 0.0001% by year 25 (based on the assumption that BGHES emissions will split equally between the two countries).

The EBRD guidance on assessment of GHG emissions sets out that hydro-electric power generation projects are considered likely to fall into the EBRD's 'Low' category (i.e. <20,000 t CO_2e/year). In line with this assumption, the BGHES is expected to meet this criterial from year 7 of operation.

Based on the calculations undertaken through this assessment, it is identified that from year 5 of operation onwards, BGHES falls beneath the 25,000 tCO_2e significance threshold, set out within the IFC Performance Standard 3 (mirrored by EBRD's 2014 Environmental & Social Policy and the Equator Principle).

Mitigation/Management Measures for during Construction

Mitigation of GHG emissions during construction can be achieved through a series of measures. These mitigation measures are split between the impacts, as follows and identified in *Table 10.8*.

Emissions associated with transport of raw materials:

- Type and quantity of raw material
- Distance the raw material is transported
- Type and efficiency of transportation vehicle
- Optimum working conditions for transportation vehicles

Emissions associated with excavation transport:

- Quantity of the subsurface material excavated
- Density of excavated subsurface material

Emissions associated with construction activity:

- Type and efficiency of construction vehicles
- Optimum working conditions for construction vehicles
- Source of on-site power generation

Emissions associated with land use changes:

- Current use of the land (quantity of carbon stored pre construction)

Table 10.8 Mitigation Measures during Construction

Impact	Mitigation Measures
Emissions associated with transport of raw materials	• Where possible, favour the use of raw materials that are easier to transport (lighter less volume) plus consideration for on-site assembly of parts. Where there are limited raw material options, focus should be on optimisation of transportation. • Reducing and / or optimising the quantities of construction material transported (dependant of the final dam design and its implementation). • Management of transport logistics to ensure efficient carriage of raw materials. • Management of voids and compaction of loads to ensure maximum safe payloads are transported. • Reducing vehicle idling times through focus on scheduling of construction operations. • Where possible, consideration for sourcing of materials from suppliers closest to the construction site. Where local suppliers are not available or their use feasible, focus should be on optimisation of transportation.

Impact	Mitigation Measures
	• Prioritise the use of fuel efficient transportation vehicles and ensure regular maintenance of vehicles. • Consider using a less carbon intensive fuel (e.g. a biofuel blend), although this needs to be considered in the context of availability. • Provide efficient driving guidelines to transportation vehicle drivers, to promote fuel efficiency.
Emissions associated with excavation	• Prioritise the use of fuel efficient excavation machinery and ensure regular maintenance of machinery. • Provide efficient working guidelines to excavation machinery operators, to promote fuel efficiency. • Management of transport logistics to ensure efficient carriage of excavated materials. • Management of voids and compaction of loads to ensure maximum safe payloads are transported. • Reducing vehicle idling times through focus on scheduling of excavation operations. • Consider using a less carbon intensive fuel (e.g. a biofuel blend), although this needs to be considered in the context of availability.
Emissions associated with construction activity	• Prioritise the use of fuel efficient construction vehicles and ensure regular maintenance of vehicles. • Provide efficient working guidelines to construction vehicle drivers, to promote fuel efficiency. • Reducing vehicle idling times through focus on scheduling of construction operations. • Consider using less carbon intensive fuel (e.g. a biofuel blend), although this needs to be considered in the context of availability. • Ensuring that on-site power generation is designed, sized and operated for emissions performance as well as reliability. • Where possible, minimise the area of land clearance.
Emissions associated with land use change	• Reduction in GHG releases through a thorough salvage of commercial timber and fuelwood. It is suggested that a timber survey be carried out to estimate the amount of commercially viable timber that could be recovered from the areas that will be cleared of vegetation during construction. It would then be possible to estimate the amount of biomass that would not release GHGs and reduce the impact from land use change emissions. It is also suggested that once an estimate of commercially viable timber is known, that markets for this are actively sought to make the proposed mitigation as commercially viable as possible. However, it is not believed that the reduction of GHG emissions from this would significantly change the conclusions of this impact assessment. • Productive utilisation of biomass material (wood) subsequent to land clearance. This will also serve to reduce the use of wood harvested away from the proposed inundation area for wood fuel for use by local communities, which is the current practice. • Consider planting/re-planting of suitable indigenous trees around the complex.

Mitigation /Management Measures for during Operations

GHG emissions associated with the operation of BGHES are primarily linked to the decay of reservoir biomass material within the inundated area; however, some measures associated with on-site fuel or energy use have been identified, as set out in *Table 10.9*. An additional measure has been identified, relating to the potential use of SF6 and refrigerants during operation: Ensure management controls that minimise the potential for losses or leakage of these substances and track any emissions that occur during operation.

Table 10.9 Operational Mitigation Measures

Impact	Mitigation Measures
Emissions associated with onsite fuel or energy use	• Prioritise the use of fuel efficient on-site vehicles and ensure regular maintenance of vehicles.
Emissions associated with the decay of reservoir biomass material within the inundated area	• Reduction in GHG releases through a thorough salvage of commercial timber and fuelwood. • Consider planting/re-planting of suitably indigenous trees around the complex.

Residual Impact (Post-mitigation)

Table 10.10 identifies the residual impact significance ratings for both the construction and operation impacts. It should be noted that whilst improvements/reductions in GHG emissions can be achieved through identified mitigation measures, the emission sources identified cannot be completely removed from BGHES construction and operation activities, and therefore residual emissions will remain (likely falling within the identified significance category). Further in depth quantification of residual emissions would require a more detailed understanding of construction and operational activities alongside likely adoption of mitigation.

Table 10.10 Residual Impact Assessment Rating

Impact	Magnitude Rating (post-mitigation)	Likelihood	Significance (post-mitigation)
Annual emissions associated with transport of raw materials	Low	Likely	**Minor**
Annual missions associated with excavation and construction activity	Low	Likely	**Minor**
Emissions associated with land use change (1)	Medium-Low to Medium-High	Likely	**Major**
Emissions associated with the decay of reservoir biomass material within the inundated area	Medium-Low	Likely	**Major**

(1) Whether considering land use change emissions occurring within year 1 of construction only or split to provide an average annual emissions across the 7 year constriction period.

Impact	Magnitude Rating (post-mitigation)	Likelihood	Significance (post-mitigation)
Emissions associated with onsite fuel or energy use (O&M transport and Operational Activity)	Low	Likely	**Minor**

When the BGHES is compared against fossil fuel electricity generation technologies over the 50 to 100 year Project lifetime, the GHG emissions associated are significantly lower per GWh of electricity generated. Although there is a high initial GHG impact primarily associated with the clearance of vegetation during construction and decay of vegetation from inundation, the emissions over the Project lifetime are significantly lower due to the minimal emissions associated with generating electricity once in operation. This means the BGHES as a whole will have a much lower contribution to climate change over its lifetime compared to any fossil fuel electricity generation technologies.

10.2.2 *Impacts on Air Quality*

The baseline air quality in the ADI and immediate surrounds is likely to be dominated by naturally occurring sources. Due to the nature of the receiving environment (semi-arid) it is likely that the concentration of airborne dust and particulate matter, PM_{10} and $PM_{2.5}$, will be elevated; particularly on the Zimbabwean side of the Zambezi River where traffic volumes are higher and where agriculture is more prevalent. Concentrations of nitrous dioxide (NO_2) and sulphur dioxide (SO_2) are also likely to be low in the ADI, as there are no significant local sources of emissions.

The proposed BGHES will primarily impact on air quality during the construction phase. The main sources of atmospheric emissions during the construction phase will be associated with:

- Site preparation activities;
- General construction activities for Project infrastructure;
- Vehicle movement over unpaved surfaces;
- Vehicle exhaust emissions; and
- Potential power generation utilising fossil fuels.

Atmospheric emissions (specifically dust) from the aforementioned sources will be short-term and of a nuisance nature only. Periodic construction traffic along unpaved surfaces and/or during site preparation activities can cause significant local nuisance to receptors in the ADI and immediate surrounds; however, this will be managed through dust suppression techniques detailed in the construction EMSP (refer to *Volume II*). Moreover, the construction ESMP includes measures for managing power generation and vehicular exhaust emissions associated with the Project. A Grievance Redress Mechanism would capture community concerns regarding dust, noise and other nuisances and allow the issue to be addressed by the Project, as required.

If the Project implements the management measures included in the construction ESMP, it is considered that activities that have the potential to result in dust, noise and other nuisances would have a negligible influence on aspects of the social or biophysical environment. Accordingly, impacts on air quality have been screened out from this assessment.

10.2.3 Impacts on Noise

The noise environment of the Project Area is likely to be low and characteristic of a rural setting with main noise sources being natural sounds from local fauna, livestock and human domestic and agricultural activities, which is typical for low-density rural areas. As with air quality, noise emissions are expected to be relatively higher on the Zimbabwean side of the Zambezi River, as this area is more populated than the Zambian side. Based on professional judgement background noise levels are expected to be between 45 and 60 dB (LA_{90}) during the daytime and 35 and 45 dB (LA_{eq}) during night time.

Site preparation (especially soil excavation/ earthworks) and access road upgrading/construction, will generate localised and short term noise emissions. Vehicle transport to and from the Project sites, while localised and transient in nature, can also adversely affect ambient noise levels along the transportation routes.

Potential noise sources during the construction phase will be derived from:

- Construction noise from staff townships;
- Construction noise from active work sites;
- Construction noise from quarries; and
- Noise and vibration from blasting required for quarrying.

Noise emissions from the aforementioned sources will be short-term and of a nuisance nature only. Emissions will be managed through general noise mitigation measures included in the construction ESMP (refer to *Volume II*). The primary objective for noise management during construction is to minimise impacts to the closest and/or most sensitive noise receptors situated in the vicinity of the Project. A Grievance Redress Mechanism would capture community concerns regarding dust, noise and other nuisances and allow the issue to be addressed by the Project, as required.

If the Project implements the management measures included in the construction ESMP, it is considered that activities that have the potential to result in dust, noise and other nuisances would have a negligible influence on aspects of the social or biophysical environment. Accordingly, impacts on noise have been screened out from this assessment.

10.2.4 *Impacts Relating to Upstream River Conditions*

Introduction

Operating a dam at its highest level is economically the most efficient. Surveyed data from two beacons on each of the proposed BGHES sites' banks indicate a valley height of 841.1 masl and 842 masl. Theoretically, the proposed BGHES FSL could be fixed at or just below these heights to maximize the economic feasibly of the scheme. A FSL at or below these heights would, however result in backwater flooding, resulting in impacts to the Victoria Falls (a World Heritage Site), the Boiling Pot (immediately downstream of the Victoria Falls and itself a tourist attraction), to the 1st and 2nd gorges (essentially the sections of the Zambezi River below the Falls most visible from the Victoria Falls Bridge and the Victoria Falls Hotel), and to the existing Victoria Falls Power Station.

A relatively large proportion of the environmental and social impacts associated with the proposed BGHES are as a direct consequence of the reservoir impoundment and the only available mitigation is to alter the operational water levels at the dam (either permanently or seasonally), and in so doing reduce the extent of the upstream effects. A reduced FSL does however have economic implications for the proposed BGHES.

A FSL of the reservoir of 762 m amsl was initially fixed; however, an analysis showed that there is a small incremental effect on water level conditions at the power stations at this FSL, due to backwater effects. These backwater effects would (on average) increase the percentage of time each year by around 2-3 %, whereby the power output at the plant is compromised due to water levels rising above the lowest tailrace. It would also reduce the return period of a potentially catastrophic event (whereby the stations become inundated above flood protection levels) from close to a 500 year flood event, to around a 200 year flood event.

A FSL of 757 m amsl was therefore selected as the preferred FSL, and is the basis of this ESIA (refer to *Chapter 6*). Lowering the FSL from 762 m amsl to 757m amsl would lead to a loss of benefit of around 140M US$ and the Benefit Cost Ratio (BCR) would be reduced from 4.71 to 3.98 but the Internal Rate of Return (IRR) would remain unchanged (refer to *Table 10.11*).

Table 10.11 Internal Rate of Return, Benefit Cost Ratio and Benefit Loss for varying Full Supply Levels

Full Supply Level (FSL)	Internal Rate of Return (IRR)	Benefit Cost Ration (BCR)	Benefit Loss
762 m amsl	28%	4.71	0 ($ 11,625 M benefit)
757 m amsl	28%	3.98	$ 140 M less ($ 11,485 M benefit)
740 m amsl	26%	4.08	$ 600 M less ($ 11,025 M benefit)
730 m amsl	25%	3.77	$ 630 M less

Full Supply Level (FSL)	Internal Rate of Return (IRR)	Benefit Cost Ration (BCR)	Benefit Loss
			($10,995 M benefit)

Victoria Falls Power Station

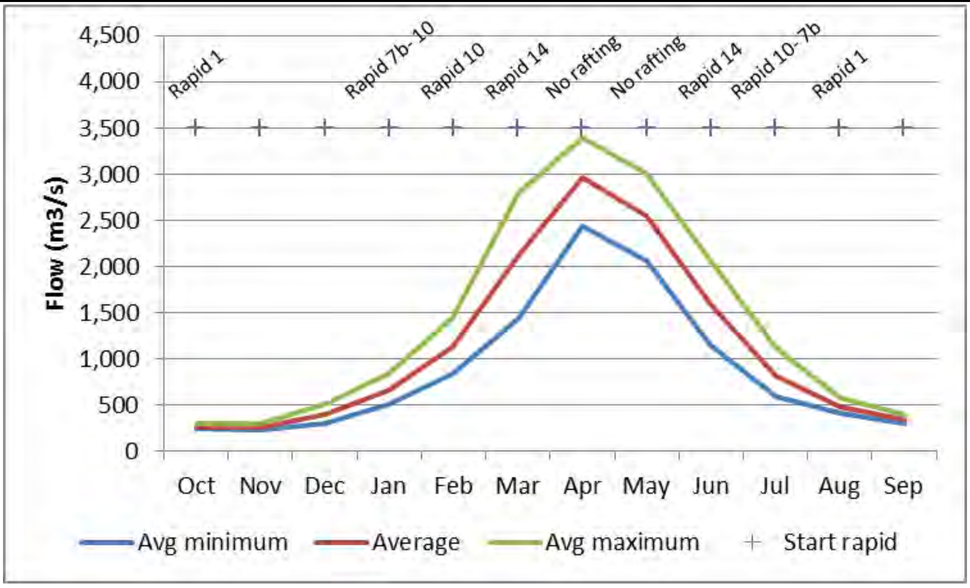
Operating the proposed BGHES at a FSL of 757 m amsl should eliminate any backwater effects from the impoundment at Silent Pool altogether over the full range of flow conditions that have been recorded in the river. That is, there should then be no discernible effect on the power station from the dam.

Rafting Activities

Figure 10.3 shows when and where rafting currently takes place on the Zambezi River in comparison to average monthly flow data, and *shows* the location of the various rapids that are referenced in *Figure 10.4*. In very general terms, rafting takes places as follows:

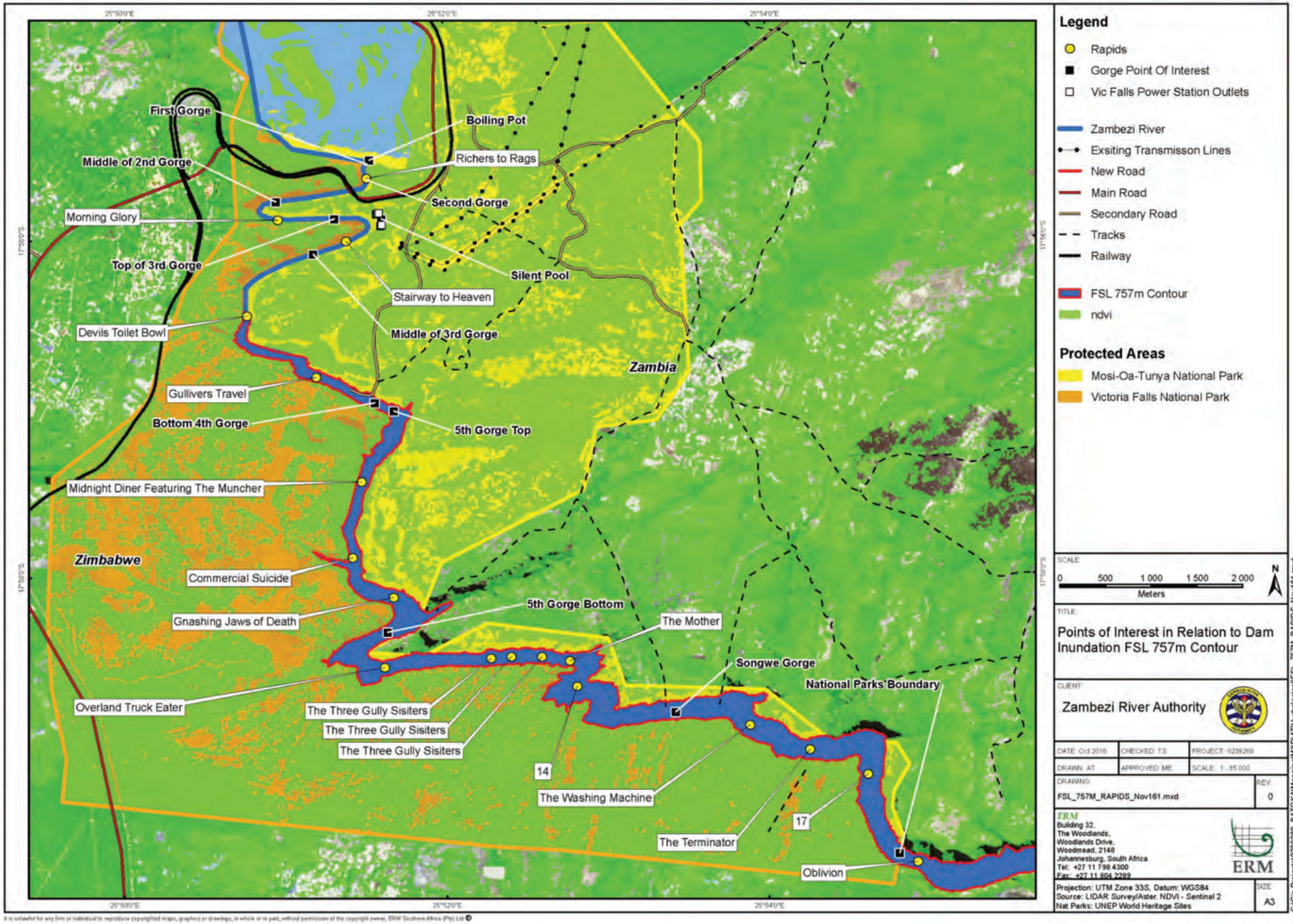
- From rapid 1 (Boiling Pot) for the period August through to the beginning of January, when flows are typically below 500 m^3/s or thereabouts;
- From rapid 7b (Gulliver's Travel) in the first half of January and the second half of July, when flows typically range from 500 to 800 m^3/s;
- From rapid 10 (Gnashing Jaws of Death) in late January through to the end of February, and the first half of July, when flows typically range from 800 to about 1,400 m^3/s;
- From rapid 14 in March and June, when flows typically range from 1,400 to about 2,500 m^3/s; and
- No rafting takes place in April or May, when flows are generally above 2,500 m^3/s.

Figure 10.3 Average Flow Conditions for Rafting on the Zambezi River



Therefore, based on the hydraulic analysis presented earlier, the proposed BGHES would preclude any rafting from late January until the second half of July since the river reach from rapid 10 downstream (where rafting normally takes place during this period) would effectively be submerged by the reservoir. Rafting would also likely be compromised throughout January and July as well since flow velocities would also be significantly affected from rapid 7b (which lies within the 5th Gorge) downstream, which is the reach currently used during this period. Rafting would still be possible from rapid 1 downstream to around rapid 4 (near the top of the 3rd Gorge) from August through to the end of December, but would most likely be compromised from rapid 5 downstream due to significantly reduced flow velocities. It should be noted that this is necessarily an approximate analysis based upon estimated hydraulic conditions in the gorge at different locations.

Figure 10.4 Points of Interest in Relation to Full Supply Level (FSL) 757m Contour



Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact relating to flow (water level and velocity) conditions in the Zambezi River upstream of the reservoir impoundment, including the potential effect on river users in the gorge, will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 10.12*). This is based on the magnitude of the impact being assessed as medium, as the impact is not likely to preclude rafting altogether, but the sensitivity of the receptors being assessed is high.

Table 10.12 Rating of Impacts Related to Upstream River Conditions (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact is confined to the area between Victoria Falls and the head of the reservoir, but will affect users on both sides of the river/border.
Duration	Permanent	The impact will be permanent so long as the reservoir remains.
Scale	40-50 km	Approximate length of river affected (as measured from Batoka site) extends upstream to top of 3rd Gorge or thereabouts.
Frequency	Periodic	Varies depending on seasonal flood conditions in river, but will occur periodically every year.
Likelihood	Likely	The impact is a direct consequence of the reservoir impoundment.
Magnitude		
Medium Magnitude		
Sensitivity/Importance of the Resource/Receptor		
High Sensitivity / Importance		
The sensitivity and importance of these receptors (and the National Parks themselves) is rated as high, in both ecological and socio-economic terms.		
Impact Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation/Management Measures

The impacts described in this section are a direct consequence of the reservoir impoundment and the only available mitigation (at least for the fixed receptors of the power station and the national parks (1)) is to alter the operational water levels at the dam (either permanently or seasonally) and in so doing reduce the extent of the upstream effects.

This Section discusses the preferred and selected mitigation option for the BGHES. The preferred option was selected by balancing the relative economic costs and benefits of the different solutions. The focus of discussion in this section is on mitigating the physical impacts of the impoundment; the

(1) The feasibility or otherwise of relocating the river rafting activities is discussed further in *Chapter 11 (Social Environment)* although in practical terms rafting downstream of the Batoka site is logistically very challenging due to the distances involved and would preclude the current short (half-day) trips that are offered to tourists from the centres in Livingstone and Victoria Falls.

discussion of the consequent effects on social and ecological receptors is presented elsewhere in this report.

The preferred and adopted mitigation option selected by the Project is to seasonally adjust the operating level at the dam as follows:

- Reduce the dry season (in rafting terms, from August to January) operational level to 730 masl, thereby freeing a reach of river for rafting during this period that extends all the way from the Falls downstream to around rapids 9 and 10, which is the current limit of half-day rafting trips on the river; and

- Increase the operating level during the high-flow season to 757 masl under normal flow conditions in the river, and to 762 masl under high flow conditions, defined as the flow above which the Victoria Falls Power Station would normally begin to flood. As shown in *Figure 10.3* this occurs at an approximate flow rate of 3,000 m^3/s.

The potential benefits of this flexible operational regime would be to maximise power generation during the high flow season whilst facilitating full half-day rafting trips in the river for the majority of the rafting season, and minimising (and potentially avoiding [(1)]) any incremental effects from flooding at the Victoria Falls Power Station. However, clearly changing the operating level of the dam by some 30 to 40 metres on a regular basis such as this will have consequences for both ecological and aesthetic conditions in the impoundment zone. Moreover, there will be periods during the filling and emptying of the reservoir at the beginning and end of the high flow season when downstream patterns of flow will be disrupted. Again, this may have consequences for downstream users, and in particular aquatic ecology.

In addition, this preferred option needs to take into consideration its economic feasibility. Stratecon (2015) estimate that although this scenario would bring about a marginal increase in tourism revenues (when compared to the 757 m FSL), under this scenario, the Nett Present Value (NPV) of the proposed BGHES would lead to a loss of benefit of around 630M US$. Stratecon (2015) in the economic feasibility also estimate a drop in the FSL of 762 m to 730 m would reduce the BCR and IRR for the proposed BGHES from 3.77 and 25% respectively (refer to *Table 10.1*).

The effects of such rapid changes in downstream flow releases are discussed further in the *Section 10.2.5*, and the consequent impacts on ecological and social receptors as well as the economics of the proposed BGHES are also discussed in *Chapter 11* (Socio-Economic Environment Impact Assessment).

(1) The higher dam operating level would only kick-in at times when the VF power station would normally flood under present conditions. However, the effect of operating the impoundment at the higher level may exacerbate flood levels at the power station and thereby compromise power production further than at present. This effect would therefore need to be examined during detailed design in order to determine a suitable flow threshold for the higher operational level that balanced power gains at the dam versus losses at the power station.

Residual Impact (Post-mitigation)

Based on the implementation of the mitigation measures, it is assessed that the impact related to flow (water level and velocity) conditions in the Zambezi River upstream of the reservoir impoundment, including potential effects on the Victoria Falls power station and river users in the gorge, will be a "**Minor Negative Impact**" post mitigation (refer to *Table 10.13*).

Note: The socio-economic and economic impacts as a result of changes in the FSL are rated separately in *Chapter 11*.

An integrated summary (physical, biological, socio-economic and economic) of the impacts as a result of changes made to the FSL of the proposed BGHES is also presented in *Chapter 13*.

Table 10.13 Rating of Residual Impact Related to Flow Conditions Upstream of Reservoir (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact is confined to the area between Songwe Gorge and the head of the reservoir, but will affect users on both sides of the river/border.
Duration	Permanent	The impact will be permanent so long as the reservoir remains.
Scale	40-45 km	Approximate length of river affected (as measured from Batoka site) extends upstream to rapid 10 or thereabouts during the low flow (peak rafting) season. There may be small incremental effects on the VF power station during high flows.
Frequency	Periodic	Varies depending on seasonal flood conditions in river, but will occur periodically every year.
Likelihood	Likely	The impact is a direct consequence of the reservoir impoundment.
Magnitude		
Small Magnitude		
Impact Significance Rating After Mitigation		
Minor Negative Impact		

10.2.5 Impacts Relating to Reservoir Water Quality

The construction of the dam is expected to affect the quality of water in the resulting reservoir, which could in turn have a detrimental impact on ecological habitats, fisheries and other water users in the area, and also further downstream. Downstream effects are discussed in *Section 10.2.6*; this Section discusses the potential water quality impacts in the reservoir itself, focussing primarily on eutrophication issues but also addressing the potential accumulation of inorganic pollutants. The consequent impacts on ecological and social receptors and associated mitigation measures are discussed in more detail in *Section 10.3* (Impacts on the Biological Environment) and *Chapter 11* (Socio-economic Environment Impact Assessment).

Potential Reservoir Eutrophication

A model of the water quality index of the reservoir was used to assess its eutrophication potential and help inform the causes (and hence mitigation) of any elevated trophic levels. The model used for this study is the US Army Corps of Engineers BATHTUB model. Comparisons of the anticipated trophic status of the reservoir were conducted under varying flow and nutrient loading conditions. *Annex I* presents the detailed results of the reservoir water quality studies, which are summarised below.

Nutrient Inflows

Water quality data were extracted from the ZRA monitoring data presented in *Chapter 8*, *Section 8.2.5* and used to develop influent nutrient (nitrogen and phosphorus) loadings into the reservoir for three representative hydrological years in the Victoria Falls flow record:

- 1931 was used to represent a median flow year (the average annual flow was around 1,100 m^3/s);
- 1957 was used to represent an extreme high flow year (the average annual flow was around 2,300 m^3/s); and
- 1995 was used to represent an extreme low flow year (the average annual flow was around 400 m^3/s).

These reservoir nutrient inflows were derived for two scenarios: a first series was derived from the water quality monitoring record at rapid 11 (R11) in the gorges downstream of the Falls, and a second series was derived from the record at "A'Zambezi River Lodge" (AZA) located upstream of the Falls. The R11 measurements are close to the headwaters of the future reservoir, and therefore represent the inflow conditions with the existing nutrient loads from all sources upstream of the Batoka HES. Location AZA measurements are upstream of the settlements at Victoria Falls and Livingstone, and are therefore representative of inflow conditions that would occur if improved wastewater controls were functional in these two urban centres (though not at the settlement of Kasane, which is further upstream).

Atmospheric phosphorus was also applied as an additional loading rate using data listed in Tamatamah *et al.* (2005) from Lake Victoria (only phosphorus was considered because it was determined from analysis of the existing data to be the limiting nutrient in the Batoka watershed).

Trophic Status Calculations

The Carlson Trophic State Index (TSI) method (Carlson, 1977) was used to quantify the trophic status of the reservoir. This scoring method provides a measure of potential algal biomass using an index that is comparable between water bodies and between present and projected conditions. *Table 10.14* relates TSI value ranges to their respective trophic status and includes attributes of the various trophic states.

Table 10.14 TSI Values and Trophic Status in Freshwater Lakes

TSI Value	Trophic Status	Attributes
< 30	Oligotrophic	Clear water, low production, oxygenated hypolimnion.
30 – 50	Mesotrophic	Moderately clear water, possible anoxia in summer.
50 – 70	Eutrophic	Low transparency, anoxic hypolimnion in summer.
> 70	Hypereutrophic	Dense algae and macrophytes, noticeable odor, fish kills possible.

The results of the analysis for the Batoka reservoir under the various different inflow scenarios described above are presented in *Table 10.15*. As mentioned previously, scenario R11 represents existing (baseline) values of nutrient loading to the reservoir, and scenario AZA represents an "improved wastewater control" level of nutrient loading (with corresponding reduced TP loadings).

Table 10.15 Summary Table of Model TSI-TP Scores

Scenario and Hydrological Year	Total Phosphorus (TP) (mg/m^3)	TSI-TP Score	Trophic Status
AZA 1931 (average)	21.7	46.4	Mesotrophic
AZA 1957 (high)	23.1	48.4	Mesotrophic
AZA 1995 (low)	16.8	41.2	Mesotrophic
R11 1931 (average)	29.0	49.9	Mesotrophic
R11 1957 (high)	30.5	51.8	Eutrophic
R11 1995 (low)	23.6	44.9	Mesotrophic

<u>Conclusions</u>

As shown in *Table 10.14*, almost all the results are mesotrophic when assessed using the Carlson TSI method. (1) Due to the positive correlation of TP concentration with flow rate, years with higher annual flows have larger TSI scores. The two scenarios derived from the highest annual inflow, in 1957, have the largest TSI scores out of the six results. Moreover, for scenario R11 1957, which combines existing levels of wastewater treatment at the two main upstream urban centres (Victoria Falls and Livingstone) with a high annual inflow rate, the reservoir is predicted to be eutrophic. The findings of the original BGHES Feasibility Study (BJVC, 1998) also indicated that the reservoir would be mesotrophic-eutrophic.

The potential effect of improved wastewater controls in the two urban centres upstream of the reservoir can be determined by calculating the percentage decrease in TSI score from Scenario R11 to Scenario AZA. These values are listed below:

- Assuming median inflow conditions results in a 7% decrease in TSI-TP.

(1) Note, this analysis does not take into account the initial surge of nutrients that will occur during the early stages of reservoir formation when the existing biomass is flooded. Unless cleared in advance this is likely to result in eutrophic conditions in the reservoir in the first few years of operation (as occurred at Lake Kariba).

- Assuming high inflow conditions results in a 7% decrease in TSI-TP.
- Assuming low inflow conditions results in a 8% decrease in TSI-TP.

These changes show the importance of wastewater treatment in controlling eutrophication. However, it should be noted that even under improved wastewater treatment conditions the future reservoir is still predicted to be mesotrophic; indicating that other nutrient sources in the upper catchment (primarily non-point source) are dominant.

Other Water Quality Impacts

As described in *Section 8.2.5,* the concentrations of inorganic pollutants in the river water at Victoria Falls are generally very low, which is consistent with the predominantly rural and relatively undeveloped catchment area above the Falls. Therefore, it is very unlikely that there will be any issues with the accumulation of inorganic pollutants in the reservoir. However, the possible exception to this relates to lead, in that fairly high levels of lead were detected in several river samples taken in 1998. These were attributed to a combination of spillage from the outboard engines of pleasure craft upstream of the Falls and untreated disposal of waste oils from industrial centres in Livingstone and Victoria Falls (ZRA, 1998). The situation with regards to industrial waste management (and wastewater controls in general) has not significantly improved since this time, and so there remains a risk that high lead concentrations may build up in the reservoir and thereafter bio-accumulate in fish stocks with consequent public health concerns.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the combined impact relating to potential eutrophication and other water quality issues in the reservoir formed by the proposed BGHES, including potential effects on water users and fisheries in the lake, will be a "**Moderate Impact**" pre-mitigation (refer to *Table 10.16*). This is based upon the likely mesotrophic (rather than eutrophic) status of the reservoir and the consequent potential for anoxia to occur during the summer months, and also the potential for the accumulation of lead pollution in the lake.

Table 10.16 Rating of Impact Related to Reservoir Water Quality Conditions (Pre-Mitigation)

Type of Impact		
Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact will be confined to the reservoir itself, but may affect users on both sides of the border.
Duration	Permanent	The impact will be permanent so long as the reservoir remains, although may be more significant in early years.
Scale	23 km2	Reservoir surface area.
Frequency	Periodic	Anoxia could potentially occur each hot season, and eutrophic conditions are likely to occur in first few years.

Likelihood	Likely	Mesotrophic status fairly clearly indicated by analysis.
Magnitude		
Medium Magnitude		
Sensitivity/Importance of the Resource/Receptor		
Medium Sensitivity / Importance		
The sensitivity and importance of the future reservoir for fisheries and/or local water supply purposes is rated as Medium (refer *Chapter 11*).		
Impact Significance Rating Before Mitigation		
Moderate Negative Impact		

Mitigation/Management Measures

The most effective mitigation measure to maintain good water quality conditions in the reservoir will be to minimise and control upstream pollution sources. Primarily, this would involve a sustained programme of investment to upgrade municipal and industrial wastewater treatment facilities and sewerage systems in the main urban centres of Victoria Falls and Livingstone, and preferably also in Kasane.

The aforementioned 1998 ZRA water quality study identified significant pollution, and especially nutrient, loadings to the Zambezi River from all three urban centres arising from an estimated 18,000 m^3/day of largely untreated sewage flowing into the river. The over-loaded and poorly functioning waste stabilisation pond systems still exist from this time, and given the population increases in all three centres the volume of untreated sewage entering the river is likely to have increased. The investment for this new infrastructure could potentially come from sources such as the African Development Bank's (AfDB) Zimbabwe Multi-Donor Trust Fund (ZimFund) that currently includes the rehabilitation of sanitation systems in certain target municipalities. Similarly, bi-lateral donors such as the Danish International Development Agency (DANIDA) are making significant investments in this sector in Zambia (such as the Kafubu Sustainable Water and Sanitation Improvement Project). Neither of these programmes currently covers the Project area, although future phases of investment could be sought.

In addition to upgrading sewerage and wastewater treatment facilities, a more specific measure would be to initiate and promote a formal waste oil collection and recycling programme for the tourism and industrial sectors in both urban centres. There are numerous examples of commercial enterprises operating such schemes on a successful and profitable basis, particularly when the necessary economies of scale can be achieved and the correct financial (eg tax) incentives are in place.

Another direct control measure that would help to mitigate any potential eutrophication issues caused by the initial 'flush' of nutrients during the first few years of reservoir operation would be to remove the majority of vegetation prior to inundation. This would clearly need to be carried out in a careful and controlled manner to avoid significant sediment disturbance and mobilisation, and with due respect to faunal conditions in the reservoir zone (e.g. along the lines of 'Operation Noah' that was carried out during the inundation of Lake Kariba). The clearance of any subsequent floating vegetation (e.g. water hyacinth) would also necessarily continue at least during the first few years of reservoir formation. This could be achieved by a combination of manual clearance and biological controls, and could also be linked to the ongoing initiative by the Zambian Southern Water and Sewerage Company in Livingstone to utilise water hyacinth and other green wastes for biogas generation in the area (the *Living Falls BioPower Project*).

Finally, the above water quality control measures will also be accompanied by a routine programme of water quality monitoring in the reservoir, as currently performed by the ZRA for Lake Kariba, with both physical and biological indicators included. The latter will include the sampling and analysis of fish tissue for the potential accumulation of toxic pollutants, in particular lead.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, it is assessed that the impact relating to water quality conditions in the reservoir will be a "**Minor Impact**" post mitigation (refer to *Table 10.17*).

Table 10.17 Rating of Residual Impact Related to Reservoir Water Quality Conditions (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact will be confined to the reservoir itself, but may affect users on both sides of the border.
Duration	Permanent	The impact will be permanent so long as the reservoir remains.
Scale	23 km2	Reservoir surface area.
Frequency	Periodic	Anoxia could potentially occur each hot season, pa.
Likelihood	Likely	Mesotrophic status fairly clearly indicated by analysis.
Magnitude		
Small Magnitude		
Impact Significance Rating After Mitigation		
Minor Negative Impact		

10.2.6 Impacts Relating to Downstream River Conditions

As described in *Chapter 2*, and as elaborated in SP (2018), the BGHES with its inflows, relatively small impoundment and hence relatively short residence time of inflows (~26 days), will operate as a hydro-peaking scheme, with sufficient storage capacity to allow only for daily peaking. In addition, and as described by SP (2018), the proposed BGHES will be used conjunctively with other hydropower schemes (Kariba, Kafue Gorge, Kafue Gorge Lower) to compensate for seasonal variations in energy production.

This *Section* discusses the potential impacts relating to flow and water quality conditions in the river downstream of the proposed BGHES during dam operation and their associated mitigation measures (construction related impacts are discussed in *Section 10.2.8*). The consequent impacts on ecological and social receptors are discussed in detail in *Section 10.3 (Biological Impacts)* and *Chapter 11 (*Social Impacts*)*.

The impacts in this Section are discussed variously in terms of their effects on ecological indicators and water quality conditions, and are discussed in terms of those flow scenarios used in the Environmental Flow Assessment (EFA) discussed below.

Environmental Flow Assessment (EFA)

The DRIFT Decision Support System (DSS) (King *et al.* 2003; Brown *et al.* 2013) was used to assess environmental flow conditions in the Zambezi River downstream of the proposed BGHES, both before and after the impoundment. The method used aims to quantify and assess the impact on the river ecosystem - in terms of both overall ecosystem integrity and change in species richness and abundance - based upon the operation of the proposed BGHES, and to find a balance between minimising environmental impacts and maximising power output during periods of peak demand.

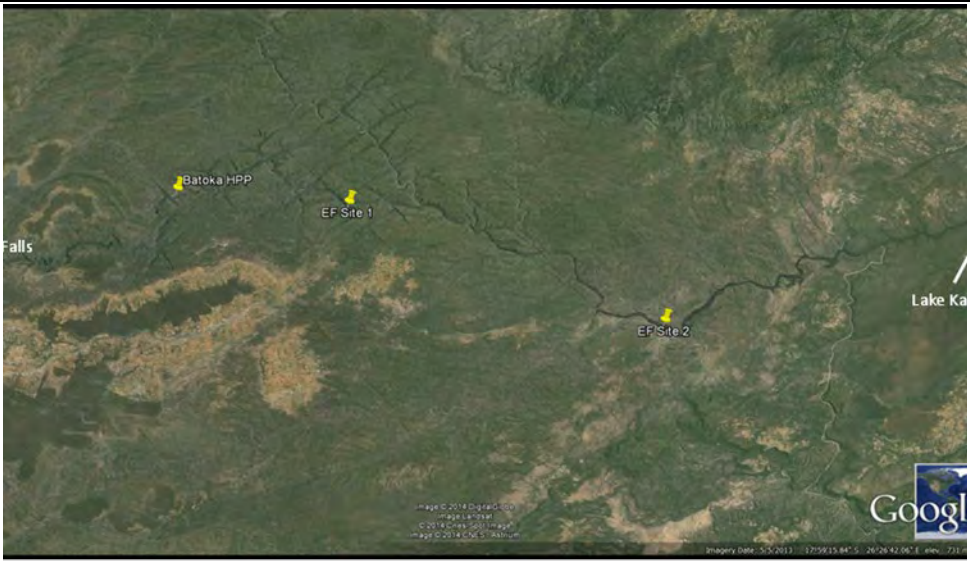
The full BGHES EFA is presented in detail in *Annex J*, which includes a detailed description of the DRIFT assessment tool. The results of the assessment are summarised below.

<u>EFA Site Selection</u>

The EFA concentrated on two sites on the Zambezi River between the proposed BGHES and Kariba Dam (refer to *Figure 10.5*). The sites were selected considering:

- Geo-morphologically different river reaches (see *Section 8.2.6* in *Chapter 8* for a detailed description of geomorphology within the study area);
- Biological variations along the length of the river;
- Different types and levels of impacts likely to be incurred as a result of BGHES placement and operation; and
- Access and safety issues.

Figure 10.5 Location of Downstream EFA Sites



In summary:

- EFA Site 1 represents the Zambezi River within Batoka Gorge. It will be affected by releases from the BGHES tailrace. It will also be affected by the barrier effect of the impoundment, which will have consequences as mentioned above and will also alter the thermal, sediment and physio-chemical regimes along the river downstream of the dam.

- EFA Site 2 represents the Zambezi River between Batoka Gorge and Lake Kariba. It will be affected by releases from the BGHES tailrace and by the barrier effect of the BGHES impoundment and will be used to predict any anticipated recovery of the river ecosystem with distance downstream of the scheme.

Present Ecological Status (PES)

The Present Ecological Status (PES) of the river in the affected reach was determined using the categories shown in *Section 10.2.6* (Kleynhans, 1996) (refer to *Table 10.18*).

Table 10.18 Ecological Status Categories Used for Assessment (Kleynhans, 1996)

Ecological category	Description of the habitat
A	Unmodified. Still in a natural condition.
B	Near natural. A small change in natural habitats and biota has taken place but the ecosystem functions are essentially unchanged.
C	Moderately modified. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.
D	Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
E	Seriously modified. The loss of natural habitat, biota and basic ecosystem

Ecological category	Description of the habitat
	functions is extensive.
F	Critically modified. The system has been critically modified with an almost complete loss of natural habitat and biota. In the worst instances, basic ecosystem functions have been destroyed and the changes are irreversible.

Table 10.19 summarises the PES for the two sites as determined on the basis of the above categories (a more detailed description is provided in the Baseline Ecology Sections of *Chapter 8*). In summary, the overall PES within the study area has been determined as *Category A/B* (i.e. slightly modified from natural conditions).

Table 10.19 Present Ecological Status for Batoka EFA Sites

Discipline	EFA Site 1	EFA Site 2
Hydrology	A/B	B
Geomorphology	A	A
Vegetation	A/B	B
Aquatic macro-invertebrates	A/B	A/B
Fish	A/B	B
Crocodiles	B	B/C
TOTAL	A/B	B

Operational Scenarios Evaluated

The following proposed BGHES operating scenarios were developed for the assessment in line with *Chapter 2* (Project Description) (1) using a range of possible off-peak flow releases provided by Studio Pietrangeli in December 2018 (refer to *Table 10.20*):

QMin Whole year: Daily 6-hour peak at maximum of 1645 m^3s^{-1}, with off-peak releases set at Qmin; no sediment flushing.

QMinB DRY Season (Jul-Jan): Daily 6-hour peak at maximum of 1645 m^3s^{-1}, with off-peak releases set at Qmin; no sediment flushing. WET Season (Feb-Jun): Baseline, i.e., no peaking.

Q05 Whole year: Daily 6-hour peak at maximum of 1645 m^3s^{-1}, with off-peak releases set at Q5%; no sediment flushing.

Q05B DRY Season (Jul-Jan): Daily 6-hour peak at maximum of 1645 m^3s^{-1}, with off-peak releases set at Q5%; no sediment flushing. WET Season: Baseline, i.e., no peaking.

Q10 Whole year: Daily 6-hour peak at maximum of 1645 m^3s^{-1}, with off-peak releases set at Q10%; no sediment flushing.

(1) These scenarios were chosen to represent the full potential range within which the eventual operating regime chosen by ZRA will fall. They do not themselves represent a proposed operating scenario, but instead were used to assess the potential impact of operating the BGHES on downstream river conditions and inform the development and refinement of environmental and social mitigation measures for consideration in the final design.

Q10B DRY Season (Jul-Jan): Daily 6-hour peak at maximum of 1645 m^3s^{-1}, with off-peak releases set at Q10%; no sediment flushing. WET Season: Baseline, i.e., no peaking.

Q20 DRY Season (Jul-Jan): Daily 6-hour peak at maximum of 1645 m^3s^{-1}, with off-peak releases set at Q20%; no sediment flushing. WET Season: Baseline, i.e., no peaking.

Q30 DRY Season (Jul-Jan): Daily 6-hour peak at maximum of 1645 m^3s^{-1}, with off-peak releases set at Q30%; no sediment flushing. WET Season: Baseline, i.e., no peaking.

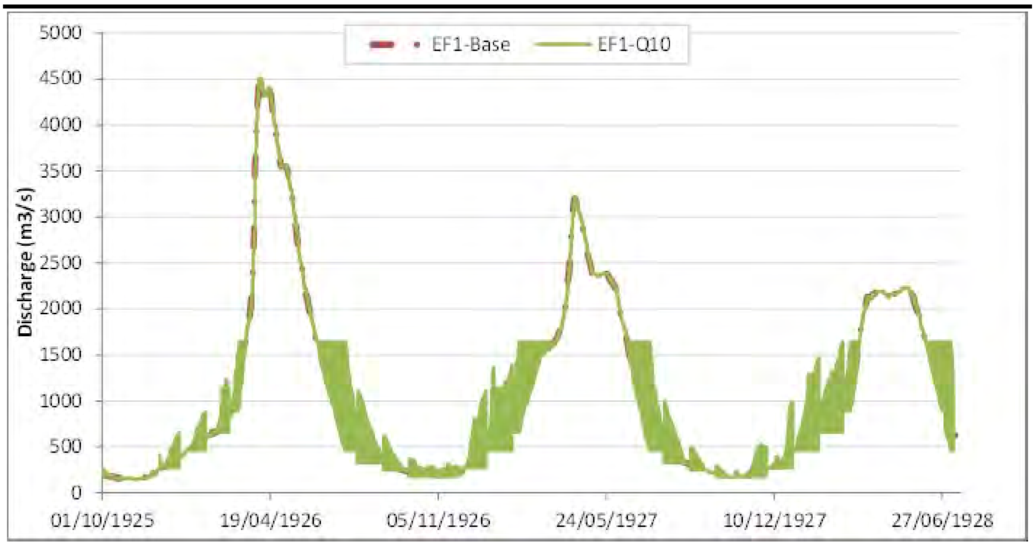
Int Whole year: Daily 6-hour peak at maximum of 1371 m^3s^{-1}; median off-peak release of 297 m^3s^{-1}; no sediment flushing.

Table 10.20 Monthly Percentiles used in Design of Operating Scenarios

	Dry	Wet	Wet	Wet	Wet	Wet	Wet/ Dry[1]	Wet/ Dry[2]	Dry	Dry	Dry	Dry
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Q avg (m^3/s)	660	1130	2112	2958	2545	1585	814	484	345	264	265	404
Q_min (m^3/s)	319	443	602	784	871	447	281	220	161	116	118	199
Q5 (m^3/s)	441	628	861	1122	1089	637	394	294	218	169	162	261
Q10 (m^3/s)	467	666	893	1230	1328	899	468	333	247	179	182	276
Q20 (m^3/s)	503	747	1048	1529	1700	1158	569	370	265	204	207	308

Time series flow data were thereafter developed for input to DRIFT for each of the above scenarios using the full period of flow record at Victoria Falls, from 1924 to 2014. As an example, *Figure 10.6* shows the resulting pattern of flow releases calculated from the BGHES under Scenario Q10 for a sample period from the record. As can be seen, the peak of the flood hydrograph retains its natural shape when the inflows exceed the maximum powerhouse capacity owing to the operation of the dam spillway.

Figure 10.6 Example Pattern of Outflow from Dam (Scenario Q10)



[1] Whether July was treated as dry or wet month depended on the scenario
[2] Whether August was treated as dry or wet month depended on the scenario.

Summary of EFA Results

Using the above hydrological simulations as the input to the model, the DRIFT assessment then used a range of hydrological, hydraulic and biophysical indicators to examine the river's response to the flow and other changes likely to result from the proposed BGHES at the two assessment sites [(1)].

Table 10.21 shows the full range of indicators that were considered for the analysis, and *Figure 10.7* and *Figure 10.8* presents the resulting overall ecological integrity scores for the two sites for each of the reservoir outflow scenarios.

Table 10.21 Indicators used for DRIFT Environmental Flow Assessment

Discipline	Indicator	EFA Site
Hydrological	Mean annual runoff	1 and 2
	Dry/wet season onset	1 and 2
	Dry/wet season minimum 5-day discharge	1 and 2
	Dry/wet season duration	1 and 2
	Dry/wet season average daily volume	1 and 2
	Dry/wet season within day range in discharge	1 and 2
	Dry/wet season maximum instantaneous discharge	1 and 2
	Dry/wet season minimum instantaneous discharge	1 and 2
	Transitional season discharge characteristics (various as above)	1 and 2
Hydraulic	Width/wetted perimeter	1 and 2
	Depth	1 and 2
	Mean velocity (across the cross-section)	1 and 2
Suspended sediments	Dry/wet: Coarse suspended sediment (min, mean, max)	1 and 2
	Dry/wet: Fine suspended sediment (min, mean, max)	1 and 2
Geomorphology	Low mid-channel rock exposures	1 and 2
	Lengths of cut marginal banks	2
	Backwater bed sediment (fine to coarse)	1 and 2
	Area of backwaters and secondary channels	2
	Vegetated mid-channel bars	1 and 2
	Channel bed sediment (fine to coarse)	1 and 2
	Depth of pools	1 and 2
	Sand bars	1 and 2
Vegetation	Single-celled diatoms	1 and 2
	Filamentous green algae	1 and 2
	Bryophyta	1 and 2
	Marginal Graminoids	1 and 2
	Marginal Shrubs	1 and 2
	Lower Trees	1 and 2
	Upper Trees	1 and 2
	Organic detritus	1 and 2
Macroinvertebrates	Species richness	1 and 2
	Ephemeroptera	1 and 2
	Bivalves	2
	Oligoneuridae	1 and 2
	Chironomidae	1 and 2
	Shrimps	2
	Ceratopogonidae	1 and 2
	Simulidae	1 and 2
Fish	Tigerfish, *Hydrocynus vittatus*	1 and 2
	Cornish jack, *Mormyrops anguilloides*	1 and 2

(1) Potential water quality impacts are discussed separately in the next section.

Discipline	Indicator	EFA Site
	Redeye labeo, *Labeo cylindricus*	1 and 2
	Alestids, i.e. *Brycinus imberi, B. lateralis and Micralestes acutidens*	1 and 2
	Cichlids	1 and 2
	Chessa and Nkupe, *Distichodus* spp	2
	Labeo altivelis	2
	Barbus spp.	2
	Vundu, *Heterobranchus longifilis*	1 and 2
	Squeaker, *Synodontis zambezensis*	1 and 2
Crocodiles	Nile Crocodile, *Crocodylus niloticus*	1 and 2

Figure 10.7 Overall Ecosystem Integrity for the Scenarios at EF Site 1

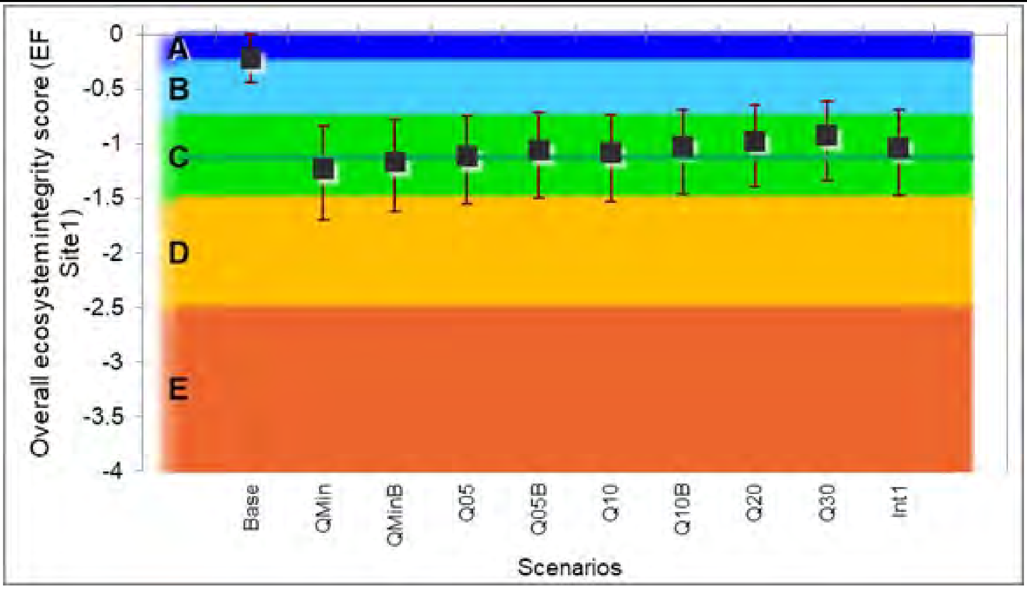
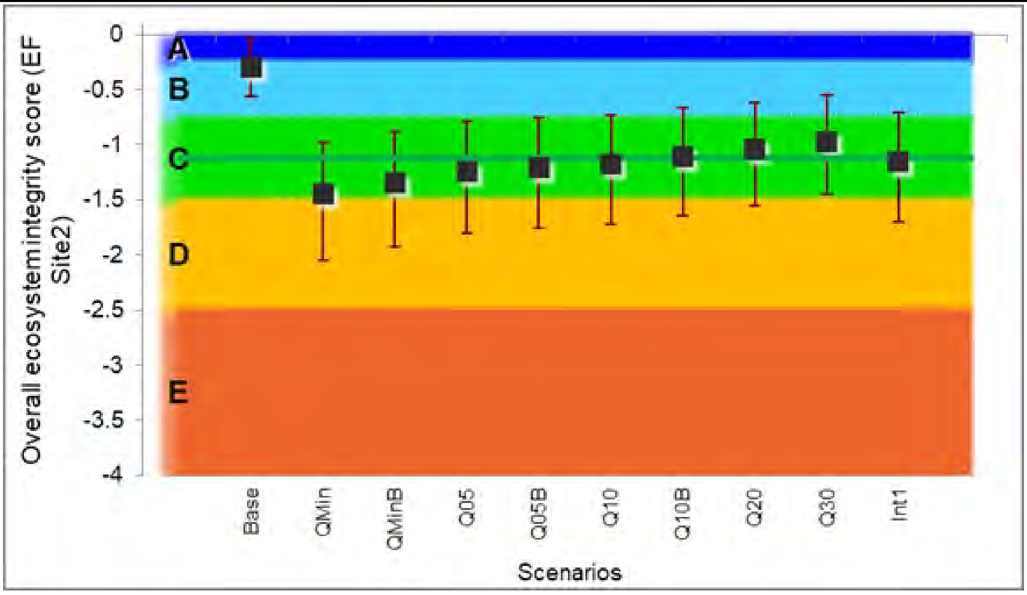


Figure 10.8 Overall Ecosystem Integrity for the Scenarios at EF Site 2



Overall Conclusions from EFA

In summary, the results indicate the following flow-related impacts on the Zambezi River downstream of the BGHES.

- The hydro-peaking operation as modelled is expected to have a moderate impact on the overall condition in the river at both EF1 and EF2 (reducing overall integrity to C), with the higher minimum flow releases resulting in increasingly fewer impacts in overall ecological integrity. Given the slope of the river through Batoka Gorge, it is highly unlikely that these effects will be attenuated to any meaningful extent before they reach Lake Kariba.

- At both EFA 1 and EFA 2, the hydro-peaking operation as modelled is expected to cause a major decrease in the abundance of some of the more sensitive fish species such as Barbel, Cornish Jack and Tigerfish.

Downstream Water Quality

The reservoir eutrophication assessment was described earlier in *Section 10.2.5*. A numerical modelling approach was also used to assess the temperature and dissolved oxygen conditions in the reservoir, and the consequent impact on downstream conditions in the Zambezi River for the different reservoir outlet configurations under consideration for the design. The modelling study is described in detail in *Annex I* and the results are summarised in the following sections.

Model Development

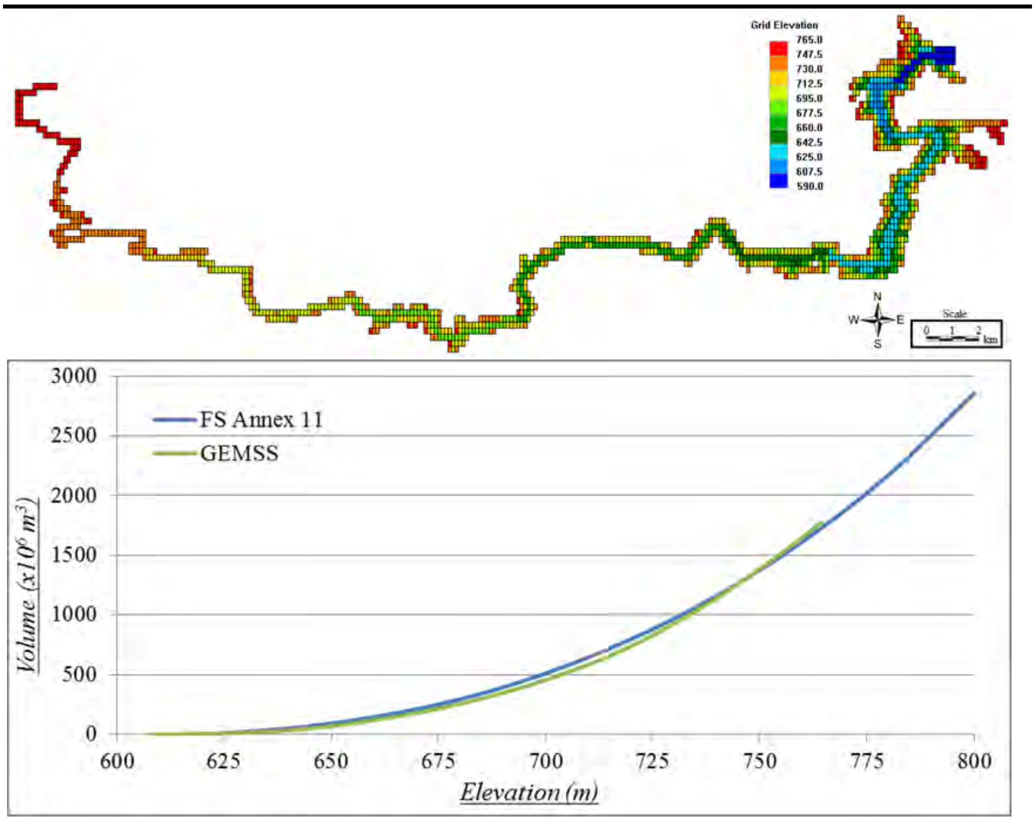
The BGHES reservoir model was developed using the time-varying, 3-dimensional hydrodynamic and water quality model, the Generalized Environmental Modelling System for Surface-waters (GEMSS). The model requires two types of input data:

- *Spatial data* to define the extent and shape of the reservoir and the locations and configuration of the hydropower structures; and

- *Time-varying data* to define inflow rates, temperatures and dissolved oxygen concentrations, outflow rates, and meteorological data to compute surface heat exchange, wind shear and re-aeration.

The former were derived from engineering drawings and data supplied by the project engineers, and were used to construct the basic reservoir model grid as shown in *Figure 10.9.* The storage-elevation characteristics are also shown in the figure in comparison to those presented in Annex 11 of the original 1993 Feasibility Study (BJVC, 1993).

Figure 10.9 GEMSS Model Grid with Storage-Elevation Characteristics



In addition, four alternative designs of the hydropower facilities were provided by the design engineers as detailed in *Table 10.22*. With respect to the parameters of interest for the modelling (spillway and intake levels), the elevations were identical for Alternatives 1 to 3. Accordingly, only Alternatives 1 and 4 were modelled, with results for Alternative 1 representing Alternatives 2 and 3 as well.

Table 10.22 BGHES Intake Design Options

Structure	Level (masl)	
	Alternatives 1, 2 and 3	Alternative 4
Spillway	757.0	757.0
Hydropower intake (centreline)	730.4	651.6
Low level intake (centreline)	619.5	619.5

As for the earlier eutrophication assessment, three different annual inflow hydrographs were selected from the Victoria Falls historical flow record to use for the analysis, as follows:

- 1931 was chosen to represent a median flow year;
- 1957 was chosen to represent an extreme high flow year; and
- 1995 was chosen to represent an extreme low flow year.

The reservoir outflow data for the model were developed for each of three inflow series using the BGHES reservoir operation scenarios as described for the EFA in the previous section.

Finally, the influent water temperature and dissolved oxygen (DO) data were derived from a combination of available river monitoring data (see *Chapter 8*, *Section 8.2.5*) and meteorological data for the study region (e.g. for atmospheric heating and cooling rates).

Summary of WQ Modelling Results

Figure 10.10 and *Figure 10.11* present the simulated time-series of temperature and DO at the BGHES reservoir outlet under the three different inflow conditions described above (1). As described earlier, Alternative 4 represents the lower hydropower outlet configuration.

(1) The results are shown for operational scenario 3d. However, as shown in *Annex I*, there was little variation between the results for all operational scenarios evaluated.

Figure 10.10 Simulated Reservoir Outflow Temperature

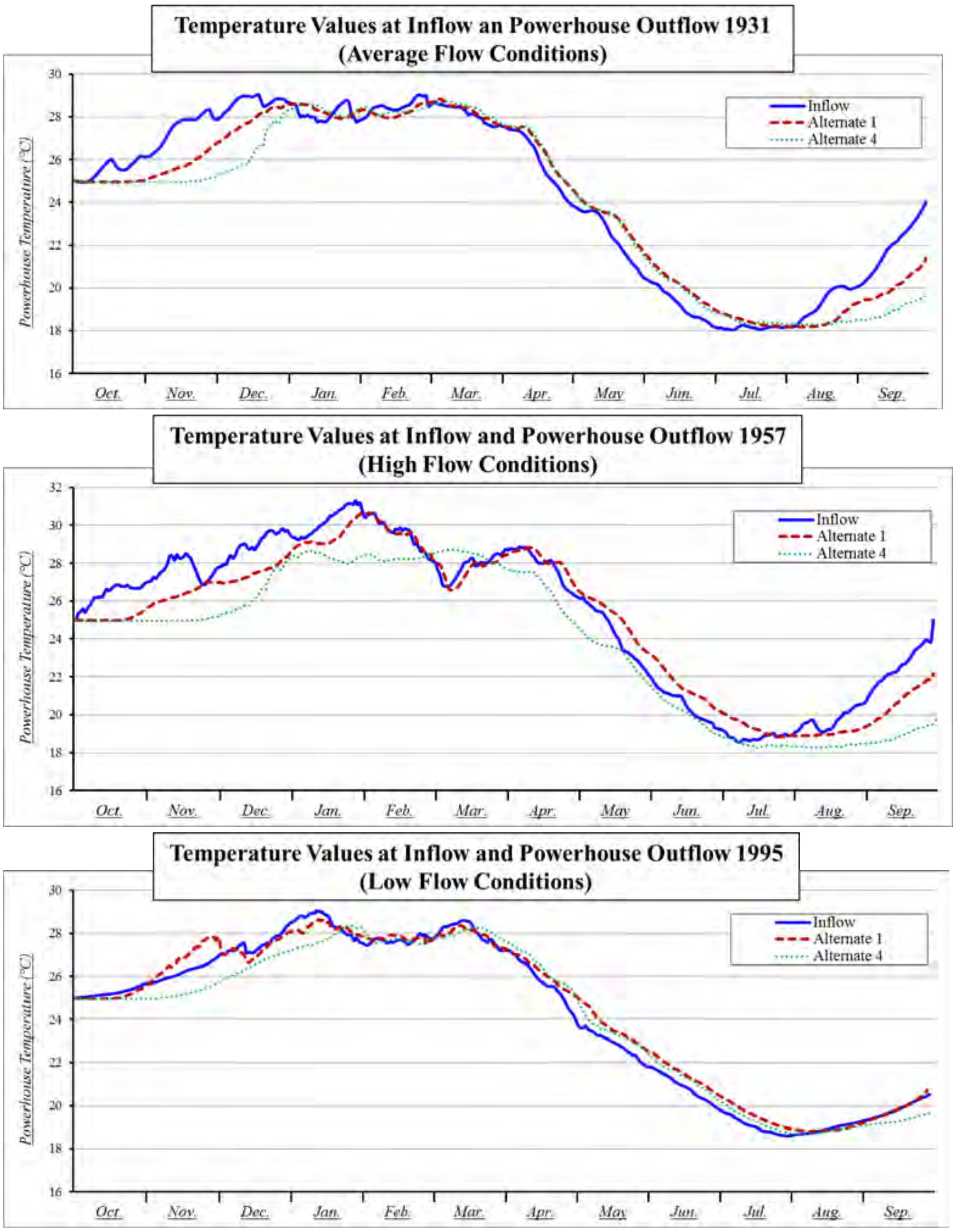
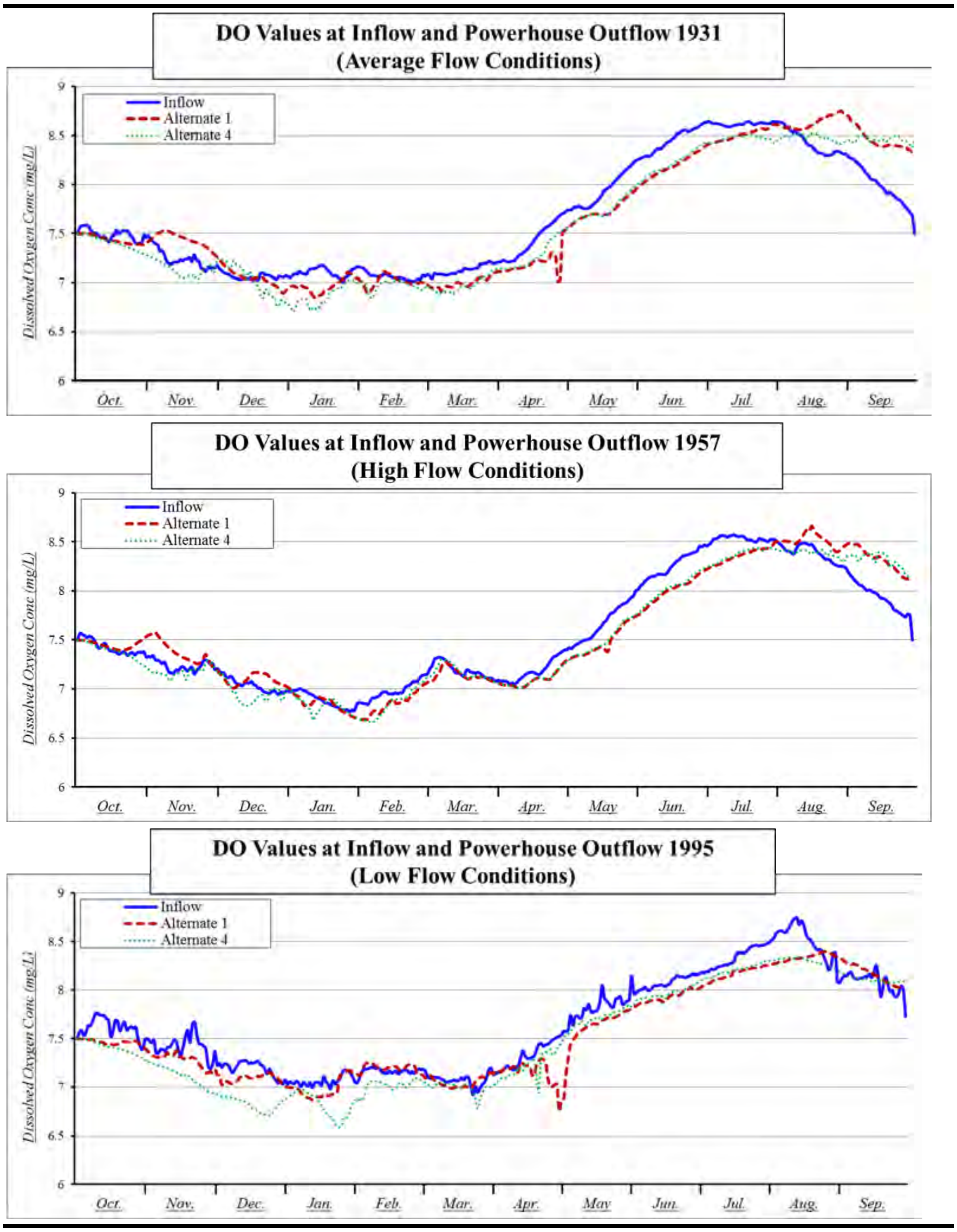


Figure 10.11 Simulated Reservoir Outflow Dissolved Oxygen (DO)



Water quality conditions further downstream were thereafter calculated based upon estimated surface heat exchange conditions and re-aeration coefficients for the river. These calculations suggest that at times of low flow (i.e. when the reservoir becomes stratified and outflow temperatures and DO values are lower than natural river values) there will be limited recovery of temperature and DO conditions between the BGHES dam and EFA site 2 some 60 km downstream (see earlier) owing to the surface area constraints introduced by the gorge and the fast flow of the river.

Potential Gas Super-Saturation (Below Spillway)

In addition to the downstream effects associated with reservoir water quality, there is also a potential issue of gas super-saturation below the spillway, i.e. the entrainment of atmospheric gases in the water due to the high pressures generated as the flow plunges into the river below. The elevated gas concentrations, particularly nitrogen that may result can be extremely harmful to fish and potentially lead to fish kills (due to so-called 'gas bubble disease').

Research has shown that these super-saturation effects are extremely difficult – if not impossible – to predict since they depend *inter alia* on very precise temperature, hydraulic and turbulent flow conditions in the plunge pool and downstream river, which can vary significantly over time and between different locations. They can also vary between different fish species in the same location owing to both the intrinsic tolerance of the fish and their adaptive behaviours.

Most of the research that has been conducted to date has been for rivers in the northern hemisphere, and so it is difficult to draw parallels to the BGHES situation. However, it is worth noting that the current fish populations in the Project area have adapted to survive in the river reaches below the Victoria Falls, where super-saturation effects would be extreme. Moreover, the proposed Project design already includes a spillway deflector whereby the some of the flow energy is dissipated before discharge to the downstream river, thereby reducing gas entrainment and the likelihood of super-saturation occurring for any significant distance downstream.

Overall Conclusions from Water Quality Assessment

In broad terms, the results show that the reservoir becomes stratified under low inflow conditions, and as a result, the outflow from the lower intake (Alternative 4) is a few degrees cooler for a period of a few months at the beginning of the hydrological year. However, under average and high flow conditions (December onwards) the reservoir becomes vertically mixed as larger inflows are passed through the powerhouse. The vertically mixed condition causes outflow temperatures to be relatively similar for the different intake levels and to natural river conditions. As shown in *Annex I*, these effects do not significantly change for the different operational scenarios considered, i.e. with different peaking and minimum outflow requirements.

A similar effect is evident for DO, whereby there is a small lag between natural and reservoir conditions due to the pattern of stratification in the reservoir as inflows begin to rise. However, there is negligible difference between the two intake configurations for these impacts.

The corresponding impact of these effects on the downstream riverine ecology is discussed in detail in *Section 10.3 (*Ecology*)*. In broad terms, it is concluded that the 3 to 5^0C temperature differential that is induced by the lower intake option (Alternative 4) in September, i.e. before the onset of the flood season, could result in the proliferation of generalist macro-invertebrate taxa at the expense of more sensitive species, which could impact on species richness. It could also delay the spawning of certain cichlid fish species, including tigerfish. However, the impacts relating to the predicted DO effects are not considered to be significant in ecological terms since they lie within the normal range of the river.

Finally, with regard to the potential occurrence and effects of super-saturation on fish populations downstream of the dam spillway, these would need actual performance data during spillway operation to properly understand since there is no reliable predictive mechanism to evaluate them. Such data would necessarily include gas saturation data upstream and downstream of the spillway, in addition to the monitoring of fish sensitivity and behavioural responses. However, it should be noted that the proposed Project design already includes a spillway deflector that should help to reduce the likelihood of super-saturation occurring for any significant distance downstream, and current fish populations in the Project area have adapted to survive in the river reaches below the Victoria Falls, where super-saturation effects would be extreme. It is therefore unlikely that this would be a significant project impact.

Other Downstream Water Users

The previous discussions have focused primarily on impacts to ecological receptors. However, the downstream flow and water quality effects from the Project could also affect other socio-economic water users in the river reach between the dam and Lake Kariba (1). In particular these include the licensed river water abstractions discussed in *Chapter 9*, *Section 9.7.4*, but in addition to these are the more occasional water uses such as for livestock watering, flood recession-based agriculture, rafting and fishing. Further details of the various formal and informal water users that are located downstream of the dam site are presented in the socio-economic baseline description in *Section 9.7.3* (for Zambia) and *Section 9.7.4* (for Zimbabwe).

In terms of formal water abstractions, under 'hydro-peaking' operations at the BGHES dam, and additionally during the initial period of post construction dam filling, the flow in the river would periodically drop to a regulated minimum flow condition that could theoretically 'strand' pumping equipment if river levels fall below the pump intake. This is an unlikely occurrence since existing pumps are likely to be designed to draw water under dry season flow conditions in the river; however, this would need to be confirmed on a case-by-case basis. The mitigation measures discussed below therefore allow for a detailed survey of pumping installations during final design, and assistance to pump owners to modify their equipment where necessary.

(1) As discussed elsewhere in this report, the present ESIA has not considered or assessed any changes to the operation of the Kariba Dam following the construction of the BGHES since these are not foreseen within the scope of the Project. However, there will be consequences further downstream if Kariba is operated differently in future as a result of the presence of BGHES. The impacts of any such changes on the Zambezi River downstream of Kariba Dam would need to be the subject of future study.

With regards to potential impacts on other river users, the effects on riverine fisheries were addressed in the previous discussions about ecological receptors.

Moreover, as described earlier, due to the relatively small storage volume behind the BGHES dam, the peak flood hydrographs each year are unlikely to be significantly modified such that any flood recession based agriculture that may take place in the broader river valley that lies between the Lower Gorge and Lake Kariba should still be feasible after the Project has been constructed (though there may be an interruption during reservoir filling when floods are impounded behind the dam and floodplain nutrients are not replenished).

However, the effects on river users such as rafters, fishermen and those watering their livestock or bathing in pools and riffles alongside the main channel (e.g. in the Deka confluence area) could be significant if rapid changes in water level occur that are associated with future 'hydro-peaking' operations at the dam. These 'ramping' operations may occur several times during the day if morning and evening hydro-peaking takes place, particularly during the dry season, and could present a health and safety risk for river users if the water level rises are rapid and unannounced. Such effects could also lead to fish strandings in some of the broader, more braided river sections of the river downstream of the Lower Gorge.

Finally, in terms of potential effects within Lake Kariba itself, given the relative storage volumes of the two reservoirs (approximately 185 km^3 for Kariba, and less than 2 km^3 for the BGHES), it is extremely unlikely that the Project would have any noticeable regulating effect on storage volumes or water levels in Lake Kariba (assuming that operating conditions for Kariba remain unchanged as discussed earlier). Therefore, there is unlikely to be any impact on direct water abstractions from the main body of the lake, and likewise on lake fisheries. This issue is considered further in *Section 10.3 (*Ecology*)*.

Significance of Impact (Pre-Mitigation)

Based on the analysis provided above, it is assessed that the impact relating to flow and water quality conditions in the river downstream of the BGHES during dam operation will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 10.23*). This is based upon the high ecological value of the river sections through the Lower Gorge and the presence of other water users further downstream, combined with the potential magnitude of flow and water quality (sediment and temperature) related effects associated with dam operation, particularly under hydro-peaking operations.

Table 10.23 Rating of Impacts Related to Downstream River Conditions (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact will be confined to the river reach between the dam site and Lake Kariba, but may affect users on both sides of the border.
Duration	Permanent	The impact will be permanent so long as the dam remains in operation, although may be more significant in early years during reservoir filling.
Scale	70-80 km	Approximate length of river affected (BGHES site to Lake Kariba).
Frequency	Periodic	Significance will vary depending on seasonal flood conditions in the river (effects generally more pronounced during dry season), but will occur throughout year.
Likelihood	Likely	The impact is a direct consequence of the BGHES impoundment.
Magnitude		
Medium Magnitude		
Sensitivity/Importance of the Resource/Receptor		
High Sensitivity		
The present ecological status of the downstream river is high (largely unmodified natural habitat) for a significant length through the gorge, and there are also important water users further downstream closer to Lake Kariba.		
Impact Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation/ Management Measures

Based upon the results of the above assessment, the environmental and engineering criteria listed in *Table 10.24* were established as a basis for selecting mitigation options to minimise the impact of BGHES on the downstream river ecosystem whilst limiting the impact on power production.

Table 10.24 Agreed Environmental and Engineering Criteria for Selecting Mitigation Options

Type	Criteria
Environmental criteria	No more than a 1.5 class drop in Overall Ecosystem Condition in the downstream river, i.e., from A/B to no less than a mid-C category. This represents a drop in ecological category from "near natural" to "moderately modified", which is still considered a healthy functioning ecosystem.
	No more than a 25% reduction in abundance for 90% of the fish species.
Engineering criteria	Minimum constraints on power generation in the wet season (when flows are lower than Q20).
	Peak discharges cannot exceed 75% of design peak flows, with Kariba to compensate for this gap.
	No constraints in the wet seasons, unless it is a low flow year in which case ramping up to reduced peak with Kariba compensating.
	Dry seasons Q20 with some minor modifications.

Additional operating scenarios were then developed and input into DRIFT, and the outcomes of impacts on downstream river ecosystem and specific issues relating to hydropower production assessed by SP, ERM and Southern Waters at a collaborative workshop convened at ERM's offices in Johannesburg with ZRA in attendance.

The predicted impacts on the downstream river ecosystem for the sets of scenarios tested as part of this process are presented in detail in Appendix A of the EFA report (attached as *Annex J*).

Figure 10.12 and *Figure 10.13* illustrate the predicted impacts on overall ecological integrity of the river downstream of the proposed BGHES.

Figure 10.12 Overall Ecosystem Integrity for Additional Scenarios at EF Site 1

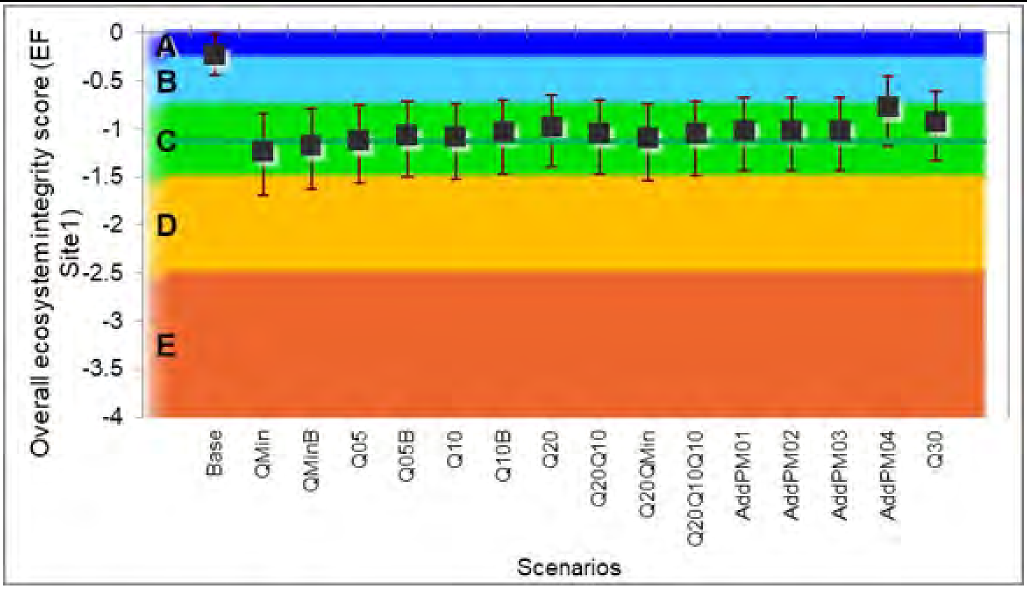
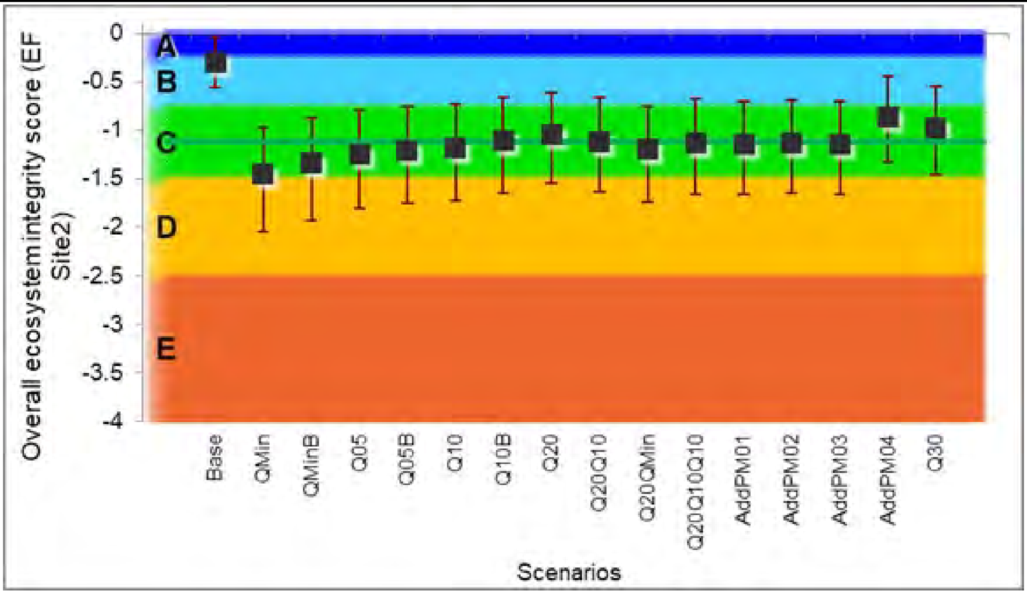


Figure 10.13 Overall Ecosystem Integrity for Additional Scenarios at EF Site 2



Of the scenarios tested three: AddPM01, AddPM02 and Add PM03 achieved the engineering criteria and met the criterion of no more than a 1.5 class drop in Overall Ecosystem Condition in the downstream river, i.e., from A/B to no less than a mid-C category, at both EF sites.

AddPM01[1]	DRY Season (**Sep-Jan**): Two 3 hour peaks a day, at maximum of 1.5 x the off-peak flows when Q is between Q10 and Q30; run of river when Q<Q10; peaking ramped up to the maximum; off-peak minimum set at Q10%; no sediment flushing. WET Season (**Feb-Aug**): Two 3 hour peaks a day, at maximum of 1.75 x the off-peak flows when Q is < Q10; peaking ramped up to the maximum; off-peak releases set at Q10%; no sediment flushing.
AddPM02	DRY Season (**Sep-Jan**): Two 3 hour peaks a day with no constraints when Q > Q30; run of river when Q<Q30; peaking ramped up to the maximum; no sediment flushing. WET Season (**Feb-Aug**): As for AddPM01.
AddPM03	DRY Season (**Sep-Jan**): Two 3 hour peaks a day, at maximum of 1.5 x the off-peak flows when Q is between Q10 and Q30; run of river when Q<Q10; peaking ramped up to the maximum; off-peak minimum set at Q20%; no sediment flushing. WET Season (**Feb-Aug**): As for AddPM01.

Only one of the scenarios tested, AddPM04, matched the engineering criteria and met both of the environmental criteria of no more than a 1.5 drop in overall ecosystem integrity and no more than a 25% reduction in abundance for 90% of the fish species represented in the DRIFT model.

AddPM04	DRY Season (**Sep-Jan**): Baseline flows; no sediment flushing. WET Season (**Feb-Aug**): QMin with one 6-hour peak a day.

- As a consequence, it was agreed to by the ZRA that the proposed BGHES will only operated as a hydro-peaking scheme during the wet season (Feb-Aug) in accordance with the operating rules established by scenario AddPM04.

- Based upon the results of the EFA, it was further agreed to by the ZRA that an off peak flow condition during the wet season of QMin as per the flow statistics in *Table 10.20* will be adopted.

- Minimum flow release conditions will still be required during the period of initial reservoir filling following construction. Based upon the results of the EFA, the ZRA have agreed that if flows are above the monthly 20th percentile values the surplus will be stored, and the remaining volume of water is released with no peaking or sediment flushing during the period of initial filling.

[1] AddPM for: Additional Scenarios, Post Meeting.

- It was further agreed to by the ZRA that there is gradual (smoothed) transition between wet and dry season minimum flow conditions, using the excess inflow volumes during off-peak hours in the wet season months (i.e. beyond what is needed to replenish the reservoir to FSL each day) to progressively increase minimum flow releases from the reservoir between February and April (i.e. until the peak floods occur and the spillway is fully operational), and thereafter reduce them between May and July.

- Moreover, during hydro-peaking itself, the rate of change of flow releases (the so-called 'ramping rate') will be restricted such that there is a correspondingly gradual change in downstream water levels. The precise rate of change that is achievable for the BGHES will be determined during detailed design, and will be dependent on a number of factors including design considerations and equipment specifications. Based upon the flow-rating curve previously shown (which is representative of river conditions within the gorge), a maximum ramping rate (MRR) of around 250-300 m^3/hour would equate to a change in river level of approximately 1 m/hour (1), which should be gradual enough for river users to respond to.

- The final MRR applied will also be accompanied by the development and routine dissemination to all downstream river users of a 'Dam Flow Release Schedule' that will detail the timing and predicted magnitude of flow and water level effects at various strategic points downstream of the dam. An early warning system will also be considered, particularly for any non-routine flood releases.

In addition to the above operational procedures, the following will also be adopted.

- A detailed survey will be carried out during Project design of pumping station intake levels for the licensed abstractions that occur between the proposed BGHES and the headwaters of Lake Kariba (see *Chapter 8*, *Section 8.2.4*). In the event that these levels fall below the predicted water level corresponding to the final chosen minimum flow condition, compensation (financial or in-kind) will be considered for abstractors to modify their pumping stations accordingly (2).

- In terms of dam outlet configurations, there is a marginal improvement in downstream temperature effects from the higher elevation powerhouse intake level associated with Alternatives 1 to 3. As discussed, this temperature effect does have some significance in ecological terms, and so higher intake level will be selected for final Project design purposes. However, we do not consider that the mitigation of this effect through such

(1) This is within the gorge itself; the rate of change in the wider river valley downstream of the Lower Gorge would be considerably less.
(2) The recommended minimum flow is based on long-term average flows in October/November, and so assuming that most abstractions are year-round it is unlikely that any will be affected in this way.

a design change would be sufficient to change the overall significance of residual downstream impacts as described in the next section.

- With regard to the potential for gas super-saturation downstream of the spillway, Total Dissolved Gas (TDG) concentrations will be monitored on at least a daily basis during spillway operation, both upstream and downstream of the spillway and for a distance of one or two kilometres downstream (to evaluate the dissipation curve), in parallel with systematic programme of fish and fish behaviour monitoring (refer to *Section 10.3 (*Ecology*))*. Based upon the results of this monitoring, an adaptive mitigation strategy will be considered that will include a combination of operational measures, such as reducing spill rates (e.g. extending flood discharge time by reducing water levels in advance of peak) and alternative energy dissipation methods (surface or sub-surface).

Residual Impact

Based on the implementation of the proposed mitigation measures, it is assessed that the impact relating to flow and water quality conditions in the river downstream of the proposed BGHES during dam operation will be a "**Moderate to Major Negative Impact**" post mitigation, depending on the final choice of operating procedures for the dam (refer to *Table 10.25*).

Table 10.25 Rating of Residual Impact Related to Downstream River Conditions (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact will be confined to the river reach between the dam site and Lake Kariba, but may affect users on both sides of the border.
Duration	Permanent	The impact will be permanent so long as the dam remains in operation, although may be more significant in early years during reservoir filling.
Scale	70-80 km	Approximate length of river affected (BGHES site to Lake Kariba).
Frequency	Periodic	Significance will vary depending on seasonal flood conditions in the river (effects generally more pronounced during dry season), but will occur throughout year.
Likelihood	Likely	The impact is a direct consequence of the BGHES impoundment.
Magnitude		
Small Magnitude (hydro-peaking in the wet season only, meeting both sets of environmental criteria to minimise impact on downstream river condition); Moderate Magnitude (hydropeaking in the wet season and the dry season, meeting only one of the required environmental criteria)		
Impact Significance Rating After Mitigation		
Moderate (run-of-river dry season)/Major (hydro-peaking in wet and dry seasons) Negative Impact		

10.2.7 *Impacts on BGHES Related to Changing Upstream Conditions*

The BGHES design process is supported by a long-term historical flow record on the Zambezi River at Victoria Falls in excess of 100 years. Under normal circumstances such a long hydrological record would give a very high degree of confidence in the estimated power generation capacity of the scheme. However, recent studies have suggested that future climate change may significantly affect the patterns and volumes of runoff from the Upper Zambezi catchment such that using the historical record alone may overestimate the future runoff potential from the catchment. Moreover, there are some major water transfer schemes being planned for the river basin that may also deplete the resource that is available for power generation at Batoka in future years. In addition to their potential impacts on the Project itself, these effects may have indirect consequences for downstream river users if the operational regime at the dam is affected.

Potential Climate Change Effects

Annex H presents the results of a climate change risk-review that was carried out for the BGHES based upon the most recent publically available reports and scientific papers for the Project area, as well as an analysis of downscaled climate data for the catchment. The latter is based on the 'multi-model mean' of the CMIP5 program used by the *5th Assessment of the Intergovernmental Panel on Climate Change* (IPCC, 2013) using the 'business as usual' greenhouse gas (GHG) emission scenario (called RCP8.5).

The results of the analysis indicate that the basin yield from the Batoka catchment could fall by between 0.9% and 3.5% per decade in the next 40 to 50 years, with a best estimate of 1.7% (1). This is driven largely by a predicted decline in precipitation in the river basin (coupled with increased temperature and evaporation losses). Moreover, the analysis also predicts a shortening of the rainfall season, including a reduction in rainfall during the peak months and a consequent delay in the onset of the peak flood season each year.

Other potential impacts of climate change on the Project could include an increase in extreme flood peaks due to higher rainfall intensities in the upper catchment, and an associated enhanced sediment runoff from the river basin into the reservoir. However, none of the literature reviewed for the study has specifically predicted or quantified these effects for the Upper Zambezi, and it is likely that they would be significantly dampened by the regulating effect of the Barotse Plain and Chobe Swamps that drain the main sub-basins in the upper catchment.

Having an installed power of 2,400MW, according to SP (2018) around 23% of the flows would be lost for spillages during the wet season. The reduction of

(1) It should also be noted that some earlier studies (eg Harrison and Whittington, 2002; World Bank, 2009; Beilfuss, 2012) have suggested that higher reductions in basin yield may occur, eg the World Bank study estimates a 16% reduction in yield by 2030. Some of these estimates though are based upon earlier global climate model projections and data.

peak flows, caused by climate change, during the wet season would therefore reduce these spilled flows, not affecting the power production. As such, and according to SP (2018), even adopting the worst case scenario for climate change, the reduction of energy production, and hence the feasibility of the scheme, during the operational life of the plant would be small (a few percentage points only) and would not alter the findings of the optimum installed power analysis.

Impacts from Upstream Abstractions

As discussed in *Chapter 8*, *Section 8.2.4*, it is estimated that if all of the currently identified irrigated agriculture projects in the Upper Zambezi were to be developed in the coming years, there would be an approximate 0.2% reduction in annual flows at Victoria Falls. It is also estimated that this figure would rise to 1.4% if the full agricultural development potential of the upper catchment was exploited in the longer term, although this is unlikely to occur within the projected lifetime of the Project.

In addition to future agricultural water demand, Botswana currently has rights to abstract some 495 million m^3 per year of water from the river (approximately 1.5% of the average runoff at Victoria Falls) under the *Chobe-Zambezi Water Transfer Scheme*, and is currently in the process of constructing the first stage that will abstract approximately 350 million m^3 for use in the Pandamatenga area. The combined effect of all of these abstractions could therefore be a reduction in basin yield at Victoria Falls of between 1.3% and 2.9%, with a figure closer to the lower estimate much more likely in the short to medium term.

Conclusions

Based upon the best estimates discussed above, the combination of increased upstream abstractions and the potential reduction in yield due to future climate change could lead to a reduction of 5-6% in the average annual runoff at Victoria Falls in the next 20-30 years, although in the worst-case scenario it could be as high as 10% or more. Moreover, superimposed on this is the long-term cyclical pattern of 15-20 year droughts that has been observed in the Upper Zambezi flow record over the last century (see *Chapter 8*, *Section 8.2.4*). The data series suggests that a period of drought may begin again in the next 15-20 years, lasting for a similar period of time.

The combination of these effects could be a gradual reduction in power generation capacity at Batoka over the next 20-30 years, with the shortfall potentially most noticeable in the late dry and early wet season due to a later onset of flooding due to climate change. Although other schemes such as Kariba, with a larger storage capacity than the proposed BGHES are designed to make up for a drop in the generation potential of the BGHES during the dry season, climate change, through a reduction in spills in the wet season could in turn have implications for downstream river conditions in the event that the dam operating procedures are subsequently modified to offset any future reduction in inflows, for example by reducing the environmental flow release requirements.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact relating to changes in upstream conditions due to the combined effects of climate change and future abstractions will be a "**Moderate Negative Impact**" pre-mitigation (refer to *Table 10.26*). This is based upon the potential for future modification of the environmental flow regime in response, and the high ecological value of the downstream river sections through the Lower Gorge and the presence of other water users further downstream.

Table 10.26 Rating of Impacts Related to Changing Upstream Conditions (Pre-Mitigation)

Type of Impact		
Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The direct impacts would occur to power generation at the dam, although indirectly these could extend downstream to Lake Kariba if dam releases are modified in response.
Duration	Permanent	The impact will be permanent so long as the dam remains in operation.
Scale	70-80 km	Approximate length of river affected (Batoka site to Lake Kariba).
Frequency	Seasonal	The power generation capacity could be affected year-round, although would likely be most affected in the late dry/early wet season, owing to the delayed onset of peak flood conditions in the catchment.
Likelihood	Possible	The impacts are related to predictions concerning climate change and future agricultural development in the basin.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity / Importance		
The present ecological status of the downstream river is high (largely unmodified natural habitat) for a significant length through the gorge, and there are also important water users further downstream closer to Lake Kariba that may be affected by any change in releases.		
Impact Significance Rating Before Mitigation		
Moderate Negative Impact		

Mitigation/Management Measures

The most effective mitigation against the potential reduction in river basin yield at Batoka in the next 20 to 30 years will be to factor this into the design of the Project itself and thus ensure its future sustainability. That is, to adjust the hydrological inflow series used in the power generation model for the scheme to take account of a potential reduction in yield over time, taking into account the gradual effects of climate change, and the potential 'step' changes as the various phases of the *Chobe-Zambezi Water Transfer Scheme* are constructed. The estimated rates for this decline in yield were presented earlier, but these will need to be verified at the time of detailed Project design based upon the latest climate science. Overall, the aim would be to design the scheme based upon the best estimates for future scenarios, but test its sensitivity to worst-case scenarios. Moreover, the hydrological calculations that are undertaken for dam spillway design will also be tested and verified against the potential effects of increased future rainfall intensities in the Upper Zambezi due to future climate change.

The hydrological inflow series that is applied to the power generation model will also be adjusted to match the long-term periodic drought cycle that is observed in the historical record at Victoria Falls. That is, the simulated inflow series used for the model to predict power generation in future years will include a drought period that is timed to be coincident with that estimated from the record.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, it is assessed that the impact relating to changes in upstream conditions due to the combined effects of climate change and future abstractions will be a "**Minor Negative Impact**" post mitigation (refer to *Table 10.27*).

Table 10.27 Rating of Residual Impact Related to Changing Upstream Conditions (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The direct impacts would occur to power generation at the dam, although indirectly these could extend downstream to Lake Kariba if dam releases are modified in response.
Duration	Permanent	The impact will be permanent so long as the dam remains in operation.
Scale	70-80 km	Approximate length of river affected (Batoka site to Lake Kariba).
Frequency	Seasonal	Assuming that the potential effects are effectively factored into the Project design there should be little or no knock-on effects downstream.
Likelihood	Possible	The impacts are related to predictions concerning climate change and future agricultural development in the basin.
Magnitude		
Negligible Magnitude		
Impact Significance Rating After Mitigation		
Minor Negative Impact		

10.2.8 Construction Related Impacts on Soil and Water Resources

There will be a range of potential impacts on water and soil resources arising from the construction activities associated with the proposed BGHES. These include both impacts on the Zambezi River itself from works associated with constructing the dam wall, and also more localised impacts on water quality, water supplies, drainage and soil conditions associated with the construction of access roads, power houses, transmission lines and other ancillary facilities such as quarries, staff townships, etc.

The precise construction details and locations of some facilities are not yet finalised, and for such a large infrastructure project there will be a myriad of construction sites. The following sections therefore provide a more generic description of the various construction activities and their potential impacts. These impacts will be mitigated through standard good practice construction management practices, which are outlined in this *Section* and presented in detail in the construction Environmental and Social Management Plan that accompanies this report.

Pollution Related Impacts

Both surface water and groundwater resources will be at risk during construction activities from pollution by accidental spillage of fuels and lubricants, soil disturbance and sediment runoff, or from the inadequate or unsafe disposal of sanitary wastewater from the staff townships and other associated facilities. These effects would generally be localised, although they could extend further afield if pollutant pathways reach the main river and contaminants are carried downstream. This is a particular risk for construction activities associated with the main dam structure itself.

Materials such as oil, diesel fuel, concrete additives, and solvents are likely to be stored and used at the various active construction sites and laydown areas and in construction traffic and equipment. Storage and handling of these materials could lead to spills on site or along access roads, and contaminated run-off from spillage sites could adversely affect soils, vegetation and receiving waters. The significance of impact will depend on the size, frequency and timing of spills in relation to rainfall events and flow conditions in the receiving waters etc., and the nature of the materials involved. The risk of water pollution can be significantly reduced by adopting protective measures to prevent spills occurring and putting in place accidental spill response plans and procedures. Suitable measures to collect treat and dispose of chemical wastes will also be required.

Activities associated with earthworks, clearance of vegetation, operation of large equipment and equipment laydown etc. can lead to significant soil disturbance, resulting in soil erosion and/or compaction, degradation of affected areas and pollution of receiving watercourses. The construction activities may also destabilise soils and channel banks, or leave exposed materials adjacent to watercourses, which may subsequently erode during heavy rainfall and lead to sedimentation in downstream water bodies. In addition, road improvements will require stream crossings and increase impervious surface areas, thereby enhancing runoff rates and soil erosion potential. However, the risks of soil erosion can be significantly reduced by the adoption of good construction site management practices.

Finally, inappropriate disposal of waste and wastewater from staff townships and active construction sites could also have negative effects on water quality. The significance of these impacts will depend on the location of discharge points and the assimilative capacity of the receiving waters; however, they could include a reduction in dissolved oxygen levels, nutrient loading causing increased algal growth, and the spread of pathogenic disease vectors. Again, these impacts can all be mitigated by adequate provision for on-site sanitation and wastewater treatment during construction.

Impacts on Local Water Supplies

Significant quantities of water are likely to be needed during the construction process to mix concrete and to wash down roads and equipment as part of dust control and cleaning, etc. It is proposed that water requirements will be drawn directly from the main river, and the volumes of water abstracted are likely to be insignificant in comparison to the overall flow. However, there may also be pressure at times to utilise local watercourses or supplies, in which case the abstractions may form a significant proportion of the resource. In such cases, direct surface water abstraction should be avoided and construction water should be tankered to site.

Impacts to community groundwater supplies may occur if dewatering is carried out as part of foundation construction. These impacts can be avoided by regular monitoring of selected wells to assess whether impacts are occurring.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact on soil and water resources relating to construction works will be a "**Moderate Negative Impact**" pre-mitigation (refer to *Table 10.28*).

Table 10.28 Rating of Impacts Related to Construction Works (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Localised	It is unlikely that the impacts would extend beyond the immediate vicinity of the construction site or spillage location.
Duration	Temporary	The risks would be present so long as construction continues.
Scale	Construction area	The impacts could occur at any or all of the various construction sites and along their access routes.
Frequency	Occasional	The impacts are primarily risk-related, although for such a large construction project it is inevitable that some will occur.
Likelihood	Possible	As above.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity / Importance		
A significant amount of the construction activities are taking place in or close to protected and valuable ecological habitat, and there are also a number of communities in close proximity to the access roads, transmission line servitudes and ancillary infrastructure sites.		

Impact Significance Rating Before Mitigation
Moderate Negative Impact

Mitigation/Management Measures

The potential contamination and/or erosion risks from construction related activities can be mitigated by standard construction management good practices. This will include:

- Regular checking and maintenance of all plant and machinery to minimise the risk of fuel or lubricant leakages;
- Dedicated, lined and bunded storage areas for all fuel, oil or chemical stockpiles, that are situated at a safe distance (preferably more than 100 m) from any surface water features or groundwater springs or wells;
- Training and equipping relevant staff in safe storage and handling practices, and rapid spill response and clean-up techniques;
- Minimal or total avoidance of soil disturbance close to watercourses (preferably establishing a 10 m buffer zone, or 50 m for main rivers, and leaving existing vegetation in place), and no stockpiling of waste or fill materials close to or within channels or community water supplies;
- Effective construction site drainage measures, utilising cut-off drains (to divert surface runoff from exposed soils or construction areas), oil interceptors and silt traps to manage and retain sediments on site;
- Leaving vegetation *in-situ* wherever possible, and re-vegetation of bare soils before the next rainy season; and
- The provision and maintenance of adequate on-site sanitation facilities. This will include temporary chemical toilets, which will be located in strategic locations near active work sites and sited away from any water bodies or wetlands. One toilet should be provided on site for every 15 contract personnel at each active working area. These toilets will have doors and locks and will be secured to prevent them blowing over. Temporary toilets will be emptied on a regular schedule. Emptied waste will be transported and disposed of at the BGHES sewage treatment plant.

In addition, with regard to water supply and drainage works:

- Siting of surface water abstraction locations to minimise impact on existing water supply sources and use of imported water as necessary;
- All drainage channels, flow control structures and culverts will be designed to transmit an appropriate design flood event based upon international best practices;
- All cross-drainage structures will be located so that backwater conditions during flooding will not impact on any village housing, settlement or infrastructure; and
- Structures to be periodically inspected, maintained, cleared of debris and design flood calculations will be checked and re-assessed if visual evidence suggests that peak flows may have been underestimated.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, it is assessed that the impact on soil and water resources relating to construction works will be a "**Minor Negative Impact**" post mitigation (refer to *Table 10.29*). Although the construction management procedures described will provide effective mitigation in most cases, a large construction project of this nature will inevitably have some impacts on soil and water conditions.

Table 10.29 Rating of Residual Impacts Related to Construction Works (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Localised	It is unlikely that the impacts would extend beyond the immediate vicinity of the construction site or spillage location.
Duration	Temporary	The risks would be present so long as construction continues.
Scale	Construction area	The impacts could occur at any or all of the various construction sites and along their access routes.
Frequency	Occasional	The impacts are primarily risk-related, although for such a large construction project it is inevitable that some will occur.
Likelihood	Possible	As above.
Magnitude		
Negligible Magnitude		
Impact Significance Rating After Mitigation		
Minor Negative Impact		

10.2.9 Impacts to Seismicity

An analysis of data from monitored dam sites shows that there is no minimum size of reservoir (both in terms of volume and maximum height) that can induce seismicity. In fact, it has been noted that several large reservoirs have not triggered any earthquakes, whereas many small ones have led to notable seismic activity. Most of the Reservoir Triggered Seismicity (RTS) cases observed have the following main features (Gupta, 2002; International Commission on Large Dams (ICOLD), 2011):

- During and after impounding, the seismic activity becomes more frequent;
- The events tend to decrease after peaking, but they may occur again when rapid reservoir level variations are taking place; and
- A greater time difference between the start of impounding and the maximum triggered shock, yields a larger maximum shock.

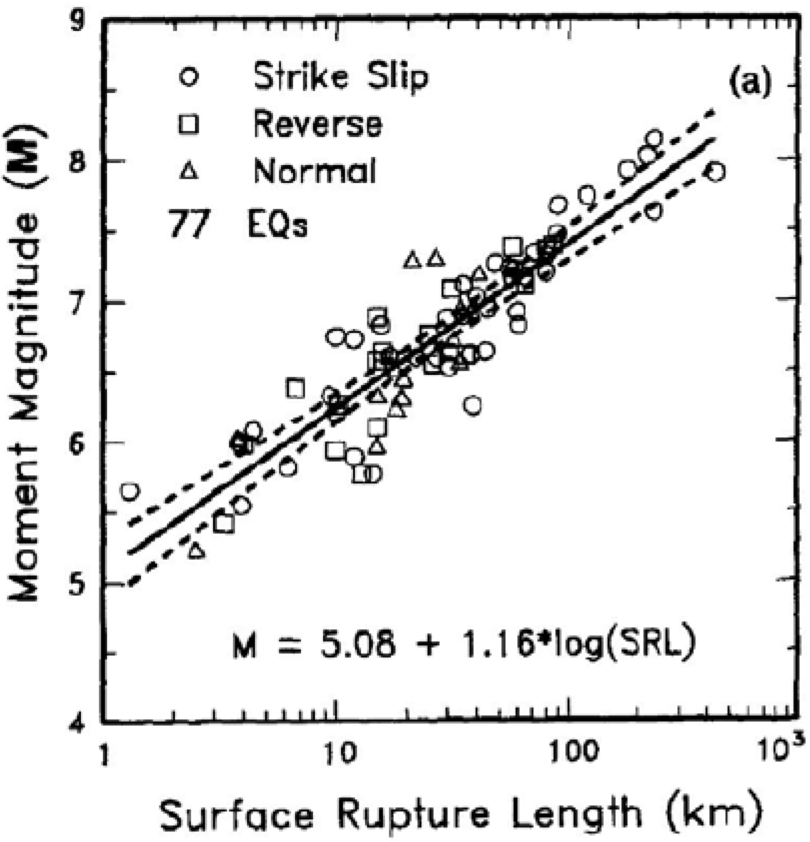
The added weight of impounded water and the propagation of pore pressure are the triggering parameters. A reservoir cannot increase the seismic energy release, but can only trigger a fault slip, if it is near failure condition. A basic requirement for the triggering activity is therefore the existence of an active fault or a fault near its failure limit (ICOLD, 2011).

For new dams, ICOLD, 2011 suggests that the maximum recorded RTS in the world should be assumed and states that, "as a rule, modern dams should be able to cope with RTS, as the largest RTS magnitude recorded to date is 6.3. But some appurtenant structures and nearby buildings and structures might require special attention."

In the case of the proposed BGHES, the initial response to reservoir filling should be lower than for Kariba, given the much smaller reservoir volume. However, because of the greater dam height, it is probable that seismic events of a magnitude similar to those presently experienced will be induced by long-term reduction of effective stresses in response to pore pressure adjustments. Looking at the seismic activity of Kariba after about 1966, i.e. the time after which pore pressure-induced quakes became dominant, the maximum magnitude was 5.5. Therefore, and as concluded by the Batoka JV Consultants (1993), the maximum magnitude verifiable at Batoka dam could be 5.5.

Wells & Coppersmith (1994) provide some empirical relationships among moment magnitude and surface rupture length, sub-surface rupture length, down-dip rupture width, rupture area, and maximum and average displacement. They carried out a log-linear regression of historical earthquakes worldwide, showing a good correlation, within standard deviations in a range of 0.25-0.35 magnitude units and correlation coefficients greater than 0.8 (*Figure 10.14*), between the rupture length of three slip types (strike, normal and reverse) and the magnitude of seismicity.

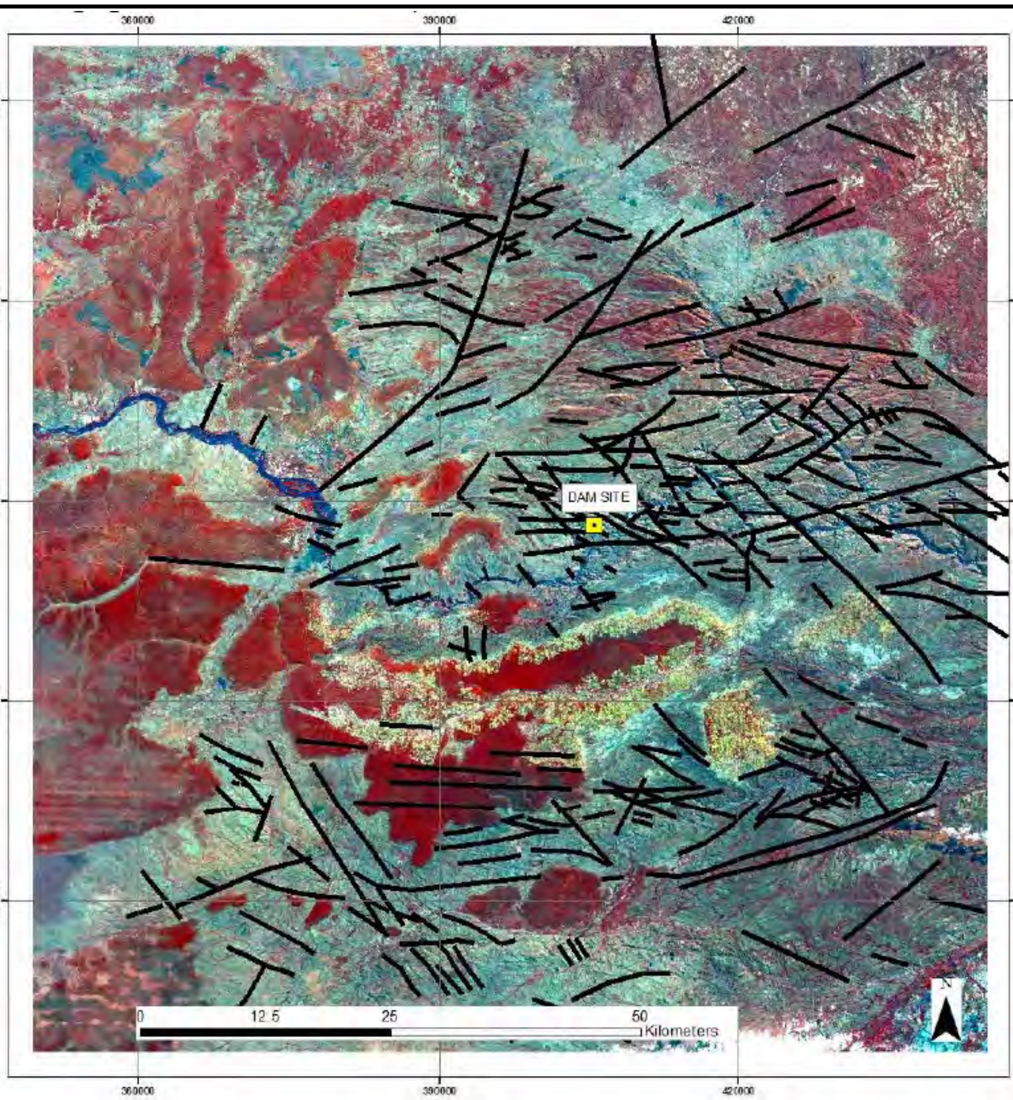
Figure 10.14 Correlation between Magnitude and Length of Fault Lines



Source: SP (2018): Seismic Hazard Assessment report

Included in SP's (2018) analysis of seismicity for the project area, a morpho-structural analysis of the area was also undertaken by identifying lineation patterns in the project area using a digital terrain model and through the analysis of remote sensing data. *Figure 10.15* shows a structural map of the area that extends about 50 km around the dam site.

Figure 10.15 Identified faults in a radius of approx. 50km from the dam site



Source: SP (2018): Seismic Hazard Assessment report

An accurate interpretation of satellite imagery to identify the faults lying within a radius of 50 km around the Batoka area revealed that 85% of these faults are less than 10 km long.

Using this data, and comparing this data with that of *Figure 10.14*, SP conclude that the maximum developable magnitude (originating from a 10 km fault) is 6.2. As such, SP (2018) conclude that this method is the more reliable for estimating the maximum seismic magnitude event at Batoka, since it considers the actual conditions of the area on which the Batoka dam will be built.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact of the dam on seismicity (RTS) will be a "**Minor Negative Impact**" pre-mitigation (refer to *Table 10.30*).

Table 10.30 Rating of Impacts Related to Seismicity (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Localised	It is unlikely that the impacts associated with seismicity will extend beyond 50km of the dam, and are likely to occur along fault lines.
Duration	Permanent	The risks would be present once the impoundment starts to fill up.
Scale	50km	The impacts could occur within a 50km radius of the dam, along the fault lines, but these seismic events are likely to be small and localised to specific fault line only.
Frequency	Occasional	The impacts – as for Kariba – are likely to be occasional.
Likelihood	Possible	As above.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Minor Sensitivity		
By in large, there are few sensitive receptors close to the impoundment, and given the likely magnitude of seismic events, such sensitive receptors are unlikely to be affected. An additional sensitive receptor includes the dam wall itself.		
Impact Significance Rating Before Mitigation		
Minor Negative Impact		

Mitigation/Management Measures

As such, SP has used both the seismic source data presented here, as well as the data on lineation patterns for the Project area defined using a DTM and satellite imagery, to devise appropriate design parameters for seismicity for the Batoka dam wall, which are also in line with those minimum design parameters stipulated by ICOLD (2010).

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, it is assessed that the impact of seismicity on sensitive receptors will remain a "**Minor Negative Impact**" post mitigation, but given the proposed design measures for the wall and associated structures, the impact of seismicity on the dam wall will be a "**Negligible Negative Impact**" post mitigation (refer to *Table 10.31*).

Table 10.31 Rating of Impacts Related to Seismicity (Post-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Localised	It is unlikely that the impacts associated with seismicity will extend beyond 50km of the dam, and are likely to occur along fault lines.
Duration	Permanent	The risks would be present once the impoundment starts to fill up.
Scale	50km	The impacts could occur within a 50km radius of the dam, along the fault lines, but these seismic events are likely to be small and localised to specific fault line only.
Frequency	Occasional	The impacts – as for Kariba – are likely to be occasional.
Likelihood	Possible	As above.
Magnitude		
Small Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Minor to Negligible Sensitivity		
The dam wall will be specifically designed to cope with RTS, thereby reducing the vulnerability of this structure to seismicity. Other existing structures (homesteads, lodges), although unlikely to be affected, are not designed for such RTS and thus remain more sensitive to RTS.		
Impact Significance Rating Before Mitigation		
Minor to Negligible Impact		

10.3 *IMPACTS ON THE BIOLOGICAL ENVIRONMENT*

The predicted impacts to the Biological environment as a result of the proposed BGHES are described in this *Section*. Potential impacts within the Project's area of influence have been consolidated into the following groups:

Habitat Loss and Degradation

- Direct Loss of Critical Habitat through Filling of the Reservoir and Development of Infrastructure.

- Habitat Degradation resulting from Altered Flow Regimes.

Impacts to Fauna

- Impacts to the Avifaunal Communities.

- Alteration of Fish Communities and their Utilisation.

- Impacts to Crocodiles and Other Fauna.

Invasive Alien Species

- Eutrophication and associated Floating Aquatic Weed Infestation.

10.3.1 *Direct Loss of Critical Habitat through Filling of the Reservoir and Development of Infrastructure*

Description of the Baseline Environment

Batoka Gorge Affected by Inundation

The baseline assessment presents arguments for recognising the Batoka Gorge as a Critical Habitat due to its importance for Taita Falcons, the unique habitat and the protected status based on two national parks (IUCN Management Category II), a UNESCO World Heritage Site and recognition of the gorge by the IUCN as a Key Biodiversity Area (KBA). These conservation areas receive international attention and have been incorporated into a number of environmental safeguard standards that include multilateral financial institutions such as the World Bank and the IFC. Threatened, rare and endemic plant species occur there and the gorge is thought to support an annual bat migration, however limited information is available on the bat ecology there.

The Joint Integrated Management Plan (JIMP) for the UNESCO Mosi-oa-Tunya - Victoria Falls World Heritage Site (WHS) developed for the period 2014 to 2018 provides a proposed zonation for these two parks and includes the Batoka Gorge within the highest ecologically sensitive zone. Only non-destructive foot and boat-based tourism activities are permitted within that zone.

Proposed Project Activities

The main activity resulting in the loss of habitat will be construction of the dam wall approximately 50 km downstream of the Victoria Falls and the resulting reservoir inundation of the Batoka Gorge above that point. The extent of the reservoir, and loss of critical habitat, will depend on the selection of a Full Supply Level (FSL). An estimate of the potential loss of critical habitat has been determined through mapping the edge of the rim of the gorge from the Victoria Falls to 58 km downstream of the proposed BGHES dam wall site (total river distance to Kariba = 109.97 km). The critical habitat extent was calculated through adding a 50 meter outer buffer from the edge of the rim, yielding a total area of 18,190 ha. *Table 10.32* presents an overview of the potential loss of river length and critical habitat for each of the FSL alternative assessed in *Section 10.2.3*.

Table 10.32 Potential Loss of River Length and Critical Habitat under each FSL

Full Supply Level	Area of Reservoir (ha)	Remaining Area of Critical Habitat (ha)	Percentage Area lost	River Length of Reservoir (km)	Percentage Loss of River Length
730m FSL	1,957.80	16,232.51	10.8%	42.33	38.5%
740m FSL	2,176.48	16,013.83	12.0%	43.83	39.9%
757m FSL	2,571.62	15,618.69	14.1%	45.54	41.4%
762m FSL	2,699.06	15,491.25	14.8%	46.66	42.4%

The ecological functioning of the Batoka Gorge critical habitat is primarily associated with the Zambezi River. Alteration of the river's hydrological functioning will alter the integrity of the critical habitat, and the linear measurement of river length may therefore be a better representation of the loss of critical habitat. Results in *Table 10.32* reveal less than 4% variation in the loss of river length between the various FSLs.

Sensitive Receptors

The key sensitive receptors are the Batoka Gorge critical habitat, and the WHS, which incorporates the uppermost 17 km stretch of the Batoka Gorge. *Figure 10.16* illustrates the predicted area of inundation by the reservoir within the WHS, for which the 762 m and 757 FSLs represent approximately 4% and 3% of the WHS respectively. These reservoir extents represent 9.3% and 8.4% of the highest ecologically sensitive zone classified by the JIMP.

The entire Batoka Gorge is recognised as a Key Biodiversity Area. The gorge was rated as being in a natural state during environmental flow assessments, qualify as a natural habitat and there is sufficient justification to be recognised as critical habitat, of which 14% is predicted to be lost. Impacts to sensitive fauna, including the Taita Falcon are discussed in *Sections 10.3.2, 0* and *10.3.4*.

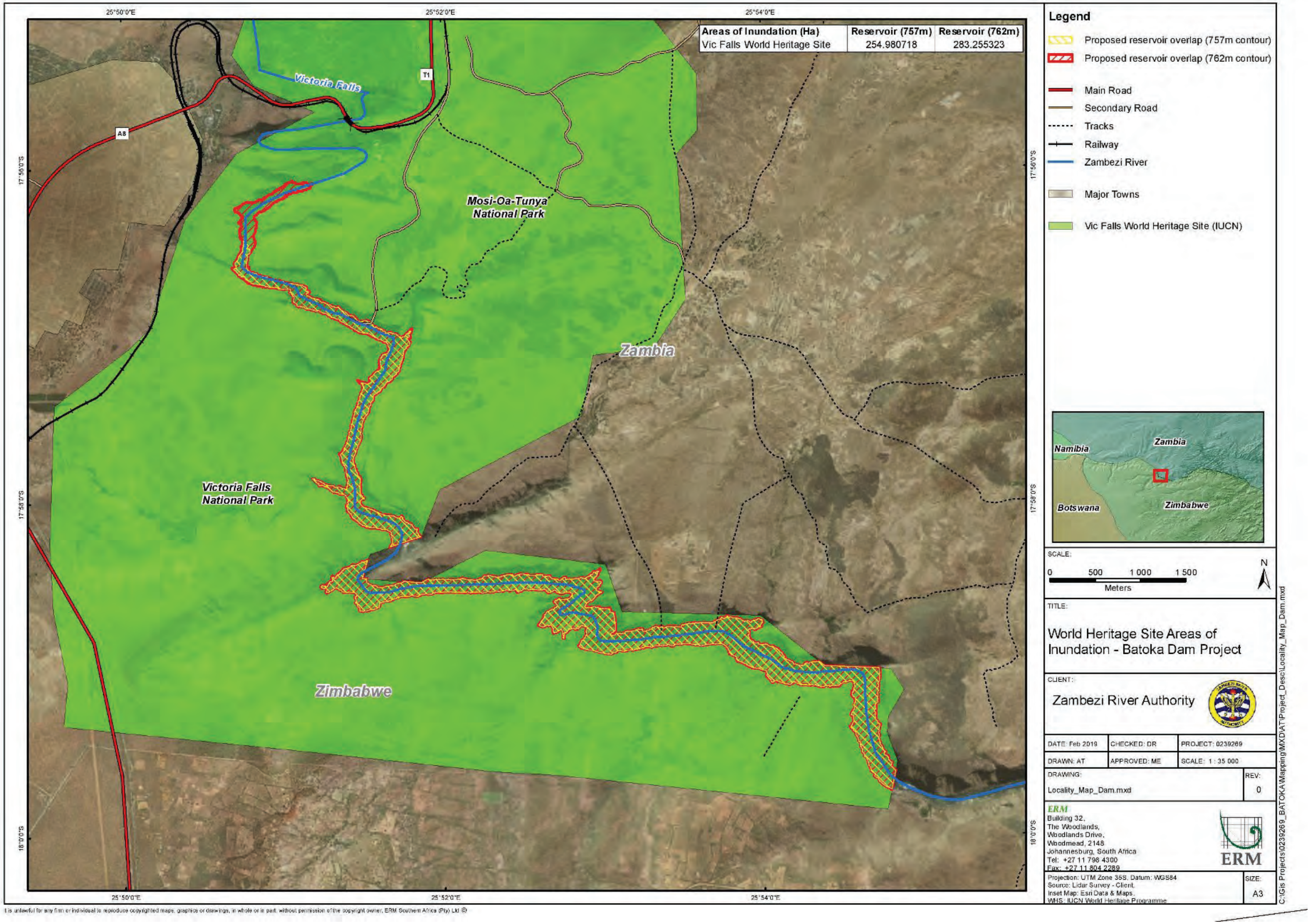
Both the ESS6 and the Performance Standard 6 (PS6) require for situations where critical habitats are impacted, that Net Gains are demonstrated for those biodiversity values for which the critical habitat was designated. The February 2019 update of the guidance notes to the PS6 provides the following text: (1)

> *GN55. Based on the mitigation and management requirements of Performance Standard 6 [for critical habitat], some areas will not be acceptable for financing, with the possible exception of projects specifically designed to contribute to the conservation of the area. Consultation with the relevant national and international organizations that designate these areas is required. These areas should be identified during the assessment of critical habitat and brought to the attention of IFC as early as possible in the financing process. They include the following:*
>
> - *UNESCO Natural and Mixed World Heritage Sites*
> - *Sites that fit the designation criteria of the Alliance for Zero Extinction (AZE)*

UNESCO have not been engaged specifically on the losses to the WHS during the course of this ESIA development.

(1) The Guidance Notes are provided by the IFC to assist the interpretation of the Performance Standard 6. The standard has not changed, and the updated guidance notes do not provide a period of applicability, and are applicable to all projects that align to the IFC Performance Standards./

Figure 10.16 Predicted Extent of Inundation of the Batoka Gorge within the Mosi-oa-Tunya Victoria Falls World Heritage Site



Significance of the Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact of loss of critical habitat through impoundment will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 10.33*). This impact straddles the border of two countries, will lead to a permanent loss of habitat and is certain to occur should the reservoir be built. There is high confidence on this assessment based on the protected areas, critical habitat for Taita falcons and knowledge of the vegetation. There are no assumptions made in assessment of this impact.

Table 10.33 Rating of Impacts Related to Direct Loss of Critical Habitat through Impoundment (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	This impact covers a large area and straddles both sides of the international border.
Duration	Permanent	The loss of habitat will be irreversible and therefore permanent
Scale	Large	Approximately 40% of the length of river habitat (depending on the selected FSL) that forms the core of the critical habitat will be lost.
Likelihood	Definite	Inundation of the gorge will lead to a definite loss of habitat.
Magnitude		
Large Magnitude		
Sensitivity of the Resource/Receptor		
High Sensitivity		
The Batoka Gorge represents a critical habitat based on international standards due to its importance for range restricted species and as a highly unique ecosystem. Parts of two national parks (Category II and III protected areas) will be lost to the reservoir. Threatened, endemic and rare plant species are known to occur in the affected habitats.		
Impact Significance Rating Before Mitigation		
Major Negative Impact (**Note** - this could be interpreted as having a Critcal significance, given that the BGHES impacts a UNESCO World Heritage Site)		

Mitigation/Management Measures

Botanical Survey and Translocation of Threatened and Endemic Plant Species

Previous impact assessments for the proposed BGHES have called for preconstruction botanical surveys to be conducted before the gorge is inundated to understand and document the diversity of floral species present. Threatened and endemic plant species that are at risk of being inundated or lost due to construction activities will wherever possible and practical, be relocated to safe areas of similar habitat. The Zimbabwe Parks and Wildlife Management Authority (ZPWMA) have requested that specially protected plant species, such as aloes which are abundant there, be transplanted into safe locations. They state that implementation will require active liaison and engagement between government and private stakeholders.

Habitat Protection
Protection of parts of the Batoka Gorge habitat not impacted by inundation (such as the rim, cliffs and scree slopes that will be maintained as no go zones) will partially address the loss of critical habitat. Development of the BGHES may alter the demand for development sites overlooking the reservoir for residential, tourism and other purposes east of the national parks. Measures will be taken to protect the rim of the Batoka Gorge and the scree slopes below through development of a conservation plan and restrictions on development to retain the wilderness character of the area (refer also to *Section 10.3.2*).

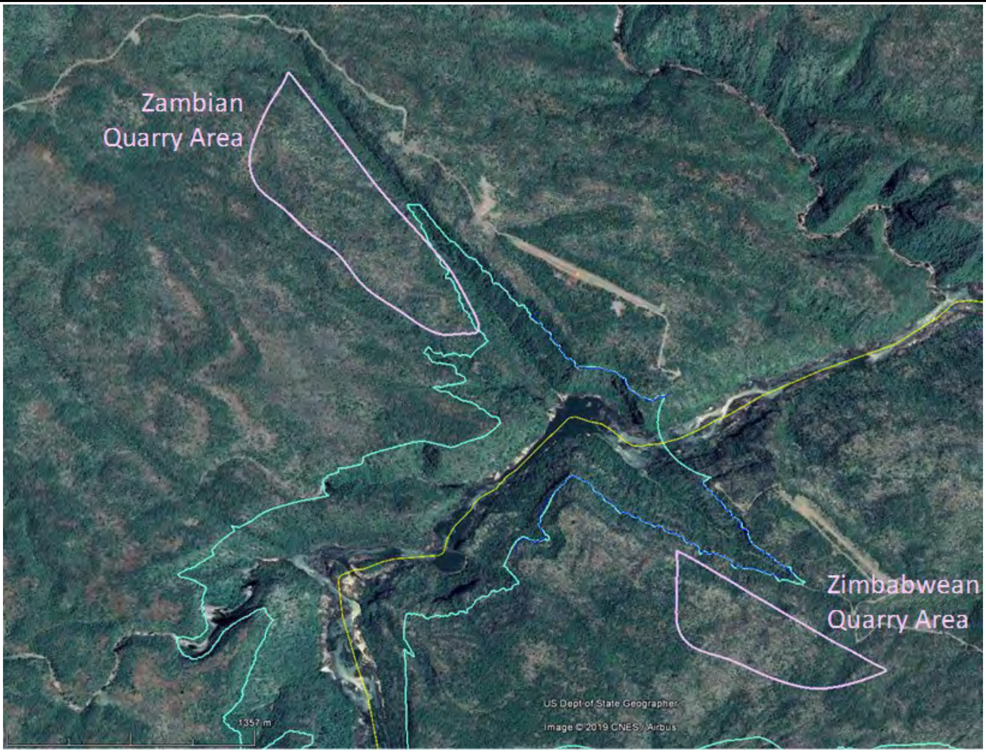
Offsetting of impacts to the Batoka Gorge critical habitat and World Heritage Site will be necessary, and needs to be addressed through an Offset Plan. The feasibility of achieving such an offsetting plan to cancel the residual biodiversity impact needs to be determined, but falls outside of the current scope of this ESIA

Quarries
Indicative areas have been identified for the development of BGHES quarries that will be used for dam construction. These areas are situated in relatively close proximity to the critical habitat associated with the Batoka Gorge (refer to (refer to *Figure 10.17*), specifically the eastern perimeters of both the Zambian and Zimbabwean Quarry areas. No go areas for these areas are as follows:

- A 50 meter buffer around the rim of the Batoka Gorge (including the rim of side tributaries entering the Gorge) will be avoided; and
- Drainage lines will also be avoided to the extent possible.

Accordingly, the location / extents (specifically the eastern perimeters) of the quarry areas will be amended such that the above is satisfied.

Figure 10.17 Location of Quarry Areas to Critical Batoka Gorge Habitat



Reshaping of quarries as part of the rehabilitation programme will consider the surrounding landscape and avoid the development of new landscape features. Future reshaping will be considered prior to excavation /establishment of quarries to minimise costs at a later stage. The following will be considered for establishment of quarry areas and final rehabilitation:

- The Batoka Gorge includes many cliff faces along the edges with scree slopes below. Cliff faces with a scree slope at a similar angle would therefore be appropriate for some sides of the quarry pits. Cliff faces provide nesting habitat for various raptor species and storks. Suitable ledges for nesting located in inaccessible places could potentially provide ecological benefits.

- Soils need to be separated when excavated and stockpiled appropriately, so that these can be returned for future revegetation of rehabilitated quarries.

- Quarry areas will be free draining.

Location of Disposal Areas

SP has provided no specific locations for the siting of disposal areas (waste rock dumps); however, the following factors will be applied for siting of these areas:

- Disposal areas will be located in such way that they will not require relocation prior to final rehabilitation;
- A 50 meter buffer around the rim of the Batoka Gorge (including the rim of side tributaries entering the Gorge) will be avoided; and

- Drainage lines will also be avoided to the extent possible.

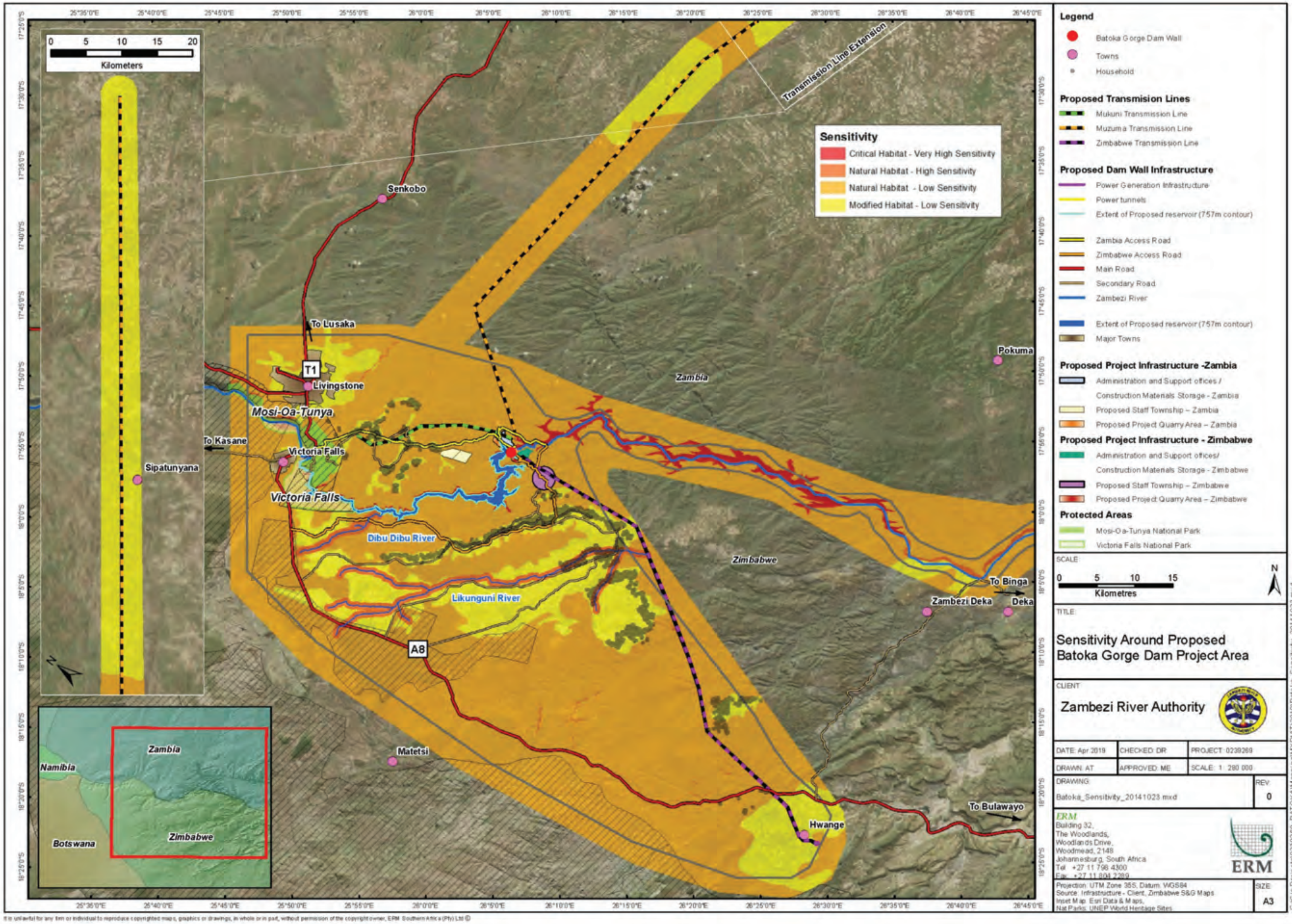
In addition to the above recommendations, and with reference to *Figure 10.18*, disposal areas will avoid critical and natural habitat areas, as these have a very high and high sensitivity. Disposal areas will as far as possible be located in areas with a lower sensitivity – i.e. – low sensitivity natural habitat and modified habitat.

Moreover –

- Disposal areas will be clearly and permanently demarcated and located in defined no go areas; and
- Disposal areas should be free draining.

Where possible the visual impact of disposal areas will also be considered. At closure, not all waste rock will be used as backfill for the quarries. As such, the disposal area will require final rehabilitation. The final slopes of disposal areas will be irregular and mimic the surrounding landscapes. The potential for erosion of the rehabilitated disposal area will be monitored and repaired when it occurs.

Figure 10.18 Habitat Sensitivity Map for the Ecological Area of Influence for the Proposed BGHES



Vegetation Clearing

Clearing of vegetation within the proposed flood area prior to inundation of the reservoir has been proposed as a benefit to affected communities as the timber within the riparian habitats may have an economic value. However, these habitats are currently inaccessible and creating access to these areas would be detrimental to sensitive biodiversity such as the Taita Falcon and other raptor nesting sites that may survive the inundation below. Pre-inundation clearing of vegetation within the gorge is therefore not supported.

River Continuity

The outflow from the powerhouse will be located approximately 750 meters downstream of the dam wall. Continuity of the Zambezi River needs to be maintained and landscaping of the riverbed will be required to allow formation of a pool through backflow of water to the base of the dam wall. Design of the backflow pool will allow some circulation of water to prevent formation of stagnant conditions.

Residual Impact (Post-mitigation)

Limited translocation of sensitive plants can be implemented but will not mitigate the widespread loss of critical habitat or alleviate the loss of the high ecological sensitivity zone of the WHS. Available mitigation is not sufficient to demonstrate Net Gain of the critical habitat components, and the residual impact significance related to loss of critical habitat through impoundment and development of infrastructure therefore remains a "**Major Negative Impact**" post mitigation (*Table 10.34*).

Table 10.34 Rating of Residual Impacts Related to Direct Loss of Critical Habitat through Impoundment (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The extent of loss of critical habitat will not change as a result of mitigation
Duration	Permanent	The loss of habitat will be irreversible despite any mitigation
Scale	Large	The area predicted to be inundated will remain unchanged
Likelihood	Definite	Inundation of the gorge will lead to a definite loss of habitat.
Magnitude		
Large Magnitude		
Impact Significance Rating After Mitigation		
Major Negative Impact		

The Batoka Gorge is classified as a Critical Habitat based on the large unique environment that it present and its Key Biodiversity Area (KBA) status based on the designation as an Important Bird and Biodiversity Area. The IFC Performance Standard 6 (PS6) states that a development within a Critical Habitat is acceptable if a set of criteria, as stipulated in *Table 10.35*, are met.

Table 10.35 Criteria Stipulated within Performance Standard 6 (Paragraph 17) for Projects within Critical Habitat

IFC PS6 Criteria for Critical Habitat	Response for the BGHES
1. No other viable alternatives within the region exist on modified or natural habitats that are not critical.	There are no known viable alternatives within non-critical habitat in the region for generation of hydropower on the magnitude proposed by the project.
2. The project does not lead to measurable adverse impacts on biodiversity values for which the critical habitat is designated, or on ecological processes supporting them. (*Biodiversity values and their supporting ecological processes are to be determined on an ecologically relevant scale*).	A large component of the unique Batoka Gorge habitat will be lost to inundation, and there is no effective mitigation (*Section 10.3.1*). This criterion cannot be met, but see discussion below to consider offsetting impacts.
3. The project does not lead to a net reduction in the global and/or national/regional population of any Critically Endangered or Endangered species over a reasonable period of time.	No significant declines of Critically Endangered or Endangered species are predicted, although impacts to Taita Falcons are a concern.
4. A robust, appropriately designed, and long term biodiversity monitoring and evaluation programme is integrated into the project's management programme.	A comprehensive environmental management system is being developed as part of this BGHES ESIA.

Paragraph 18 of the IFC Performance Standard 6 states:
"*Where a client is able to meet the requirements defined in paragraph 17, the project's mitigation strategy will be designed to achieve net gains* (1) *of those biodiversity values for which the critical habitat was designated*".

There are no effective avoidance or minimisation measures that will reduce the significance of the impact the Batoka Gorge critical habitat. The World Commission on Dams states for the majority of large hydropower schemes: "it is not possible to mitigate many of the impacts of reservoir creation on terrestrial ecosystems and biodiversity" (2). An offset to compensate this loss provides the only option to address the impact to the Batoka Gorge critical habitat. The magnitude of such an offset would need to be large to compensate for this impact, particularly when considering the World Heritage status of part of the affected area.

The IFC PS6 references the Biodiversity for Business Offset Programme (BBOP) for the development of offsets. The IFC PS6 states that the design of a biodiversity offset must adhere to the "like-for-like or better" principle and must be carried out in alignment with best available information and current

(1) The IFC PS6 defines Net Gains as additional conservation outcomes that can be achieved for the biodiversity values for which the critical habitat was designated. Net gains may be achieved through the development of a biodiversity offset and/or, in instances where the client could meet the requirements of paragraph 17 of Performance Standard 6 without a biodiversity offset, the client should achieve net gains through the implementation of programs that could be implemented in situ (on-the-ground) to enhance habitat, and protect and conserve biodiversity.
(2) Findings and Lessons (pg 93) within Chapter 3: Ecosystems and Large Dams - Environmental Performance. In: *Dams and Development - A New Framework for Decision-making. Report of the World Commission on Dams*. Nov 2000. Available at: www.unep.org/dams/WCD/report/WCD_DAMS%20report.pdf

practices [1]. The Batoka Gorge is unique and there are no similar habitats that meet a Like-for-Like requirement, however this concept could be applied to improve the protection of similarly unique habitats. The nearest unique habitat on a similar scale of sensitivity is the Mosi-oa-Tunya Victoria Falls World Heritage Site and the associated national parks in Zimbabwe and Zambia, which will be partially impacted by loss of the Batoka Gorge critical habitat. The World Commission on Dams suggests the establishment of trust funds through grants from developers to manage parts of the revenue stream and use it for environmental purposes [2]. In addition, financial institutions committing to financing construction of the hydropower scheme will need to waive the IFC interpretation provided by guidance note GN55 (Feb-2019) to the Performance Standard 6.

<u>Assess Offset Feasibility</u>
The feasibility of available options for an offset, including consideration of a compensatory offset needs to be investigated. The IFC PS6 (paragraph 10) requires external specialist input into the offset design and implementation, but is beyond the scope of this ESIA.

10.3.2 Impacts to the Avifaunal Communities

Description of the Baseline Environment and Sensitive Receptors

Rock Pratincoles are intra-African migrating small birds whose habitat is restricted to rocks emerging from fast flowing rapids and sandbanks during the low flow season. Populations occur above the Victoria Falls and below Lake Kariba and Williams *et al.* (1989) estimated that approximately 100 Rock Pratincoles utilised the proposed flood zone of the Batoka reservoir. 1000 birds are required to constitute 1% of the bioregional population for Rock Pratincoles (WPE online database, 2014), and construction of the dam does not constitute a threat to the survival of the species, but could result in a significant shift in the distribution pattern in the southern limits of this birds range.

Severe impacts to Taita Falcons have been predicted in previous impact assessments for the BGHES. This small falcon is an extremely rare cliff-dwelling raptor and the Batoka Gorge has for a long time been recognised as hosting the single largest population in existence. Recent studies have however observed a decline in this population. Actual causes are unknown, but there is speculation that excessive helicopter activity within the confines of the Batoka Gorge associated with Victoria Falls tourism disturbs these birds; and a recent increase in breeding pairs of Lanner Falcons has displaced the lesser Taita Falcons. The cumulative effect of the habitat alteration, helicopter activity and competition from other raptors may result in the disappearance of the rare Taita Falcon.

(1) Paragraph 10, IFC Performance Standard 6 for Biodiversity Conservation and Sustainable Management of Living Natural Resources.
(2) Box 3.1 Mitigating and compensating for terrestrial impacts (pg 75). In: *Dams and Development - A New Framework for Decision-making. Report of the World Commission on Dams.* Nov 2000.

Primary prey of the Taita Falcons is the numerous swifts and rock martins that feed on midges emerging from the fast flowing waters of the Zambezi River within the gorge. It is not known if the prey populations will remain and/or if other small birds will provide sufficient prey for the Taita Falcons once the proposed reservoir inundates the gorge.

Protection of the entire Batoka Gorge has been motivated by Birdlife International due to the abundance and diversity of raptor species there. These include, apart from Taita Falcons described above, Verreaux's Eagle, Crowned Eagle, Peregrine Falcon, Lanner Falcon, Bat Hawks and Augur Buzzards. Most raptor species are wide ranging and a high diversity of raptors are known to occur in the greater area. Prominent large raptors, in addition to species nesting in the gorge, are Lappet-faced Vulture, White-backed Vulture, White-headed Vulture, Hooded Vulture, Martial Eagle, Brown and Black-chested Snake Eagles and Pale Chanting Goshawk.

The Batoka Gorge supports an important breeding population of Black Storks, which exceeds 1% of the Southern African bioregional population (1560 to 4050 birds in 2012; WPE website, 2015) and could support 1% of the global population of this species (global population estimated at 22 500 to 44 000 birds in 2012; WPE website, 2015).

Table 10.36 Names and Threatened Status of Birds Listed in the Text

Common Name	Species Name	IUCN Red List Status (2018)
Raptors		
Lappet-faced Vulture	*Torgos tracheliotos*	Endangered
White-backed Vulture	*Gyps africanus*	Critically Endangered
White-headed Vulture	*Trigonoceps occipitalis*	Critically Endangered
Hooded Vulture	*Necrosyrtes monachus*	Critically Endangered
Martial Eagle	*Polemaetus bellicosus*	Vulnerable
Verreaux's Eagle	*Aquila verreauxii*	Least Concern
Crowned Eagle	*Stephanoaetus coronatus*	Near Threatened
Brown Snake Eagle	*Circaetus cinereus*	Least Concern
Black-chested Snake Eagle	*Circaetus pectoralis*	Least Concern
Bat Hawk	*Macheiramphus alcinus*	Least Concern
Augur Buzzard	*Buteo augur*	Least Concern
Peregrine Falcon	*Falco peregrinus*	Least Concern
Lanner Falcon	*Falco biarmicus*	Least Concern
Taita Falcon	*Falco fasciinucha*	Vulnerable
Dark Chanting Goshawk	*Melierax metabates*	Least Concern
Water Birds		
Black Stork	*Ciconia nigra*	Least Concern
Rock Pratincole	*Glareola nuchalis*	Least Concern

Proposed Project Activities

The primary activity that will affect conservation important species is the construction of the BGEHS dam wall approximately 50 km downstream of the Victoria Falls and the resulting inundation of the Batoka Gorge above that point. Cliff-nest sites may be flooded or no longer in inaccessible locations.

Significance of the Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact to avifauna from losses of key biodiversity features will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 10.37*). Alteration of habitats will be permanent and have a regional extent. Some of the species may be permanently affected while others may be able to adapt to the altered situation.

The current state of the Taita Falcon populations in the middle stretch of the Batoka Gorge has not been surveyed, but there is high confidence on the importance of the gorge for other raptor species, Black Storks and Rock Pratincole. The response of Taita Falcons to inundation of the gorge is uncertain.

Table 10.37 Rating of Impacts Related to Avifauna (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	• The local Taita Falcon population has been described as the single largest known population, and any impacts could affect the species as a whole. • Loss of Rock Pratincole habitat could result in a shift in their distribution patterns.
Duration	Permanent	The loss of habitat for these species will be permanent
Scale	Large	• The Taita Falcon population is small and every falcon present would be affected, similarly for Rock Pratincole. • Most raptors are wide ranging and survive at low densities, and the loss of a few individuals can be significant to the population.
Likelihood	Likely to definite	The response of the different species is uncertain, some species may adapt to the change in habitat while others may not. Without mitigation, the transmission lines will lead to electrocutions and collisions.
Magnitude		
Medium to Large Magnitude		
Sensitivity of the Resource/Receptor		
High Sensitivity		
Taita Falcons, the most sensitive species affected, are extremely rare, yet classified as Vulnerable by the IUCN Red-list of Threatened Species. Populations are reduced due to other factors. Large numbers of Endangered vultures and other red-listed birds are at risk from the transmission lines.		
Impact Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation/Management Measures

Address Data Gaps and Develop Mitigation for Taita Falcon Conservation

Taita Falcons are defined as a provisional trigger of critical habitat for the Batoka Gorge, and are therefore a priority species for which mitigation is required to prevent their further decline as a result of the proposed Project. However large data gaps exist in the current understanding of Taita Falcon presence in the Batoka Gorge, which limits the available understanding of their ecology and the ability of this ESIA to predict the significance of impacts resulting from the proposed BGHES.

The recent survey report (1) surveyed only the upper 25 km stretch of the Batoka Gorge for Taita Falcons, and a large part of the Batoka Gorge that will be impacted by hydropower development remains unassessed. There is no assessment of Taita Falcon presence or habitat suitability below the proposed BGHES dam site, which is important as this stretch will be impacted, and to put the proposed Project impacts to an extremely rare species into context.

The recent survey report agrees with speculation that Taita Falcons may be impacted by (i) changing landuse in the surrounding areas leading to increased competition/displacement by an influx of Lanner Falcons; and (ii) tourist-associated helicopter activity within the Batoka Gorge is causing disturbance. Unfortunately, there is no analysis of patterns of landuse change, or data/engagement with tour operators on helicopter flights. Such data can be easily obtained and could potentially provide further insight to support or disprove the speculation on the prevailing impacts to Taita Falcons.

There is a lack of practical mitigation measures available to support the *in situ* conservation of Taita Falcons, largely because so little is known about the species. The recent report states: 'consider a compensation scheme', but provides no guidance on further activities required to implement this recommendation.

The impact of creating a reservoir on the Taita Falcon population is unknown, and key gaps in the ecological understanding continue to exist. A reliable Impact Assessment cannot be finalised until these gaps have been addressed, which ZRA have committed to do. Collaborative workshopping is required between all Taita Falcon specialists to consolidate available information, establish an approach to addressing gaps and development of mitigation to address impacts. This approach must not be restricted to Taita Falcons but will include all affected raptors, Black Stork, Rock Pratincole and African Finfoot populations that depend on the same Batoka Gorge habitat and overlap in terms of the area of impact.

Accordingly, an action plan is urgently required that outlines an approach to thoroughly assess the occurrence of Taita Falcons, obtain an improved level of confidence on status of the population and potential threats, and to identify suitable mitigation that will be accepted by the international specialist community. A peer review of the action plan will need to be undertaken prior to it being implemented. The following actions will need to be included in the Taita Falcon action plan:

(1) Wildlife Departments of Zambia and Zimbabwe. 2018. Joint Report on the Reconnaissance Survey for Status of Taita Falcon(*Falco fasciinucha*) and Rock Pratincole (*Glareola nuchalis*) In the Batoka Hydro Electric Project Area. Report issued to the Zambezi River Authority.

1. Conduct a Taita Falcon field survey within the 30+ km stretch of the Batoka Gorge that have not yet been adequately surveyed.
   - A 7-day site visit is required when Taita Falcons are likely to be breeding, to directly assess and survey the gorge for:
     - Resident pairs of Taita Falcon and other cliff-nesting species.
     - Other sensitive raptor species should be included, such as Martial Eagle, Crowned Eagle, Bat Hawk and Pel's Fishing-Owl.
     - Assess the suitability of available habitats likely to support populations of the sensitive raptor species.

   - The mid Batoka Gorge is largely inaccessible, and will need be accessed using a boat chartered from and operated by a commercial rafting company based either at Victoria Falls or Livingstone. A small but competent specialist team will need to pull into the shore at all discrete, vertical cliff faces to spend time conducting passive observations of target cliff-lines from suitable vantage points to record numbers, evidence of breeding and territorial behaviours of the target species.

   - Whenever possible, larger and emergent trees along the river should be checked for tree-nesting raptor species and nest structures.

   - All incidental sightings of target species must also be recorded, with a view to generating density estimates (if enough sightings are accumulated).

2. Collect data on potential impacts to Taita Falcons, including:
   - Conduct an analysis of changing landuse patterns within an acceptable buffer of the full length of the Batoka Gorge.
   - Engage with tour operators, helicopter pilots, jet-boat operators, white-water rafting outfits to determine the nature and frequency of flights and other leisure activities, and which parts of the Batoka Gorge are most affected by these potential sources of disturbance.

3. Consolidate all available information on Taita Falcons within the Batoka Gorge.

4. Host a workshop with all Taita Falcon species specialists to interrogate all available data and obtain consensus on the status of populations, potential impact that will likely result from the BGHES, and identify specific mitigation measures to address those impacts.

5. Compile outputs of the above workshop into a presentable format for international peer review. The Peregrine Fund is an internationally accredited NGO that should be approached to provide peer review of the objectives and approach to gather Taita Falcon baseline data, investigate impacts and develop a mitigation strategy. We further propose the Peregrine Fund is asked to provide peer review of the final outputs of this exercise.

Monitoring of Taita Falcons and Habitat Management

The impact of the reservoir on the Taita Falcon population is unknown, and careful monitoring of the Taita Falcon population has been requested in the 1993, 1998, 2008, 2014 and 2018 studies, is listed as a requirement by the ZPWMA, and will be implemented by the ZRA. Taita Falcons are small and elusive birds and detecting their presence is a specialised task, which needs to be outsourced to competent species specialists. The bird monitoring will not be restricted to Taita Falcons but will include all raptors, Black Stork, Rock Pratincole and African Finfoot populations (see below) that depend on the same Batoka Gorge habitat and overlap in terms of the area of impact. Results of monitoring will be evaluated to assess the effectiveness of management actions, which will be revised where necessary.

The Zimbabwe Falcon Club (ZFC), BirdWatch Zambia (partners of Birdlife International) and South African Taita Falcon specialists who have experience with this population of Taita Falcons and recommended by WWF to be involved in all bird monitoring activities. The ZRA will support their continued involvement in monitoring and subsequent evaluation of data.

Minimise Disturbance to Nesting Sites

- Flooding of the Batoka Gorge will result in the water surface being close to the level of some of the Taita Falcon nesting sites, and movement of boats on the reservoir for fishing or tourism purposes may present a disturbance to these birds. The above raptor monitoring programme needs to include an assessment of the various disturbance factors and an ongoing assessment of how these can be managed to avoid or minimise loss of the Taita Falcon population.

- Controls are required for developments above the rim of the Batoka Gorge (see *Section 10.3.1*) as demand for tourism or residential developments may rise as a result of the BGHES development. Lodges producing noise and potential waste above the Taita falcon nests are likely to render these sites unsuitable for these birds, similarly for other sensitive raptors.

- There is an illegal demand for Taita Falcon eggs and chicks by falconers, and the locations of Taita nests are therefore kept confidential by the ZFC and BirdWatch Zambia. These ornithological organisations must however be involved in the design of fair control measures and restrictions for future developments along the rim of the Batoka Gorge and acceptable use of the reservoir.

Artificial Falcon Nest Creation

Taita Falcons prefer to breed in large holes high on a vertical cliff face, and few suitable breeding sites exist naturally. Experiments should be conducted to create of additional nesting holes in the cliffs under the supervision of specialist ornithologists.

The Batoka Dam Wall will be over 90 meters in height and one or two artificial nesting sites could be created in locations on the wall where they would be safe from surplus water overflow.

Captive Falcon Breeding Programme

Based on the results of monitoring and expert ornithological opinion, captive breeding programmes will be considered, whereby eggs are taken from nests, the young are reared and released back into their natural habitats with financial support from the income generated by the hydropower scheme.

Monitoring of Rock Pratincole and African Finfoot

A separate Rock Pratincole monitoring programme will be required for the stretches of the Batoka Gorge that are not inundated by the reservoir. Ornithologists involved in the activities to monitor and minimise impacts to raptors will be well placed to advise on the necessary monitoring procedures for Rock Pratincole. WWF have requested that bird monitoring be extended to include the African Finfoot (*Podica senegalensis*) as this uncommon bird may be affected by development of the Batoka reservoir.

Collaboration with Specialist Raptor Ornithologists

A collaboration with specialist raptor ornithologists such as the ZFC and BirdWatch Zambia (partners of Birdlife International) will be required to assess the feasibility and effectively implement the above monitoring and management actions.

Construction of Raptor-friendly Transmission Lines

Electrocutions of raptors and other large birds can cause power disruptions and reliability. Transmission lines with a 330 kv capacity and a length of approximately 90 km will be required for the evacuation of power from the Batoka Power Station to Livingstone and Hwange Towns. These transmission lines will be constructed by Zambia and Zimbabwe Electricity Supply Authorities (ZESCO). These lines will have a negative impact on a diversity of other large raptors, which are common in the area (*Table 10.36*). Design and construction will be the responsibility of ZESCO, but the ZRA can motivate for raptor-friendly approaches to be considered. Details of various raptor-friendly designs are presented in the CESMP.

Residual Impact (Post-mitigation)

This assessment of residual impact excludes the impacts to Taita Falcons, as inadequate information is available to understand the impacts to that species.

Based on the implementation of the proposed mitigation measures, the residual impact (post mitigation) will be a "**Moderate Negative Impact**" (*Table 10.38*).

Table 10.38 Rating of Residual Impacts Related to Avifauna, excluding Taita Falcons (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**

Extent	Regional	Many of the impacted birds are wide-ranging, and the impacts will be felt over a far greater extent than the limits of the area of inundation.
Duration	Long term	The duration of impact may be reduced by facilitating some species to adapt to the changing circumstances, such as creation of nesting sites.
Scale	Large	The Batoka Gorge is an isolated habitat, and many of the sensitive bird species exist in small populations and a large proportion or even the entire local population could be affected.
Likelihood	Possible	The response of the different species is uncertain, but some of the mitigation measures may facilitate some species to adapt to the changing conditions. Adoption of raptor-friendly powerline designs could reduce the loss of raptors.
Magnitude		
Moderate Magnitude		
Impact Significance Rating After Mitigation		
Moderate Negative Impact		

10.3.3 *Alteration of Fish Communities and their Utilisation*

Description of the Baseline Environment and Sensitive Receptors

Fisheries studies conducted in 1997/98 and for the recent environmental flow studies (2014) provide an overview of the community of fish species present in the Zambezi River within the Batoka Gorge and immediately downstream of the BGHES. Both studies have found that the fast-flowing conditions within the Batoka Gorge support a typically riverine fish assemblage but no fish species are known to be unique or restricted to this habitat. Assessments during EFlow studies have revealed that various aquatic ecology components of the affected Batoka Gorge exist in an unmodified to near natural condition (*Table 10.39*). These conditions can readily be interpreted as a natural habitat.

Table 10.39 Present Ecological Status for Batoka EFA Sites

<table>
<tr><th>Ecological Component</th><th>EFA Site 1 - Downstream of the BGHES site</th><th>EFA Site 2 – Below the Batoka Gorge but upstream of Kariba</th></tr>
<tr><td>Hydrology</td><td>A/B</td><td>B</td></tr>
<tr><td>Geomorphology</td><td>A</td><td>A</td></tr>
<tr><td>Vegetation</td><td>A/B</td><td>B</td></tr>
<tr><td>Aquatic macro-invertebrates</td><td>A/B</td><td>A/B</td></tr>
<tr><td>Fish</td><td>A/B</td><td>B</td></tr>
<tr><td>Crocodiles</td><td>B</td><td>B/C</td></tr>
<tr><td colspan="2">Key to Ecological Categories and their Interpretation:
A - Unmodified conditions, i.e. aquatic systems exist in a pristine condition.
B - Near natural conditions. A small change in natural habitats and biota can be detected, but the ecosystem functions are essentially unchanged.
C - Moderately modified conditions. Loss and change of natural habitat and biota has occurred, but the basic ecosystem functions are still predominantly unchanged.</td><td>Categories A, B and C are interpreted as Natural Habitat</td></tr>
<tr><td colspan="2">D - Largely modified. A large loss of natural habitat, biota and basic ecosystem functions has occurred.
Ecological categories E and F describe greater levels of aquatic transformation than are relevant to this project.</td><td>Categories D, E and F are Interpreted as Modified Habitat</td></tr>
</table>

The dam wall will be constructed approximately 50 km downstream of the Victoria Falls to create an extensive reservoir of deep standing water. This represents a dramatic alteration of the riverine aquatic habitat into an open water pelagic habitat. The sides of the reservoir will be constrained by the steep sides of the Batoka Gorge and fluctuating water levels are expected to prevent the establishment of riverine vegetation along the shores. The shorelines are therefore expected to consist largely of exposed rock, which will provide minimal suitable breeding habitat for shore-dependent fish species such as Cichlids (Tilapia-like species). Riverine habitats will be lost but pelagic habitats will be created, and an ecological niche will be created for the establishment of pelagic fish populations. This will be a fundamental change to the current fish ecology.

Table 10.40 presents an overview of the important fish species/genera and their responses to the creation of the BGHES reservoir. Tiger fish are able to survive in both habitats provided adequate prey populations exist (i.e. a pelagic fish population gets established), good water quality is maintained and the adult fish are able to access to upstream flowing habitats for breeding purposes.

Table 10.40 Summary of Expected Responses of Important Fish Species to Creation of the Batoka Reservoir

Positive Response (large populations could potentially establish)	Slight Response / No Important Change (species expected to remain in low populations)	Negative Response (species may disappear from the reservoir)
Hydrocynus vittatus (Tiger Fish) Subject to water quality and successful introduction of *Limnothrissa miodon* (Kapenta)	*Clarias gariepinus* (African Catfish) *Distichodus sp.* *Heterobranchus longifilis* (Vundu) *Hippopotamyrus discorhynchus* (Zambezi Parrotfish) *Mormyrops deliciosus* (Cornish Jack) *Mormyrus longirostris* (Eastern Bottlenose) *Pharyngochromis darlingi* (Zambezi Happy) *Synodontis zambezensis* (Brown Squeaker) *Tilapia / Oreochromis* species	*Anguilla nebulosa labiata* (Indian Mottled Eel) All *Barbus* species All *Labeo* species *Micralestes acutidens* (Sharptooth Tetra)

Fundamental habitat alteration caused by the Batoka reservoir will require the establishment of entirely new fish populations. Low numbers of fish will survive from current conditions, and an interim die-off of fish is possible as a result of early eutrophication due to the decomposition of flooded terrestrial vegetation. Fish populations that survive the transformation are therefore expected to develop from small populations and there will be a limited genetic diversity and potential inbreeding effects.

Aquatic habitats will also be altered below the dam wall, with impacts caused to changes to the environmental flow of the river depending on the selection of a scenario for release of flow from the reservoir. Changes to sediment flows, locations of sandbanks and frequent water level fluctuations will impact upon fish communities and their utilisation by fishermen. Population size of the riverine fish communities will be significantly reduced with the loss of the upstream gorge habitat and the ability to migrate within the gorge will be lost.

EFlow analyses of fish ecology have revealed that the proposed hydropeaking model will result in a major decrease in the abundance of some fish species such as Catfish, Cornish Jack and Tiger fish within the Batoka Gorge downstream of the BGHES. The twice-daily fluctuations in water levels caused by peaking could also lead to fish strandings in some of the broader, more braided river sections of the river downstream of the Lower Gorge. This effect could rapidly reduce populations when peaking is first introduced.

Operation of the BGHES could lead to elevated gas concentrations, particularly nitrogen, that may result can be extremely harmful to fish and potentially lead to fish kills (due to so-called 'gas bubble disease'). There is little data available to understand the impact on African fish species, as most research into this phenomenon has been conducted for rivers in the northern hemisphere. There is speculation that fish in the Batoka Gorge, particularly in the vicinity of

Victoria Falls may have adapted to survive similar conditions, but this has not been demonstrated.

The effect of the reservoir and operation of the BGHES could result in a 3^0C to 5^0C temperature differential of the water that is induced by a lower intake option during the early spring (September), i.e. before the onset of the flood season. This could result in the proliferation of generalist macro-invertebrate taxa at the expense of more sensitive species, which could impact on species richness, with corresponding impacts higher up the food chain affecting fish and some bird populations. This temperature change could delay the spawning of certain cichlid fish species and tiger fish, leading to population wide changes.

Proposed Project Activities

The primary Project activities that will affect the fish communities and their possible utilisation are:

- Construction of the BGHES dam wall approximately 50 km downstream of the Victoria Falls and the resulting inundation of the Batoka Gorge above that point.

- Flow release scenario adopted for power generation activities, which will affect the aquatic habitats downstream of the dam wall.

- EFlow studies recommend that no more than a 1.5 class drop in Overall Ecosystem Condition in the downstream river conditions downstream of the BGHES is acceptable, i.e., from A/B to no less than a mid-C category. This condition may be interpreted as a natural habitat based on *Section 10.2.5*.

Significance of the Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact to fish communities and their utilisation will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 10.41*). Alteration of habitats will be permanent and have a regional extent.

There is high confidence that there will be a dramatic change to the diversity and abundance of riverine fish species occurring in the Batoka Gorge. The actual response of fish species to inundation of the gorge is however uncertain, and assumptions are made the eutrophication of the water body may occur initially but will not be a permanent feature of the development.

Table 10.41 Rating of Impacts Related to Fish Communities and their Utilisation

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The migratory nature of the fish populations will be affected leading to impacts over a greater area.
Duration	Permanent	The habitat alteration for fish species will be permanent
Scale	Large	The aquatic habitats along the full length of the Batoka Gorge are impacted
Likelihood	Definite	Fundamental alteration of the upstream aquatic habitat is unavoidable
Magnitude		
Large Magnitude		
Sensitivity of the Resource/Receptor		
Medium Sensitivity		
The fish communities within the Batoka Gorge are considered to be in a natural state with minimal utilisation due to the inaccessibility of the habitat, although downstream of the gorge (site EF2) there is evidence of heavy utilisation. No unique fish species are known to occur within the gorge.		
Impact Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation/Management Measures

Monitoring and Management of Fisheries

Both 1993 and 1998 studies for past ESIA developments have emphasised the need for careful monitoring and appropriate management of fish populations in the BGHES Reservoir.

Two types of fisheries could be established after water impoundment, namely the capital-intensive Kapenta-based pelagic fishery and an artisanal gill-net fishery. Regulatory and control mechanisms to prevent overfishing need to be developed by the fisheries authorities in both Zambia and Zimbabwe with involvement of the ZRA be needed for both these fisheries and need to be based on monitoring of fish populations and catch effort. Regulatory mechanisms would need to aim to achieve a maximum sustained yield of fish from the reservoir. The license terms and conditions for the pelagic fishery in Kariba can be adapted for the Batoka reservoir. Cooperation between Zambia and Zimbabwe in the management of the Batoka fishery is essential. Sport fishing for Tiger Fish may develop into a valuable industry that supports local economies and would need to receive consideration in the management of the fisheries.

Introduction of Kapenta

A vacant niche for pelagic fish will develop and introduction of *Limnothrissa miodon* (Kapenta) is suggested. Successful establishment of this species is expected to lead to a healthy population of *Hydrocynus vittatus* Tiger Fish in the reservoir provided water quality is maintained. The resulting habitat will have limited suitability for Cichlids (Tilapia-type fish) due to the steep sides of the gorge and minimal extent of spawning grounds.

Monitoring of Individual Fish Populations and Possible Introduction

Genetic Management: Once fish populations show evidence of surviving in the new reservoir habitat, limited numbers of adult fish from each of the important species will be introduced to the reservoir to supplement the genetic stock. Introduced fish will be sourced from Lake Kariba or the Zambezi River downstream of the Batoka Gorge to supplement the genetic diversity with local genetic material. Fish species to be considered for translocation include the 10 species/groups in *Table 10.40* expected to show positive and slight responses to creation of the reservoir.

Tiger Fish: The establishment of healthy Tiger Fish populations requires an adequate prey base, clean water for visibility of prey and upstream shallow flowing conditions for breeding. There is uncertainty whether sufficient breeding habitat will remain upstream of the full supply level to sustain an adequate population of these fish to fully utilise the extent of the reservoir if the former requirements are met (prey availability and water quality). Tiger Fish will need to be monitored for breeding success and population growth, and if necessary appropriate numbers of fingerlings may need to be introduced annually to achieve the fisheries potential of the reservoir.

Introduction of Eels: Mottled Eels (*Anguilla labiata*) were detected in the Batoka Gorge during 1998 but not during recent studies and are thought to have disappeared from the Middle Zambezi system since as this is a migratory species that breeds in the ocean. Their migration routes are cut off by Kariba and Cahora Bassa dam walls. Young fingerlings will be introduced to the Batoka reservoir and the Zambezi River downstream of the wall to complement the fish diversity and contribute an important species to the fisheries there.

Residual Impact (Post-mitigation)

Loss of the former fish communities is inevitable and the residual impact Major significance remains for that impact. However, mitigation measures are presented for management of fisheries of the BGHES reservoir, which if well implemented could lead to the development of a viable fishing industry where formerly minimal utilisation of fisheries was possible. The residual impact therefore measures the potential for substitution of the existing riverine fish population with a new pelagic fish population. Based on the implementation of the proposed mitigation measures, the residual impact (post mitigation) will be a "**Moderate Negative Impact**" (*Table 10.42*).

Table 10.42 Rating of Residual Impacts Related to Related to Fish Communities and their Utilisation (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The extent of the impact remains unchanged as a result of mitigation measures presented.

Duration	Short term	The habitat alteration for fish species will remain permanent however fish communities can be compensated with different species.
Scale	Large	The aquatic habitats along the full length of the Batoka Gorge are impacted
Likelihood	Possible	The successful substitution of fish species to develop a viable fisheries is not guaranteed and is therefore rated as possible.
Magnitude		
Moderate Magnitude		
Impact Significance Rating After Mitigation		
Moderate Negative Impact		

10.3.4 Impacts to Crocodiles and Other Fauna

Description of the Baseline Environment and Sensitive Receptors

The Batoka Gorge represents a unique geological formation that is widely separated from remotely similar mountainous and fast-flowing river habitats. Few unique species are present but the faunal species assemblages are unique and different from surrounding habitats.

A large Nile Crocodile population is present, particularly in the lower reaches of the Zambezi before Lake Kariba. The crocodile population declined dramatically in the 1950s and 1960s but has since recovered and many mature breeding adults are now present. Lake Kariba supports a large crocodile population but the shorelines are not steep sided and provide breeding and refuge areas for these animals. Breeding and refuge habitats within the Batoka Reservoir may be limited but crocodiles are expected to adapt to the new conditions and their populations should persist there.

Large numbers of bats are thought to migrate into the Batoka Gorge on a seasonal basis, and are thought to be attracted to midges emerging from the rapids of the Zambezi River. Little is known about these bats and the impacts associated with development of the BGHES are unknown.

Other sensitive receptors include the broad diversity of lesser fauna at risk by increased activity through general disturbance, road kills and displacement by construction activities. These species include a wide diversity of small mammals, birds, reptiles, amphibians and other fauna.

Proposed Project Activities

The primary Project activity that will affect conservation important species is the construction of the BGHES dam wall approximately 50 km downstream, of the Victoria Falls and the resulting inundation of the Batoka Gorge above that point. Township developments, road construction and erection of transmission lines will impact upon a diversity of fauna in the terrestrial environments adjacent to the Batoka Gorge.

Significance of the Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact related to losses of crocodiles and other fauna will be a "**Minor Negative Impact**" pre-mitigation (refer to *Table 10.43*). Alteration of habitats will be permanent and have a regional extent. Some of the species may be permanently affected while others such as crocodile may be able to adapt to the altered situation.

There is a lack of knowledge on the occurrence of bats in the Batoka Gorge, or the importance of this habitat for this group of small mammals. There is a moderately high confidence on the occurrence of other faunal species. The response of Nile Crocodiles to inundation of the gorge is uncertain.

Table 10.43 Rating of Impacts Related to Crocodiles and Other Fauna (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Impacts extend over parts of both Zambia and Zimbabwe and a long length of the Batoka Gorge
Duration	Permanent	The loss of habitat for affected species will be permanent
Scale	Moderate	The impacts to fauna resulting from township developments, road upgrades and transmission lines have a regional extent but involve only a relatively small part of the regional landscape.
Likelihood	Likely	The response of the different species is uncertain, some species may adapt to the change in habitat while others may not
Magnitude		
Medium Negative Magnitude		
Sensitivity of the Resource/Receptor		
Low Sensitivity		
No faunal species existing in the gorge or adjacent terrestrial habitats that may be affected by development of the BGHES (with the exclusion of birds discussed in *Section 10.3.2*) are unique to the area or highly threatened. Information on bat migrations is insufficient to provide an assessment of their sensitivity here.		
Impact Significance Rating Before Mitigation		
Minor Negative Impact		

Mitigation/Management Measures

Appoint and authorise a Safety Health Environmental and Quality (SHEQ) Manager and associated Environmental Officer(s)
A qualified and competent SHEQ Manager and Environmental Officer(s) will be appointed with sufficient authorisation to ensure protection of the environment is prioritised. He/she will ensure that mitigation listed with the ESMPs is implemented to minimise environmental impacts.

Internal Biodiversity Protection Statement
A Biodiversity Protection Statement is required to conserve plants and animals, and is to be applicable for all staff and contractors involved in the Project. The following activities will be prohibited by ZRA personnel, dam operational staff

and contractors within and surrounding the Project Area, both during and outside work hours:

- Any forms of hunting of wildlife by staff and contractors.
- Purchase, sale or transport of any bush meat products from local communities or passing traders.
- Collection of any animals or animal products for consumption, medicinal or other use.
- Camp residents keeping pets either introduced species such as cats or dogs, or native wildlife.
- The intentional killing of any animals including snakes, lizards, birds or other animals. Awareness of the Animal Rescue Method Statement will be promoted as a means of addressing the presence of animals at risk or presenting a risk to the implementation of activities.
- Camp residents purchasing local wildlife or wildlife products for any reason.
- Sellers of wildlife must not to be allowed on any of the project sites. Such people will be reported to local authorities or wildlife agencies as appropriate.
- Contamination or disposal of waste in the aquatic environments.

ZRA must include such information as part of the site induction process so that all workers are aware of these prohibitions, as well as including in environmentally related information campaigns such as a quarterly newsletter.

<u>Awareness Programmes</u>
Awareness programmes will not be limited to staff and contractors, but will include an outreach programme to prominent individuals and community organisations such as schools, youth groups, women's groups. Active steps being taken by ZRA to protect the environment and collaborate with local communities need to be publicised and promoted.

<u>Conservation Biology Project</u>
IFC standards require that developments in natural habitats demonstrate have a no net loss of biodiversity values as a result of their activities. This can be achieved through maintaining a structured inventory of species that are present. The species within this inventory will be classified into taxonomic groups and families, threatened status using the IUCN Red List and their perceived threat status within the Project area and surrounding areas.

Mitigation measures presented in the 1993 Impact Assessment motivated for establishment of a Conservation Biology Project to assess the diversity and abundance of species present and to explore effective means of mitigation to secure their continued existence. The following programmes are suggested, although such a Project will not be limited to these actions only:

- Monitoring of elephant abundance and movements through satellite tracking;

- General monitoring of wildlife populations;
- Monitoring how crocodile populations adapt to impoundment of their habitat by the reservoir;
- Evaluation of Problem Animal (such as crop raiding and livestock loss) incidents and explore means of addressing these without loss of the animals;
- A bat monitoring programme tailored to the ecology of the bat species is required, which needs to assess a baseline state prior to filling of the reservoir and frequent monitoring thereafter; and
- Assess the diversity of other small mammals, reptiles and amphibians, with emphasis on threatened, rare, endemic or large concentrations of species.

Implement an Animal Rescue Plan

An animal rescue procedure will be developed and implemented for dealing with faunal species found to be at risk from or posing a threat to Project operations. Such animals will be safely translocated to safe areas of similar habitat type where the animals can be released without harm to Project operations, surrounding communities or harm to that animal.

Handling Dangerous Animals: Personnel will to be identified who are professionally trained to handle dangerous wildlife and venomous snakes, with particular emphasis on species likely to be encountered in and around the Project Area. The Wild Horizons Wildlife Trust based in Victoria Falls currently provide such services, and collaboration agreements need to be explored with them, including their involvement on the Zambian side or identification of a similar service there.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the residual impact (post mitigation) will be a "**Minor Negative Impact**" (*Table 10.44*).

Table 10.44 Rating of Residual Impacts Related to Related to Crocodiles and Other Fauna (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	Impacts extend over parts of both Zambia and Zimbabwe and a long length of the Batoka Gorge
Duration	Permanent	The loss of habitat for affected species will be permanent
Scale	Low	The scale of impacts to fauna can be reduced through implementation of a Biodiversity Protection Policy, awareness programmes and an animal rescue method statement
Likelihood	Possible	The response of the different species is uncertain, some species may benefit from mitigation measures while others may not
Magnitude		
Medium Magnitude		
Impact Significance Rating After Mitigation		
Minor Negative Impact		

10.3.5 *Habitat Degradation resulting from Altered Flow Regimes*

Description of the Baseline Environment

A detailed Environmental Flow Assessment has been conducted for the Zambezi River stretching from the proposed Dam Wall down to the upper flood limits of Lake Kariba. The assessment was based on two assessment sites representative of the Upper Gorge (Site EF1) and Rejuvenated Cascades (Site EF2) zones of the Batoka Gorge. Eleven flow release scenarios were evaluated using a modelling approach known as DRIFT. The scenarios evaluated and the results obtained are summarised in *Table 10.45*. The present ecological status (PES) of the Zambezi River was assessed between A/B and B (unmodified to near-natural but with ecosystem functions essentially unchanged). Analyses of the peaking scenarios predict varying levels of decline. Operating as a run-of-river scheme without peaking leads to a slight decline in PES, whereas the peaking scenarios result in dramatic PES declines of C/D to D (moderately to largely modified with loss of natural habitat, biota and basic ecosystem function).

Table 10.45 Summary of the Results of Environmental Flow Assessments for Two Study Sites on the Zambezi River below the Proposed Dam Wall

Scenario	Minimum flow release	Predicted Impact at Site EF1	Predicted Impact at Site EF2
Base flow	Not applicable	Natural state	Natural state
Scenario 1: No defined flow conditions			
Sc1a	Run of river	No change from A/B	Slight decline: B to B/C
Sc1b	Wet season sediment flushing	No change from A/B	Slight decline: B to B/C
Scenario 2: Three-hour peaking every morning and evening with reservoir storage balanced over a 24 hour period			
Sc2a	94 m^3/s	Decline from A/B to D	Decline from B to D
Sc2b	180 m^3/s	Decline from A/B to C/D	Decline from B to D
Sc2c	216 m^3/s	Decline from A/B to C/D	Decline from B to D
Sc2d	255 m^3/s	Decline from A/B to C	Decline from B to D
Scenario 3: Three-hour peaking every morning and evening weekdays with reservoir storage balanced over a weekly period			
Sc3a	94 m^3/s	Decline from A/B to D	Decline from B to D
Sc3b	180 m^3/s	Decline from A/B to C/D	Decline from B to D
Sc3c	216 m^3/s	Decline from A/B to C/D	Decline from B to D
Sc3d	255 m^3/s	Decline from A/B to C	Decline from B to C/D

Proposed Project Activities

The patterns of flow release from the BGHES will have an overriding influence of the PES of the Zambezi River downstream of the dam wall. *Table 10.45* demonstrates that a run-of-river scheme (Sc1) will result in minimal change to the PES while a maximum level of peaking will cause the PES to drop from a slightly modified state (B) to a largely modified state with loss of natural habitat, biota and basic ecosystem function (D).

Sensitive Receptors

The sensitive receptor is the ecosystem as a whole from the dam wall site to the start of Lake Kariba. The Zambezi River ecosystem supports extensive aquatic habitats, riparian vegetation that serves as an important ecological corridor and sustains rich floral and faunal diversity and populations of large fauna including hippo, crocodile and elephant populations.

The flow release scenario may disrupt the natural movements of sediments down the river, which may result in the loss of sand banks in the lower reaches of the Zambezi above Lake Kariba. These sand banks are important habitat for a number of wading birds, waterfowl and Rock Pratincole. A scenario was therefore assessed which includes seasonal sediment flushing, which may have beneficial effects for wading birds, waterfowl and Rock Pratincole, but the overall assessment does not differ from a run-of-river scheme without sediment flushing (*Table 10.45*).

The environmental flow assessment conducted for the project reveals that the riparian habitats along the banks of the Zambezi River are unlikely to be affected by different flow release scenarios. Marginal vegetation along the river's edge, dominated by reeds, grasses and sedges may increase slightly as a result of peaking scenarios but the overall change will be limited. Mosses (Bryophyta) growing on rocks are expected to increase but will have limited impacts to the ecology as a whole.

Significance of the Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact from habitat degradation resulting from altered flow regimes will be a "**Major Negative Impact**" pre-mitigation, which assumes a worst case scenario (*Table 10.46*). The release of flow from the reservoir will be the result of management practices implemented during the operational phase of the BGHES. The resulting impact can range from major to minor based on the adopted release scenario as presented by the environmental flow studies.

The ecological responses to different hydrological flow scenarios are predicted based on computer modelling with inputs based on extensive fieldwork. The categories (A to F) into which ecological states of the river, associated habitats, fish and other components are relatively broad categories and there is a therefore a moderately high confidence that these predictions are accurate.

Table 10.46 Rating of Impacts Related to Habitat Degradation resulting from Altered Flow Regimes (Pre-Mitigation)

Type of Impact		
Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	This impact covers a large area and straddles both sides of the international border.

Duration	Long term	Operation of the BGHES will be managed over the long term.
Scale	Large	The Zambezi River is a large system and a long stretch of the river (up to Lake Kariba) could be impacted by the flow release system that is adopted.
Frequency	Daily	Daily peaking of flow releases may occur
Likelihood	Likely	Some level of daily fluctuation of peaking flow release is likely to occur.
Magnitude		
Large Magnitude		
Sensitivity of the Resource/Receptor		
High Sensitivity		
The Zambezi River is one of the large rivers in Africa and supports numerous ecosystem services and has a broad diversity of dependent habitats and species downstream of the proposed BGHES. The Batoka Gorge is considered to be a Critical Habitat due to the uniqueness of the ecosystem.		
Impact Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation Measures

<u>Avoid Peaking</u>

Results from the environmental flow assessment (*Annex J*) demonstrate that peaking operations are expected to have a significant negative impact on the integrity of the downstream Zambezi River ecosystem, and given the slope of the river through the Batoka Gorge, it is highly unlikely that these flows will be attenuated to any meaningful extent before they reach Lake Kariba. Peaking power releases will as far as possible be avoided at the BGHES.

With reference to *Section 10.2.6*, the BGHES will only be operated as a peaking scheme during the wet season (Feb-Aug) in accordance with the operating rules established by scenario AddPM04, which will meet both of the environmental criteria of no more than a 1.5 drop in overall ecosystem integrity and no more than a 25% reduction in abundance for 90% of the fish species represented in the DRIFT model.

<u>Downstream Monitoring of the Impacts of Flow Releases and Subsequent Management Adjustments</u>

A comprehensive ecological monitoring programme will be required to assess the impacts of the hydropower scheme on the downstream stretches of the Zambezi River. This monitoring programme will need to include hydrological aspects as well as the state of ecological receptors. The following aspects will be included (but not necessarily limited to):

- Water levels;
- Water quality;
- Sediment availability and movements;
- Biomonitoring of aquatic macro-invertebrates;
- Fish communities and harvesting levels;
- Riparian vegetation;
- Crocodile populations and harvesting of eggs; and

- River-dependent birds.

Develop and Implement a Sediment Management Plan

The Environmental Flow Assessment encourages the adoption of a scenario that includes an annual flushing of sediment from the BGHES Reservoir during the high flow season. The World Commission on Dams Report (2000) supports this approach and promotes the development and implementation of a sediment management plan as a means to minimise adverse impacts from altered flow regimes. A sediment management plan would consist of:

- Monitoring sediment in the reservoir, including quantitative and qualitative analysis of sediment to verify properties and pollution levels;
- Minimising sediment deposition in reservoirs where possible by sluicing or density current venting;
- Removing accumulated deposits where possible by drawdown flushing (drawing the water level down during high-flow seasons), and excavation of sediments; and
- Catchment management programmes to reduce sediment inflow to the reservoir where possible as part of a basin-wide plan.

Residual Impact (Post-mitigation)

If the proposed BGHES is only operated as a hydro-peaking scheme during the wet season (Feb-Aug) in accordance with the operating rules established by scenario AddPM04, and if this includes an annual flushing of sediments, then the downstream impacts to the Zambezi River resulting from the management of flow release will be limited. The significance of the residual impact resulting from altered flow regimes will be a "**Moderate Negative Impact**" post mitigation (*Table 10.47*).

Table 10.47 Rating of Residual Impacts Related to Habitat Degradation resulting from Altered Flow Regimes (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	This impact covers a large area and straddles both sides of the international border.
Duration	Long term	Operation of the BGHES will be managed over the long term.
Scale	Small	Limited change to the downstream Zambezi River will occur if the proposed BGHES is only operated as a hydro-peaking scheme during the wet season (Feb-Aug) in accordance with the operating rules established by scenario AddPM04, and if this includes an annual flushing of sediments
Likelihood	Possible	Some level of daily fluctuation of peaking flow release is likely to occur, but mitigation measures can reduce the likelihood of serious impacts.
Magnitude		
Small Magnitude		
Impact Significance Rating After Mitigation		
Moderate Impact		

10.3.6 Eutrophication and Associated Floating Aquatic Weed Infestation

Description of the Baseline Environment

The risk of eutrophication of the BGHES reservoir based on analyses of historical water quality data is considered possible and is increased by the poor state of upstream sewage management facilities in Victoria Falls, Livingstone and Kasane towns. Initial inundation of the terrestrial habitats of the Batoka Gorge will result in the decomposition of large quantities of vegetative biomass and arid-adapted soils will become waterlogged, and large quantities of nutrients will therefore be released into the reservoir during its initial period.

Eutrophication could reach a level that leads to fish die-offs but may be restricted to the initial stages of the reservoir development. Water quality may improve to a mesotrophic level but this may not provide sufficient water quality for all fish species required to maintain a balanced ecosystem and productive fishing industry.

Infestation outbreak of floating aquatic weeds occur upstream of the proposed BGEHS, with Water Hyacinth (*Eichhornia crassipes*) occurring in the Livingstone sewage facilities (Livingfalls Biopower website) and significant Kariba Weed (*Salvinia molesta*) infestations in the Chobe river system (Naidu *et al.* 2000). Other potential floating weeds include the floating fern Azolla (*Azolla filiculoides*) and Duckweed (*Lemnoideae* species).

These weeds can be useful in the bioremediation processes as they grow rapidly (doubling in mass in three to 10 days) and absorb excess nutrients, particularly nitrogen and phosphates. However, their control is difficult and infestations that blanket the water surface dramatically increase the level of water loss and deplete the oxygen levels of the water below, leading to collapse of fish populations and other aquatic life.

Proposed Project Activities

The primary Project activity that may lead to an infestation of floating aquatic weeds is the inundation of the Batoka Gorge which is expected to lead to eutrophication of the waters as the initial standing biomass of vegetation decomposes. This impact will be cumulative with the upstream dysfunctional sewage systems of Livingstone and Victoria Falls towns.

Sensitive Receptors

The altered aquatic ecology that will develop in the proposed BGHES represent the primary sensitive receptors for this impact, however aquatic weed infestations could spread to downstream river habitats, Lake Kariba and even be spread by birds or other means to upstream river habitats. Depleted oxygen levels of the reservoir would impact the aquatic habitats of the Zambezi River for a stretch below the tailrace release point.

Significance of the Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact of habitat degradation through aquatic alien weed infestation as a result of eutrophication will be a "**Moderate Negative Impact**" pre-mitigation (refer to *Table 10.48*).

The eutrophication response of the reservoir is uncertain and is predicted, however an assumption is made that eutrophication may occur but will not be a permanent feature of the proposed development. Weed infestation in response to eutrophication is an unplanned event and there is little confidence on the timing, extent or severity of this impact.

Table 10.48 Rating of Impacts Related to Aquatic Habitat Degradation through Floating Alien Weed Infestation as a Result of Eutrophication (Pre-Mitigation)

Type of Impact		
Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to Regional	The entire reservoir surface could be affected and may serve as a source of infestation for other areas, and have an impact over a greater area than just the reservoir surface.
Duration	Long term	Eutrophication of then reservoir water body is expected to decline as the level of decomposition decreases and the river is able to flush the reservoir.
Scale	Large	Potentially the entire reservoir surface could be affected
Frequency	Initially Continuous, declining thereafter	A severe infestation of aquatic weeds may occur as a result of the eutrophication, but is expected to decline after a period of time.
Likelihood	Likely	Upstream sources of infestation do exist and the probability of the eutrophic waters leading to a booming growth of floating aquatic weeds is likely to occur.
Magnitude		
Medium Magnitude		
Sensitivity of the Resource/Receptor		
Medium Sensitivity		
The aquatic habitats at risk of alien weed infestations will be fundamentally modified from their natural state as a result of reservoir development, however important ecosystem services will be dependent on this habitat.		
Impact Significance Rating Before Mitigation		
Moderate Negative Impact		

Mitigation Measures

Efficient Functioning of the Livingstone and Victoria Falls Sewage Works

The physical impact assessment highlights the need to raise the standard of upstream sewage facilities and recommends that the ZRA motivate for allocation of funds from the respective governments or interested donors.

Promote Flushing of the Reservoir in Early Stages

The initial decomposition of flooded vegetation will contribute to eutrophication during the initial filling. The physical impact assessment recommends removal of vegetation from the flood area but this is unlikely to be practical due to the inaccessibility of much of the Batoka Gorge. Gradual filling together with extensive flushing of the reservoir will reduce the quantities of vegetation flooded at any one time and will slow down the release of nutrients into the water.

Biological Control of Floating Aquatic Weeds

Effective biological control mechanisms are available for many of the floating aquatic weeds. Specialist advice on the management of floating aquatic weeds will be sought to manage this issue. The Zambezi River is a watercourse shared by other countries, and it will be important to understand the position of the Zambezi Watercourse Commission (ZAMCOM) on biological control in this shared watercourse. The presence of extensive floating aquatic weeds could lead to a public outcry against the BGHES as these plants are widely considered to be undesirable. Careful and proactive management of information to downstream users, stakeholders and the general public will be needed to maintain the ZRA's reputation.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the residual impact of eutrophication and associated aquatic weed infestation will be a "**Minor Negative Impact**" post mitigation (refer to *Table 10.49*).

Table 10.49 Rating of Residual Impacts from Aquatic Habitat Degradation through Floating Alien Weed Infestation as a Result of Eutrophication (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The area of potential infestation remains the same as described for the impact pre-mitigation.
Duration	Short term	Regular flushing and effective and proactive control measures could reduce severe eutrophication of the reservoir. Upgrading of upstream sewage facilities would reduce the long term eutrophication risk.
Scale	Small	Effective biological control could minimise an infestation of aquatic floating weeds
Frequency	Once-off	Severe eutrophication is expected initially, but could decline with appropriate management.
Likelihood	Possible	Effective and proactive control measures could minimise the risk of eutrophication and the associated growth of aquatic weeds.
Magnitude		
Small Magnitude		
Impact Significance Rating After Mitigation		
Minor Negative Impact		

11 SOCIO-ECONOMIC, HEALTH AND CULTURAL HERITAGE IMPACT ASSESSMENT

This *Chapter* assesses the predicted socio-economic, health and cultural heritage impacts associated with the Proposed BGHES (the Project), specifically for the following Project components:

- Dam wall and impoundment, including a spillway;
- Surface power houses, one on each side of the river; and
- Project townships (in both Zambia and Zimbabwe) and other ancillary infrastructure (such as quarries, spoils area and batching areas).

Potential social impacts (both positive and negative) of these components of the Project are discussed in the following sub-sections and include the following:

Displacement

- Physical displacement
- Economic displacement of land based livelihoods
- Economic displacement of fishing activities
- Economic displacement of downstream river users

Positive Economic Benefits for the National Economy

Negative Economic Impact on Tourism

- Economic impact and displacement of White Water Rafting Activities
- Economic impact and displacement of Non-River Based Tourism Activities
- Impact on Accommodation in the Gorge
- Local Economic Impact on Victoria Falls and Livingstone

Social Benefits

- Local employment opportunities
- Local procurement of goods and services
- Opportunities for community development
- Unmet expectations

Impacts related to In-Migration

Impacts on Health and Safety

- Increased incidence of communicable diseases
- Increased incidence of malaria and other vector borne diseases
- Increased risk of traffic accidents
- Disturbance due to dust and noise
- Impact to community security

- Worker Health and Safety Impacts

<u>Change to Socio-Cultural Heritage and Heritage Resources</u>

- Destruction/Disturbance to Sites of Heritage Value
- Impacts to Living Cultural heritage

11.1 DISPLACEMENT

11.1.1 Physical Displacement

Based on fieldwork and review of satellite imagery of the Project area, physical displacement (loss of land for residential or business purposes) is not anticipated for these components of the Project including the location of the dam, area of inundation, proposed location of the staff townships and quarries is not currently inhabited. This was confirmed in field visits to these areas in December 2018 and June 2019.

The following activities may result in economic displacement, which is discussed in the next section:

- <u>Staff townships</u> – current preferred footprints have been selected by the ZRA to avoid settled areas, however these are likely to have economic displacement implications.

- <u>Area of inundation</u> – is within the gorge, where access is challenging and there are no inhabitants.

- <u>Dam wall and associated infrastructure</u> – there is no displacement associated with the reservoir impoundment, waterways, spillways and its associated powerhouses.

During operation, no further land will be required; hence additional displacement is not anticipated.

11.1.2 Economic Displacement of Land Based Livelihoods

Economic displacement is defined as the loss of income, or access to livelihood activities resulting from the acquisition of land associated with a project.
Economic displacement can either be permanent or temporary. The loss of access to land will take place during the construction phase of the Project and could continue to remain in effect or restricted during the operational phase.

The land required for Project infrastructure in both countries is summarized in *Table 11.1*.

Table 11.1 Project Infrastructure Land Requirements

Project Component	**Land Required –Zimbabwe**	**Land Required- Zambia**
Dam wall, impoundment including spillway	Land is located immediately along the banks of the river	Land is located immediately along the banks of the river
Staff township area	706 hectares	491 hectares
Quarry	40.70 hectares	70.40
Total	**746.70 hectares**	**561.40 hectares**

Box 11.1 Description of the Baseline Environment

The communities within the Project Area rely heavily on agricultural activities for subsistence. The majority of produce (with the exception of sunflower and cotton) are consumed by the household or within the community. If food produce is sold, it is usually to community members within the villages. Often this may be done on a barter system, in exchange for other goods, as opposed to cash. Animal husbandry, gardening and crops served as primary livelihood activities. The most common crops grown are maize, sorghum, sunflowers, millet and groundnuts are the most important crops. . Poor soil fertility and climatic factors limit farming efforts, as does reliance on traditional farming methods.

Livestock important for livelihoods were cattle, chickens, goats and pigs.
Vegetable gardening is undertaken in all communities throughout the year and used for both subsistence and economic purposes. Garden plots are cared for primarily by women and are often communal in nature.

All villages in the Project Area that attended FGDs in 2019 were found to be harvesting ecosystem services for a number of livelihood activities (including curios). Resources are harvested by both men and women for fruit, honey, medicinal plants, honey, firewood, livestock fencing, housing material (roof beams, wale poles etc.), furniture and charcoaling.

Hunting was only undertaken in one community (Lafalale).

Limited formal employment opportunities exist.

Proposed Project Activities - Construction

The following facilities will require land and may cause economic displacement:

- Staff townships and associated infrastructure.
- Quarries and borrow pits for dam construction material. These will be required to source material for the construction of the dam wall and access roads.

There is no displacement of land based livelihoods associated with the reservoir impoundment and its associated infrastructure. There is however economic displacement because of loss of access to the Zambezi river for its current purposes. This is addressed in the impacts that follow this. (Fishing and downstream river users)

In addition, there is the potential for damage or loss of access to water sources including pumps, springs, boreholes/wells and natural water courses used by local communities for drinking, irrigation and for use by animals during construction. Furthermore, any Project induced influx is likely to be associated with increased demand for natural resources and/or reduced access to them (see *Section 11.5*).

Proposed Project Activities - Operation

During operations, no further land acquisition/access associated with these components of the Project is anticipated.

Impact Description

Economic displacement with reference to land based livelihood activities can result in:

- loss of initial investment (time and resources) for establishing crops;
- stress and ill-health as a result of disruption to livelihoods;
- increased food insecurity and potential for nutritional diseases;
- reduced income and economic activity within the communities; and
- tensions between stakeholders and Project developers.

This loss of land may also result indirectly from the development promoting new land uses in the project area (that will generate a higher economic return) and as a result land currently been utilised for land based livelihoods no longer being available. In Zimbabwe during fieldwork undertaken in 2014, a buffer zone of 2 km from the river to the adjacent communities was under consideration by the District Council. The intention of this zone is to improve ecotourism opportunities and hence it is likely that land loss will be realised. This is also possible in Zambia given that the Mukuni Development Plan sees tourism as one of the key economic opportunities for the Chiefdom. Fieldwork undertaken in 2018 indicate that there has been no further progress on establishing the buffer zone in Zimbabwe.

Sensitive Receptors

Loss of land will particularly affect those households reliant on one natural resource-based livelihood activity. Vulnerability of affected people is heightened by dependency on agricultural and other land based activities and limited education to take advantage of other economic opportunities, where these exist.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above and the fact that adjustments to the precise location of the staff township can be made to minimize displacement, it is the opinion of this ESIA that the impact will be a "**Moderate Negative Impact**" pre-mitigation (refer to *Table 11.2).*

Households facing economic displacement will experience disruption to their livelihoods and without support are unlikely to be able to re-establish their current livelihoods. The amount of productive land that will be lost as a result of the Project and the precise number of people that will be affected will be fully quantified during the Census and Asset Inventory (CAI) which will be undertaken as part of the preparation of Resettlement Action Plans (RAPs).

Table 11.2 *Rating of Impacts Related to Economic Displacement of Land Based Livelihoods (Pre-Mitigation)*

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact will be experienced primarily by households affected by land take for the staff townships and quarries i.e. those located within the Districts of Kazungula (Zambia) and Hwange District (Zimbabwe).
Duration	Permanent	It has been assumed that access to specific land lost will not be re-established in the same place, however alternative areas may be identified
Scale	Medium	Displacement will lead to a fundamental change in the livelihoods of people affected, especially considering most are reliant on land based livelihoods.
Frequency	One-off	The act of displacement will only occur once.
Likelihood	Likely	As land is required for various components of the Project, and there is evidence of cultivation and grazing on some of the land required, the likelihood of economic displacement is high.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Subsistence based livelihoods means communities affected by economic displacements are vulnerable.		
Significance Rating Before Mitigation		
Moderate Negative Impact		

Mitigation/Management Measures

The following mitigation measures will be applied:

Pre-construction and Planning

- Position infrastructure to avoid physical displacement and minimize economic displacement. The positioning of Project infrastructure will be designed to avoid resettlement requirements, and minimize economic displacement as far as practicable, taking into account feasibility of the location, as well as safety and legislative restrictions.

- Prepare Livelihood Restoration Plans (LRPs) for the BGHES. Project Resettlement Policy Frameworks (RPFs) have already been compiled (refer to *Annex L*). The RPFs are aligned with both national requirements and international standards. These documents:

    - Set out guidelines on how to deal with displacement;
    - Set out procedures to follow in order to address compensation issues;

- Identify affected households and provide a consultation record for the engagement with these parties;
- Identify and record assets held by each affected household that will be displaced;
- Detail how households will be compensated for loss of assets and disruption to livelihood activities;
- Present livelihood restoration and improvement measures;
- Present a monitoring and implementation plan;
- Present anticipated costs of resettlement.

Also to note, LRPs have been developed for the staff townships (in both Zambia and Zimbabwe) and the access road in Zimbabwe. These are attached as Annex Annexure S.

- Establish a community development programme. The Project will consult with affected communities and in partnership with them, identify community development initiatives, based on their development priorities.

- Implement the Grievance Redress Mechanism (GRM). The ZRA will implement and disseminate information regarding the GRM that has been developed for the Project (refer to *Annex E* of the ESIA report). Stakeholders will be made aware of the key guiding principles of the mechanism, as well as how and where they can submit any grievances.

- Re-establish and promote access to replacement natural resource source areas where viable pre-construction.

- Ensure communities participate in pre-construction harvesting of resources as part of clearing activities. Identify optimal methods of storing harvested materials.

- Work with Project affected communities and local authorities to assist in protecting land-based resources. This will include the provision of education for local agencies and communities related to threats to biodiversity from human activities and sustainable harvesting and grazing of natural resource.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the economic displacement of subsistence agricultural activities will be reduced to a "**Minor Negative Impact**" (refer to *Table 11.3*).

Residual impacts will require determination and continual assessment through a post-resettlement evaluation. A carefully implemented consultation process with all affected people, the development and implementation of a RAP including the livelihood restoration element, which affords households improved and more secure livelihoods, assistance to vulnerable people and the introduction of livelihood optimisation projects, will greatly reduce the severity of the impact.

Table 11.3 Rating of Residual Impacts Related to Economic Displacement of Land Based Livelihoods (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This rating would not change and the impact would still occur at the local level within Zambia and Zimbabwe.
Duration	Permanent	Economic displacement will be permanent.
Scale	Small	Optimisation of location of Project infrastructure will reduce numbers affected. Implementation of RPF and subsequent RAPs will ensure livelihoods are not adversely affected, and will ideally be improved.
Frequency	One-off	The act of displacement will only occur once.
Likelihood	Likely	Some displacement will occur as a result of the Project.
Magnitude		
Medium		
Significance Rating After Mitigation		
Minor Negative Impact		

11.1.3 Economic Displacement of Fishing Activities

This *Section* discusses the impact that the Project will have on existing fishing activities and the consequential effects to livelihoods.

Box 11.2 Description of the Baseline Environment

The Zambezi and other tributaries located downstream from the proposed BGHES are used by villagers from both Zimbabwe and Zambia.

Fishing is done by men only and is undertaken at fishing camps along the Zambezi River and other rivers in the Project Area where men stay between a few days and a week. Fishermen came in season from as far as the DRC to make use of fishing camps in the Project Area

Fishermen reportedly catch a wide variety of species including bottle fish, tiger fish and Kariba bream. Fishing is undertaken in both the rainy and dry season; however, the catch is reported to be larger in the rainy season (between December and March). Fish are caught using both traditionally woven nets and baited fishing lines. Once caught, fish are commonly processed to preserve it, either through drying, frying or smoking.

Fish are sold at market within villages, in Victoria Falls, Mukuni village, Livingstone and as far as Kinshasa by men and women. They are transported to market by light vehicles rented by fishermen. Only some of the catch is used for household consumption.

Proposed Project Activities - During Construction

During construction, access to fishing points will be restricted in the areas in which the dam wall and powerhouses will be constructed, as well as the gorge in general. Security measures, such as the patrol of the area by security personnel, will help to enforce access restrictions.

Impact Description

Loss of access to fishing areas will affect income levels and food security of fishermen and their families. This can have detrimental effects on standards of living and health and wellbeing, as families struggle to meet their basic needs.

Sensitive Receptors

Sensitive receptors will be fishermen, especially those who are dependent upon it for their primary livelihood. Those who do not possess the necessary fishing licenses will also be vulnerable as they will be at risk of exposing their illegal activity to security personnel, thereby placing them in danger of arrest.

Significance of Impact (Pre-mitigation) - Construction

Based on the analysis provided above, it is the opinion of this ESIA that the impact from a Project perspective will be a "**Moderate Negative Impact**" pre-mitigation (refer to *Table 11.4)*. However, it is important to note that for those households who rely primarily on fishing to sustain their well-being (i.e. income levels and food security), the impact will be major.

Table 11.4 Rating of Impacts Related to Fishing during Construction (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact will be limited to those households who use the Batoka Gorge and the surrounding environs for fishing purposes
Duration	Medium term	This impact will occur for the duration of the construction period (i.e. 7 years).
Scale	Medium	The precise number of fishers has not been confirmed, however as indicated in the baseline survey, for most it is not their primary occupation. However, for those impacted the impact will be significant without mitigation.
Frequency	Constant	Fishing is undertaken all year round and access to fishing sites at and around the gorge will be restricted for the whole of the construction period.
Likelihood	Likely	Placement of Project infrastructure in an area that is used to undertake fishing by local households makes this impact likely.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Fishing is not undertaken as a primary livelihood activity and less than 20% of households fish. Those who do fish however are unlikely to have licenses.		
Significance Rating Before Mitigation		
Moderate Negative Impact		

Mitigation/Management Measures

The specific mitigation measures required include the following:

- Development of a livelihood restoration programme specifically focused on the impacts and needs of those who fish in the Project area.

- Consultations with affected stakeholders regarding potential impacts and the need for transitional livelihood support, establishment of fishing monitoring program and feasibility of establishing alternative fishing areas that will not be affected by the Project and/or alternative livelihood options.

- Re-establish and promote access to alternative fishing areas where viable pre-construction.

- Assess the need for compensation as part of livelihood restoration planning.

Residual Impact (Post-mitigation)

The proposed mitigation measures are expected to address the needs of some affected households, however it is possible that for those whose well-being relies solely on fishing, livelihood restoration may not be achievable. Hence the significance of the impact will remain "**Moderate Negative Impact**" (refer to *Table 11.5)*

Table 11.5 Rating of Residual Impacts Related to Fishing (Post-Mitigation) - Construction

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This rating would not change and the impact would still occur at the local level.
Duration	Medium term	This impact will occur for the duration of the construction period. However, after construction, access will be re-established to the Gorge.
Scale	Small	Size of impact is limited by the relatively low number of people reliant on it as their primary livelihood activity. Mitigation will help households to find alternative fishing area or livelihood support.
Frequency	Constant	This rating will not change.
Likelihood	Likely	This rating will not change as the placement of Project infrastructure on Batoka Gorge will restrict fishing activities to a degree.
Magnitude		
Medium Magnitude		
Significance Rating After Mitigation		
Moderate Negative Impact		

Proposed Project Activities - During Operation

After water impoundment, an extensive reservoir of deep standing water will be created which could be used for fishing purposes. The dam will sit approximately 90 m below the top of the Gorge, however, making current fishing practises unlikely to continue, although boat fishing opportunities could be fenced. Also, as noted in *Chapter 10: Biophysical Environmental Impact Assessment,* fishing habitats will be fundamentally altered by the Batoka reservoir as a result to changes in water temperature, quality and flow. Population size of the riverine fish communities will be significantly reduced with the loss of the upstream gorge habitat, and an interim die-off of fish is possible as a result of early eutrophication due to the decomposition of flooded terrestrial vegetation. However, pelagic habitats will be created and large populations of Tiger fish could potentially be established, if adequate prey populations (such as pelagic fish) exist.

Once access roads have been developed (e.g. new roads constructed or existing ones upgraded), access to the greater vicinity of the Batoka Gorge will be enhanced. This could serve to increase fishing activities in the area.

Significance of Impact (Pre-mitigation) – During Operation

Fishing may improve as a result of the development of a reservoir. However, it is not known if the potential increase of Tiger fish would match the decline in riverine fish. The degree of household reliance on fishing downstream has not been fully quantified, however as *Chapter 10: Biophysical Environmental Impact Assessment* notes, change in the flow regime of the river downstream could result in a decline in fish resources. Any decline in fish numbers has the potential to impact on food security and income levels of fishermen.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is the opinion of this ESIA that the impact will be a "**Minor Negative Impact**" pre-mitigation (refer to *Table 11.6)*

Table 11.6 Rating of Impacts Related to Fishing during Operation (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact will be felt by households who use the Batoka Gorge and the surrounding environs for fishing purposes, as well as by fishermen who use the Zambezi River downstream of the Project.
Duration	Long term to Permanent	The impact will be permanent as long as the reservoir remains.
Scale	Small	Size of impact will be limited by the relatively low number of people reliant on it as their primary livelihood activity.
Frequency	Constant	Fishing is currently undertaken all year round so any decline in fish numbers impact will be felt constantly for the duration of the operation period.
Likelihood	Likely	Re-establishment of access to fishing sites and use of the reservoir for fishing purposes makes this impact likely.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Medium sensitivity on the basis that fishing is not undertaken as a primary livelihood activity and less than 20% of households fish. Those who do fish however are unlikely to have licenses thus the presence of Projects could make them vulnerable to detection.		
Significance Rating Before Mitigation		
Minor Negative Impact		

Mitigation/Management Measures

The specific mitigation measures required are therefore all those that were mentioned for the Construction period for the Fishing impact, as well as the following:

- Establishment of fisheries. In collaboration with the Departments / Units of Fisheries in Zambia and Zimbabwe, fisheries will be established in the reservoir created by the inundation. Two types of fisheries could be established, namely a capital intensive Kapenta-based pelagic fishery and an artisanal gill-net fishery (refer to Chapter 10: Biological Environmental Impact Assessment). As a result of the introduction of Karpenta, a healthy population of Tiger Fish in the reservoir may be established, provided water quality is maintained. The fisheries could be utilized as a commercial resource which can be marketed regionally. Sport fishing for Tiger Fish could also be developed into a valuable industry that supports local economies and should receive consideration in the management of the fisheries.

- As part of the livelihood restoration programme, provide support to households and / or local enterprises in terms of how they can use the fisheries to support engagement with the tourism trade.

Residual Impact (Post-mitigation)

This impact has the potential to be a "**Positive Impact**" if fisheries are developed that can be used to sustainably harvest and sell fish in the local and regional market. Experience from other dam projects around the world suggests that these fisheries are likely to be more productive than the current riverine fishery. However, they would need substantial development. The fisheries would have the potential to provide or enhance the income derived from fishing, and potentially tourist facilities. See *Table 11.7* below.

Table 11.7 Rating of Impacts Related to Fishing during Operation (Pre-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to Regional	This impact would primarily be experienced by the districts of Hwange in Zimbabwe and Kazungula in Zambia however, the impact could be felt at the regional scale if tourism numbers increase as a result and fish is sold to markets outside of the local area.
Duration	Long term	The fisheries could be used for the total life of the operation provided they are well maintained.
Scale	Medium	A greater number of households may undertake fishing than what do previously. Fishing activities may result in increased household income if catch is sold.
Frequency	One-off	Establishment of the fisheries will be a one-off event.
Likelihood	Possible	Establishment of the fisheries will need investment from relevant authorities.
Significance Rating After Mitigation		
Positive Impact		

11.1.4 *Economic Displacement of Downstream River Users*

This impact is anticipated during both the Construction and Operational Phases of the project as a result of changes to the flow regime of the Zambezi River.

Box 11.3 Description of the Baseline Environment

Limited downstream users have been identified between the proposed dam wall and Lake Kariba. These are predominantly informal abstractions (i.e. unlicensed) and in support of agricultural activities. Vegetable gardening is the primary agricultural activity being undertaken. These users are also not located immediately adjacent to the proposed dam wall and are found at least 50 km away, thus reducing impacts that may be felt through fluctuating releases from the Dam. Abstraction for these uses is for the most part via hand held buckets (on Zambian side) and submersible pumps (Zimbabwean side).

Crocodile farming, tourism, domestic use and fishing are also water uses identified in the area. Significant water users have been identified on the Zimbabwean side and include Hwange Colliery, ZINWA via ZPC and numerous agricultural schemes.

Larger, more intensive water users are associated with Lake Kariba, but it has been assumed for the purposes of this study, that this impact will not be felt as far downstream as Kariba.

Proposed Project Activities - During Construction and Operation

During construction and operation there may be a change to the flow regime – with a river diversion during construction and a dam release regime, which may not be run-of-river during the operational phase of the project. In addition to impacts on water flows, there could also be impacts on water quality, most likely heightened following the initial flooding of the dam and release of nutrients into the system.

Impact Description

Fluctuating water levels and quality may impact on downstream water users in the following ways:

- Exposure of pumps during low flows;
- Modified distance to abstraction points;
- Flooding of agricultural activities;
- Disturbance of crocodile nesting sites;
- Modified fishing as a result of a modification to species composition;
- Poor water quality impacting on human and livestock health.

Sensitive Receptors

Sensitive receptors will be those whose only livelihood is reliant on water from the Zambezi River. Specifically those that do not have an alternative for domestic water are likely to be the most vulnerable to this impact.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is the opinion of this ESIA that the impact will be a "**Moderate Negative Impact**" pre-mitigation (refer to *Table 11.8)*

Downstream water users are limited as the areas are not heavily populated and these are all found further than 50 km downstream where impacts may have already been reduced as water fluctuations will not be as extreme.

Table 11.8 Rating of Impacts Related to Downstream Impacts during the Construction and Operational Phase (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact will be limited to those households who use the water from the Zambezi River.
Duration	Long term	This impact will occur for the duration of the dam operational period.
Scale	Small	There are relatively few downstream water users that have been identified, although impacts on these users could in some cases increase their vulnerability.

Frequency	Constant	Constant, but likely to be more severe during periods of lower flow when releases from the dam may be reduced or times of flooding when releases are much higher.
Likelihood	Likely	Downstream water impacts are anticipated as a result of this project.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
There are only a few operations/households completely reliant on these activities for their livelihood and therefore although limited, there is some level of flexibility should these livelihoods be impacted on.		
Significance Rating Before Mitigation		
Moderate Negative Impact		

Mitigation/Management Measures

The specific mitigation measures required are therefore all those that were mentioned in *Section 11.1.2*, as well as the following:

- Involvement of the affected households in the stakeholder engagement programme for the Batoka Gorge ESIA so they are able to provide comment thereon.

- Communication to affected stakeholders about the exact nature of impact once flow releases have been defined by the Engineers.

- A detailed survey needs to be carried out during Project design of the pumping station and submersible pump intake levels for the abstractions that occur between the proposed BGHES and the headwaters of Lake Kariba. In the event that these levels fall below the predicted water level corresponding to the final chosen minimum flow condition, compensation (financial or in-kind) will be provided for abstractors to modify their pumping stations accordingly.

- Detailed surveys will also be undertaken of the agricultural activities downstream so that if there are impacts as a result of flooding, these can be appropriately compensated for. An understanding of the seasonality of the subsistence agricultural activities and harvesting and growing timeframes will need to be developed so as to ensure that the duration of livelihood loss is considered in the calculation of compensation.

- Environmental flows are to be maintained during all phases of the Project.

- See further measures detailed in *Section 10.2.3* with regard to water quality management and the management of dam releases.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the impact will be reduced to "**Minor Negative Impact** (refer to *Table 11.9)*

Table 11.9 Rating of Residual Impacts Related to Downstream Water Users (Post-Mitigation) – Construction and Operation

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This rating would not change and the impact would still occur at the local level.
Duration	Medium term	This impact will occur for the duration of the dam operational period.
Scale	Small	Mitigation will help households sustain themselves should there be an impact on their livelihood activities.
Frequency	Constant	This rating will not change.
Likelihood	Likely	This rating will not change as the placement of Project infrastructure on Batoka Gorge.
Magnitude		
Medium		
Sensitivity reduced to Low		
Significance Rating After Mitigation		
Minor Negative Impact		

11.2 *POSITIVE ECONOMIC BENEFITS FOR THE NATIONAL ECONOMY*

It is expected that there would be an estimated unserved demand of 227 MW in Zambia when the proposed BGHES starts operating in 2022. In Zimbabwe, current predictions are for an unserved demand of 444 MW. The BGHES is anticipated to provide 2,400 MW (1200 MW per country) which will meet this demand and provide additional power. Economic benefits therefore likely to be provided by the Scheme include:

- Meeting current and future demand for electricity and therefore reducing the impacts on ongoing electricity blackouts;
- Generating profits as a result of the sale of this electricity;
- Enabling business development and household benefits that result directly from the provision of reliable power in both countries; and
- Increased employment opportunities as a result of spin-off economic benefits.

Box 11.4 Description of the Baseline Environment

Approximately 22% and 41% of the national populations of Zambia and Zimbabwe respectively have access to electricity. Connectivity is much lower however in rural areas. Zimbabwe in particular suffers from frequent load shedding and the demand for power in both countries is expected to become more acute as their economies grow. Most villages in the Project area do not have a connection to the electricity transmission supply. Wood is the most common energy source used in both countries however, solar panels, batteries, paraffin, generators and torches and charcoal are also utilised for lighting, cooking and warming requirements. Women are primarily responsible for collecting wood and making charcoal. The engineering team for the BGHES have assumed that the dam with a FSL of 757 m will require an investment of US$2 625 million.

Proposed Project Activities - During Construction and Operation

National economic benefits will accrue predominantly during the operational phase of the project. This will be a result of power generation and either use within Zimbabwe and Zambia or the export thereof. Infrastructure development costs will be incurred during the Construction Phase of the Project.

Impact Description

It is anticipated that the power generated as a result of the BGHES will contribute as follows to the power generation requirements of Zimbabwe and Zambia:

- Installed Power (MW) of Batoka Gorge would cover:
  - 38% of the peak demand for Zambia in 2025 and 29% in 2030.
  - 37% of the total peak demand for Zimbabwe in 2025 and 32% in 2030.
- The generation in GWh would generate sufficient electricity to supply:
  - 23% of the generation forecast in Zambia in 2025 and 18% in 2030.
  - 29% of the generation forecast of Zimbabwe in 2025 and 25% in 2030.

In addition, the Scheme will provide electricity at a cost that would be considerably lower than most of the reasonable alternatives. In Zambia, it is expected to generate the fourth cheapest electricity of the 17 planned power plants in Zambia and in Zimbabwe it will be the lowest cost for electricity production.

The costs of this electricity generation have been modelled against the anticipated benefits. Costs are anticipated to include:

- The building and running of the proposed BGHES.
- Connection costs and electrical appliances for households and businesses wanting to utilise the additional power.

- Cost of the loss of tourism activities to the Project area.

Benefits associated with the scheme include:

- Savings in generator costs.
- Savings from fewer power outages.
- Alternative fuel savings for individual households.
- Increased income generation for individual households.
- Health benefits for households.
- Export revenue if the electricity is to be exported.

The cost-benefit model (which only considers direct costs and benefits) has assumed various scenarios for the operation of the dam and concludes overall that:

- An NPV of US$ 11,485 million is anticipated for operating at a FSL of 757 m amsl.

- A BCR of 4.67 i.e. for each US$1.00 spent this is anticipated to be the ratio of return for operating at a FSL of 757 m amsl.

- IRR of 28% for operating at a FSL of 757 m amsl.

- If the electricity is to be exported, this will increase the BCR to between 5.17 and 5.19 and the IRR to 32%.

Macro-economic benefits which quantify the impact of the expenditure related to the costs and benefits on the Zimbabwean and Zambian economies are anticipated to be as follows:

- A cumulative contribution of US$ 1,458 million to the GDPs of both countries by the end of the construction phase of the project.

- GDP contributions of 2035 of US$ 45,670 million are anticipated by 2035.

- Direct jobs are anticipated to increase from greater than 1500 from the 3rd year of construction to 54,000 in 2030

- Indirect jobs are estimated to be 11,900 (2016), 94,000 (2022) and 110,000 (2035).

Multiplier effects have been used in the macro-economic analysis (both costs and benefits) using multipliers derived from a Social Accounting Matrix.

Sensitive Receptors

Sensitive receptors are those that are negatively impacted on in terms of their economic livelihood and this impact has been assessed further as part of *Section 11.3.*

Significance of Impact (Pre-mitigation) – Construction and Operation

Based on the analysis provided above, it is the opinion of this ESIA that the impact will be a "**Positive Impact**" pre-mitigation (refer to *Table 11.10).*

Benefits of the proposed Scheme at a National Level are expected to be at a large scale in terms of returns and extent. Where there is an export of the electricity, this may then also manifest as an International Benefit.

Table 11.10: Rating of Impacts Related to National Economic Benefits during Construction (Pre-Mitigation)

Type of Impact		
Direct Positive Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	International	There is a high possibility that some of the power generated will be exported in the southern African region. This will have benefits extending beyond the border of the two countries concerned.
Duration	Long term	This impact will occur for the life of the Scheme.
Scale	US$ 45,670 million GDP contribution anticipated by 2035	Size of impact in terms of GDP contribution and employment anticipated to be significant.
Frequency	Constant and Ongoing	Benefits will be experienced for the life of the Operation on an ongoing basis
Likelihood	Likely	These benefits will be experienced should the Project proceed.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Given the current electricity demand impacts, electricity users in both economies are likely to be highly sensitive to improvements to the current state. Locally the income on individual businesses utilising the river will be experienced.		
Significance Rating Before Mitigation		
Positive Impact		

Mitigation/Management Measures

The specific mitigation measures required to minimise the economic negative impact associated with the impact on the local economy are detailed in *Section 11.3.4*

No enhancement measures for this impact are currently envisaged with the exception of maximising power generation through the operational regime. This will influence the significance of the impact on the local river based tourism businesses in the area.

11.3 NEGATIVE IMPACT ON TOURISM

With the development of the proposed dam to the 757 m FSL, the area from the top of the 4th Gorge on the Zambezi to the dam wall will be inundated. This will therefore remove any rapids downstream of mid-3rd Gorge (Rapid 5) and reduce flows above this, having a resultant impact on activities making use of this stretch of water. This will preclude white river rafting and Jet Extreme Boating on this stretch of the river while under inundation (which may be slightly lower when there is a risk of flooding the Victoria Falls Power Station). Other tourism activities taking place in the Batoka Gorge including guided birding and angling, hiking and camping trips and helicopter and microlight trips may continue and the impact thereof is detailed in *Section 11.3.2* Other tourism activities taking place in the Victoria Falls/Livingstone area that are not reliant on this stretch of river are anticipated to continue and the impact on these is detailed in *Section 11.3.2.*

11.3.1 Displacement of White River Rafting Activities

Box 11.5 Description of the Baseline Environment

The rafting industry in Victoria Falls and Livingstone has played a vital role in establishing adventure tourism in the area (Rogerson 2004).

There are approximately 20 000 rafting trips a year (the average over the past five years). Although rafting tourist numbers have fallen since the 1990s, rafting still plays a major role in attracting tourists to the area. All of the rafting companies interviewed indicated that rafting attracts a large proportion of clientele.

The Zambezi River is classified as a high-volume, pool-drop river, meaning there is little exposed rock in the rapids themselves or in the pools of water that lie below the rapids. At the starting point for rafting, the gorge is approximately 400 feet (122 m) deep. Over the 25 kilometres covered during a day of rafting the river drops approximately 400 feet (122 m) so that at the end point the gorge is 750 feet (229 m) deep. The first section of rafting (rapids 1 to 8) is classified as "Grade 5" rapids characterised by steep gradients, big drops and pressure areas (Figure 5). The rapids decrease in size and difficulty as one moves further down the river. Rafting is not constant throughout the year and is dependent on annual flow conditions, which are dependent on the timing and quantity of catchment rainfall.

			Approx. FSL
Low Flow	Rafting August to early January	• From Rapid 1 to Rapid 10 (Half-day) • From Rapid 1 to 19 (Zimbabwe) • From Rapid 1 to 25 (Zambia)	Rapid 10 = 729.8 m Rapid 19 = 683.9 m Rapid 25 = 668 m
Intermediate	Rafting first half of January and second half of July	• From Rapid 8	Rapid 8 = 739.48 m
High	Rafting from late January to end February, and for the first half of July	• From Rapid 11 to 23 (Zimbabwe) • From Rapid 10 to 25 (Zambia)	Rapid 10 = 729.8 m Rapid 11 = 725.99 m Rapid 23 = 674.53 m Rapid 25 = 668.04 m
High (Splash and Dash)	During March and June	• From Rapid 14	Rapid 14 = 715.38 m
No Rafting possivle	April and May	• No rafting	

Rafting trips offered are either a half-day, full-day, full day plus overnight or a 2 - 5 day trip throughout the main low water season from August to December. Between 2007 and 2018, the average low-water season lasted 136 days (4.5 months), the closed season lasted 55 days (2 months) and the high-water season lasted 174 days (5.5 months) (pers. comm. Representatives of The Rafting Association of Zimbabwe, 2019

In 2019 there were 10 white river rafting operator in the Project Area. Many more licenses have however been awarded on both the Zimbabwe and Zambian sides.

Approximately 250-300 people are employed by the industry in some form, either as river guides, porters, drivers, assistants, as well as those engaged through other companies that are directly associated with rafting, such as media sales companies that film the daily rafting trips and take photographs. Due to the nature of the industry it is likely that this number is a slight under estimate of total employment as it is difficult to determine the exact numbers of casual staff which fluctuate with each season.

A large proportion of them are either part time or casual staff. Almost all of the employees are from local communities in the area.

Proposed Project Activities - Construction

Dam construction would not impact on the white river rafting activities and jet extreme boating until the point that the dam is flooded.

Proposed Project Activities –Operation

The dam area of inundation will impact on rapids, white water rafting and jet extreme boating upon flooding and for the life of the operation.

Impact Description

Based on the flow descriptions and data provided in Section 10.2.3 of the Biophysical Environment Impact Assessment included in the ESIA, the following was concluded about the extent to which the operating of white-water rafting would be impacted with the proposed BGHES impoundment in place (FSL 757m ASL during the wet, high-water season and FSL 730m ASL during the dry, low-water season):

- Based on the hydraulic analysis the proposed BGHES would prevent any rafting during the high-water season (between January to July) since the river reach from rapid 10 would be submerged by the reservoir
- Rafting would be compromised throughout January and July due to flow velocities being significantly affected from rapid 7b
- Rafting would only operate from rapid 1 to rapid 9 or 10 during the low-water season (between August to December)

Note that this has changed since 2015, when only FSL 757m ASL was being considered year-round. This would have resulted in rafting only taking place from rapid 1 to rapid 5 during the low-water season, a situation considered to be unviable for all rafting operators.

With the proposed amendments to the operating levels, rafting would be available for approximately 136 days per year, between August and December, and would include rafting from rapid 1 to rapid 9/10. The practicality and feasibility of this for rafting companies makes rafting less viable under such conditions but, according to the diversified activity provider businesses interviewed, they would still operate under these conditions but would likely have to downsize and therefore retrench some employees. The white-water rafting companies not providing alternative activities indicated that this will likely force them to close their businesses in the study area.

The low-water season is where rafting companies make the majority of their annual revenue, however, the bulk of this is made up of full-day rafting trips. Using the proportion of activity sales during the low-water season provided by businesses, Vic Falls would receive approximately 6 900 rafters a year and Livingstone would receive approximately 6 175 rafters a year, for a total of 13 075 rafters a year (62.3% of the average annual number of rafters; Table 25). Using the same average rafting rates of $150 for Vic Falls and $170 for Livingstone, the total value generated by rafting would decline by 37.5% to just over $2 million per year. The economic impact of this would be significant and losses in direct tourism expenditure would be around $2 million. Indirect expenditure lost would be much larger than this. Many of those working in the rafting industry would lose their jobs. Retrenchment costs could be substantial for rafting companies.

Sensitive Receptors

Sensitive receptors will be businesses that provide white water rafting activities and Jet extreme boating, (especially those whose business is solely centred on these activities), and those people employed by them. Businesses engaged in other tourism activities may be able to diversify in order to sustain their income.

Significance of Impact (pre-mitigation)

Based on the analysis provided above, it is assessed that the socio-economic impact relating to white water activities on the Zambezi River upstream of the reservoir impoundment will be a "**Major Impact**" pre-mitigation (*refer to Table 11.11*). This is based on the magnitude of the impact being assessed as Large, as the impacts effect all white water activity companies, their staff and other businesses associated indirectly with the rafting industry.

Table 11.11 Rating of Impacts Related to White Water Activities (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact affects white water businesses in Victoria Falls and Livingstone and will adversely affect local communities in the study area.
Duration	Permanent	The impact will be permanent.
Scale	Large	Impact to businesses and local communities will be significant: job losses, decreased daily income, and complete closure of some businesses. Indirect impacts include the losses experienced in other sectors associated with the rafting industry (e.g. maintenance and servicing).
Frequency	Constant	The impact will be permanent
Likelihood	Likely	The impact is a direct consequence of the reservoir impoundment.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The vulnerability and importance of this receptor is rated as high		
Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation/ Management Measures

The impacts described in this section are a direct consequence of the reservoir impoundment and, because lowering the operating level to below 730m ASL would not be feasible for power generation, there is no option to mitigate the impact by altering the operating level of the dam. However, to compensate rafting companies for the expected loss in revenues, rafting companies could be granted operating licences, as well as being provided with tax incentives, for other tourism products and activities, which could take place on the reservoir, such as houseboats or lakeside lodges and campsites. This would allow rafting companies to create a full-day trip for tourists by rafting a half day from rapid 1 to 9/10 and then moving guests to a houseboat for a fishing trip or sunset cruise on the reservoir.

Therefore, the compensation that would need to be paid to white-water activity companies that will either go out of business as a result of construction of the dam or that will have to retrench employees would need to be evaluated by ERM as part of the RAP process. In theory, such compensation can fully address the direct white-water rafting business impact. However, note that it would be necessary to compensate all other losers as well. This includes all other companies and employees in associated sectors that gain from the rafting businesses, other businesses that benefit from use of the gorge and more pertinently, the rest of society that suffers a loss of welfare. It will be very difficult and costly to adequately compensate all affected parties.

Residual Impact (Post-mitigation)

Based on the analysis provided above, it is assessed that the impact relating to white water activity businesses upstream of the reservoir impoundment will be a "**Moderate Impact**" post-mitigation (refer to *Table 11.12*). This is based on the magnitude of the impact being assessed as Medium.

Table 11.12 Rating of Residual Impact Related to White Water Activities (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact affects white water businesses in Victoria Falls and Livingstone and will adversely affect local communities in the study area.
Duration	Permanent	The impact will be permanent.
Scale	Medium	Medium impact to white water rafting businesses and local communities as there may be complete closure of some businesses with associated job losses but for others, losses from white water rafting could be compensated for by other tourism opportunities and incentives on the reservoir.
Frequency	Constant	The impact will be a permanent occurrence as long as the reservoir remains.
Likelihood	Likely	The impact is a direct consequence of the reservoir impoundment.
Magnitude		
Medium Magnitude		
Significance Rating After Mitigation		
Moderate Negative Impact		

11.3.2 Economic Displacement of Non-river Based Tourism Activities in Batoka Gorge

With the development of the proposed dam to the 757 m amsl FSL, the area from just below mid-3rd Gorge (at Devils Toilet Bowl) on the Zambezi to the dam wall will be inundated. This may therefore restrict hiking/birding/angling/accommodation and scenic flight activities taking place within the Gorge itself.

Box 11.6 Description of the Baseline Environment

Other activities in the gorge include birding, angling and hiking Although these activities employ fewer people than the rafting industry, they are nonetheless very popular activities amongst nature- and adventure-based tourists that are visiting the area.

Birding in the area is popular and birders travel considerable distances in order to see a number of endemic and rare raptors found in the Batoka Gorge. These include the Taita Falcon, Peregrine Falcon, Verreaux's (Black) Eagle and the Augur Buzzard. A further 363 bird species have been recorded in or near to the Gorge over the past 12 years (D. Tiran, pers. comm.). Many birding day trips are taken from Victoria Falls to Gorges Lodge on the Zimbabwean side or from Taita Falcon Lodge on the Zambian side. Approximately 30% of the guests that come to stay at these lodges are birders and it is estimated that birding tourists amount to around 800 – 1000 visitors per year.

Angling is a popular tourist activity both upstream and downstream of the Victoria Falls. However, the angling experience upstream of the Falls is very different to angling experience downstream in the Batoka Gorge. This activity involves hiking and sometimes camping in the Gorge in order to find the most productive fishing spots. Although most of the angling trips sold are upstream of the Falls, it is estimated that approximately 20% of the total angling trips sold are downstream of the Falls.

Hiking in the Batoka Gorge is often done in combination with another activity, such as birding, angling or local village tours. Hikers are attracted to the Gorge as it offers steep climbs and extensive scenic views of the river, rapids and sheer cliffs. Hiking is the best way to experience the vastness of the Gorge. Taita Falcon Lodge on the edge of the Gorge offers a range of hiking and walking trips. The lodge also receives regular international and regional school groups who come to do 1-3 day hiking excursions into the Gorge. Hiking activities are usually a half day or full day trip but multi-day hiking trips can be organised from Victoria Falls and Livingstone.

Jet Extreme Boats (1 operator on the Zimbabwe side) are powerful speed boats that can reach speeds of 100 km an hour as they fly over the water between rapids 23 and 27. The boats are custom-built 22-seaters with super twin engines. A cable car transports guests into the gorge and back out again to avoid the steep 220 metre hike, allowing guests of all ages to enjoy the activity. During high water levels, when rafting is not available, Jet Extreme provided an alternative adventure activity to tourists wanting to experience the Batoka Gorge.

Proposed Project Activities - During Construction

Dam construction would not impact on Gorge tourism activities until the point that the dam is flooded.

Proposed Project Activities - During Operation

Based on the flow descriptions and data provided in *Chapter 10: Biophysical Environment Impact Assessment*, the presence of the Project with impoundment in place (FSL 757 m amsl) is likely to affect tourist activities other than rafting and jet extreme boating that take place in the Batoka Gorge, such as scenic flights, hiking and birdwatching, due to the flooded area from the reservoir extending well into the Victoria Falls National Park and Mosi-oa-Tunya National Park.

Impact Description

Based on the flow descriptions and data provided in Section 10.2.3 of the Biophysical Environment Impact Assessment included in the ESIA, the following was concluded about the extent to which other activities such as scenic flights, hiking and birdwatching would be impacted with the proposed BGHES impoundment in place (FSL 757m ASL during the wet, high-water season and FSL 730m ASL during the dry, low-water season):

- Based on the hydraulic analysis the extent of the flooded area from the reservoir extends well into the Victoria Falls National Park and Mosi-oa-Tunya National Park
- The backwater effect from the reservoir causes a rise in the natural water levels extending as far as the bottom of the third gorge (after rapid 5) during the high-water season and as far as the bottom of rapid 9/ 10 during the low-water season.

As a result of the inundation of the rapids, it is expected that the available habitat for river borne insects will be severely reduced. With fewer river borne insects to feed on, insectivorous birds and bats will move out of the gorge, further impacting on the larger raptors relying on them for prey. The increased water levels up the Gorge will remove prime habitat along the sheer cliff faces. Decreased food availability and the removal of prime nesting sites will force raptors such as the Taita Falcons and Peregrine Falcons to move out of the gorge. Without these rare raptors and other birds in the Gorge, birders will no longer be attracted to the area and guided birding trips in the gorge will no longer operate. These trips form a significant part of guided birding activities in the area.

Hiking in the gorge will be affected in that hikers will only be able to hike for a few months of the year (during the low-water season) and for a short distance (to rapid 9/10) along the bottom of the Gorge due to the increased water levels from the reservoir. Overnight hiking and camping trips will also be impacted as water levels rise and remove hiking trails and camping sites along the edge of the river. Even during the low-water season when the dam is operating at FSL 730m ASL, the areas previously inundated by water will be muddy, slippery and unconducive to hiking and camping. Again, these activities form a major component of guided hikes in the area.

While the Falls are the main attraction of scenic flights, the gorge also adds significant value to this visitor experience, and the inundation of the gorge could reduce the demand for these flights.

Sensitive Receptors

Sensitive receptors will be those tourist operators, and their employees, that only offer activities in the Gorge and have not diversified in other tourism activities.

Significance of Impact (pre-mitigation)

Based on the analysis provided above, the tourism activity businesses making use of the gorge for activities other than white-water activities will suffer a

"**Major Impact**" pre-mitigation (refer to *Table 11.13). * This is based on the magnitude of the impact being assessed as Large, as the impacts of the reservoir are likely to prevent hiking and birding in the long term and could reduce the demand for scenic flights. It is understood that once the birds move off due to lack of food and nesting sites the probability of them returning is extremely low.

Table 11.13 ***Economic Displacement of non-river based tourism activities in Batoka Gorge (Pre-Mitigation)***

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact affects tourism businesses in Victoria Falls and Livingstone and will adversely affect local communities in the study area.
Duration	Permanent	The impact will be permanent.
Scale	Large	Impact to businesses offering birding and hiking activities and loss in birding tourists to the area. Local communities will incur job losses and decreased daily income. Indirect impacts include the losses experienced in other sectors associated with birding and hiking (e.g. accommodation sector).
Frequency	Constant	The impact will be a permanent occurrence as long as the reservoir remains.
Likelihood	Likely	The impact is a direct consequence of the reservoir impoundment.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The vulnerability and importance of these receptors (and the National Parks themselves) is rated as high, in both ecological and socio-economic terms.		
Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation / Management Measures

The impacts described in this section are a direct consequence of the reservoir impoundment and the only mitigation would be to alter the height of the dam wall and in so doing reduce the extent of the upstream impacts. However, as mentioned above, power generation becomes ineffective below a certain dam wall height and therefore there is no mitigation measure that will adequately alleviate the loss of birding and hiking habitat.

In order to compensate the affected businesses, it would be necessary to establish the amount of turnover that would be lost as a result of inundation. This is likely to be more straightforward in the case of activities involving direct use of the gorge, than in activities such as scenic flights. As discussed above, this does not consider the non-use value associated with the Gorge and the potential permanent loss of an ecosystem and associated endemic flora and fauna.

Residual Impact (Post-mitigation)

Based on the analysis provided above, it is assessed that the tourism activity businesses making use of the gorge for activities other than white-water activities will be a "**Major Impact**" post-mitigation (refer to *Table 11.14*). This is based on the magnitude of the impact being assessed as Large.

Table 11.14 Rating of Residual Impact of Non-river Based Tourism Activities in Batoka Gorge (Post-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact affects activity businesses and other tourism businesses in Victoria Falls and Livingstone and will adversely affect local communities in the study area.
Duration	Permanent	The impact will be permanent.
Scale	Large	Impact to businesses offering birding and hiking activities and loss in birding tourists to the area. Local communities will incur job losses and decreased daily income. Indirect impacts include the losses experienced in other sectors associated with birding and hiking (e.g. accommodation sector).
Frequency	Constant	The impact will be a permanent occurrence as long as the reservoir remains.
Likelihood	Likely	The impact is a direct consequence of the reservoir impoundment.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The vulnerability and importance of these receptors (and the National Parks themselves) is rated as high, in both ecological and socio-economic terms.		
Significance Rating After Mitigation		
Major Negative Impact		

11.3.3 Impact on the Accommodation Establishments in the Gorge

With an impact on some of the tourism activities taking place on the Zambezi River, there could be a resultant impact on accommodation specifically placed for Gorge activities. .

Box 11.7 Description of the Baseline Environment

Accommodation establishments located along the edge of the Batoka Gorge have extensive views of the Gorge and the river below. A number of the guests staying at these lodges are birders and hikers choosing to stay at these lodges for this reason. These lodges contribute approximately $1.4 million in tourism expenditure.

Proposed Project Activities - Construction

Dam construction would not impact on broader tourism activities until the point that the dam is flooded.

Proposed Project Activities - Operation

Based on the flow descriptions and data provided in *Chapter 10: Biophysical Environment Impact Assessment*, the presence of the Project with impoundment in place (FSL 757 m amsl) is likely to affect water levels due to the flooded area from the reservoir extending well into the Victoria Falls National Park and Mosi-oa-Tunya National Park.

Sensitive Receptors

Tourism in the Livingstone and Victoria Falls towns may be impacted on by the proposed Project, but the tourism economy is not solely reliant on tourism derived from the Gorge.

Impact Description

Based on the flow descriptions and data provided in Section 10.2.3 of the Biophysical Environment Impact Assessment included in the ESIA, the following was concluded about the extent to which water levels in the Gorge would change with the proposed BGHES impoundment in place (FSL 757m ASL during the wet, high-water season and FSL 730m ASL during the dry, low-water season):

- Based on the hydraulic analysis the extent of the flooded area from the reservoir extends well into the Victoria Falls National Park and Mosi-oa-Tunya National Park
- The backwater effect from the reservoir causes a rise in the natural water levels extending as far as the bottom of the third gorge (after rapid 5) during the high-water season and as far as the bottom of rapid 9/ 10 during the low-water season.

Taita Falcon Lodge on the Zambian side of the river is located just downstream of Songwe Gorge above rapids 15 to 17 (Figure 19). The lodge is located on the edge of the Gorge with views upstream to rapid 15 and downstream to rapid 17. Gorges Lodge is located further downstream on the Zimbabwean side of the river above rapid 18 (Figure 20). Both lodges are built on communal land and concession fees and royalties are paid to the local village communities.

- The accommodation establishments along the Gorge will be impacted in the following ways:
- The views from these lodges will be significantly altered as water levels rise and the Gorge environment is completely changed
- The views offered by these lodges as well as their proximity to the Gorge for hiking and birding are their main selling points
- Compromised views, altered landscape and lack of birding/hiking will influence tourist's decision to stay at these lodges
- Tourists will choose to stay at lodges either closer to the Falls or upstream of the Falls where the views are uninterrupted and natural

Acknowledging the above, it is estimated that tourist numbers to these lodges may decrease after the construction of the proposed BGHES. This will result in a loss of revenue as well as the potential loss of staff due to decreased bed occupancy. A further consideration is the potential impact of earthquakes caused by the inundation process which may put these establishments in jeopardy as they are located on the edge of the Gorge walls.

Figure 11.1 Location of Taita Falcon Lodge in Zambia on the edge of the Batoka Gorge

Figure 11.2 Location of Gorges Lodge in Zimbabwe on the edge of the Batoka Gorge

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is assessed that the impact relating to accommodation establishments upstream of the reservoir impoundment will be a "**Moderate Impact**" pre-mitigation (refer to *Table 11.15*). This is based on the magnitude of the impact being assessed as medium, as the impacts of the reservoir are likely to change the current views as well as disrupt activities offered by these establishments.

Table 11.15: Rating of Impacts Related to Accommodation Establishments in the Gorge (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact affects accommodation establishments located downstream of Victoria Falls and along the Batoka Gorge, as well as local communities in the study area.
Duration	Permanent	The impact will be permanent.
Scale	Medium	Impact to lodges offering birding and hiking activities and loss in birding tourists. Local communities will incur job losses and decreased daily income. Indirect impacts include the losses experienced in other sectors associated with accommodation establishments (e.g. food and beverage industry).
Frequency	Constant	The impact will be a permanent occurrence as long as the reservoir remains.
Likelihood	Likely	The impact is a direct consequence of the reservoir impoundment.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Moderate Sensitivity		
The sensitivity and importance of these resources is rated as medium as there is some ability to adapt.		
Significance Rating Before Mitigation		
Moderate Negative Impact		

Mitigation / Management Measures

Currently both of these lodges are marketed for their views and are also very popular amongst birding and hiking tourists. After construction of the proposed BGHES, the views from these lodges will be altered and the birding and hiking opportunities no longer available. The only available mitigation option would be to market the lodges differently to attract visitors coming to the area to enjoy the activities available on the dam. Compensation for altering marketing material should be assessed by ERM as part of the RAP.

The lodges are situated close to the proposed reservoir and visitors to the area wanting to participate in the new activities available on the reservoir would be attracted to these accommodation options. The lodges could provide activities themselves, such as fishing trips and reservoir cruises. Predicting whether tourists will be attracted to the new activities and the dam, when these activities are currently available upstream of Victoria Falls and on Lake Kariba, is difficult and therefore this mitigation measure needs to be approached with caution. The shaded nature of the gorge, and the fact that the appearance of the gorge sides will be unattractive due to fluctuations in water level leading to vegetation die-off, means that the attractiveness of the inundated gorge area is likely to be limited. If visitors are not attracted to the new activities and visitor numbers decrease over time, then these accommodation establishments could be impacted without mitigation.

Residual Impact (Post-mitigation)

Based on the analysis provided above, it is assessed that the impact relating to accommodation establishments upstream of the reservoir impoundment will be a "**Minor-Moderate Impact**" post-mitigation (refer to *Table 11.16*). This is based on the magnitude of the impact being assessed as Small-Medium.

Table 11.16 Rating of Residual Impact Related to Accommodation Establishments in the Gorge (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact affects accommodation establishments located downstream of Victoria Falls and along the Batoka Gorge, as well as local communities in the study area.
Duration	Permanent	The impact will be permanent.
Scale	Small to Medium	Small to medium impact to lodges offering birding and hiking activities. Local communities may still incur job losses and decreased daily income. Indirect impacts include the losses experienced in other sectors associated with accommodation establishments (e.g. food and beverage industry). New activities could provide opportunities for new visitors to stay at these lodges.
Frequency	Constant	The impact will be a permanent occurrence as long as the reservoir remains.
Likelihood	Likely	The impact is a direct consequence of the reservoir impoundment.
Magnitude		
Low to Medium Magnitude		
Significance Rating After Mitigation		
Minor to Moderate Negative Impact		

11.3.4 *Impact on the Local Economy*

This section describes the overall economic impacts of the proposed BGHES in the study area, focusing on all the possible negative and positive impacts and any mitigation options available. The estimated magnitudes of the impacts are described qualitatively based on information obtained during the tourism business interviews and the site visit.

Box 11.8 Description of the Baseline Environment

Tourism in Victoria Falls contributes 21% of tourism revenue generated in Zimbabwe, i.e. directly and indirectly contributing approximately 1.2% of the country's GDP. In Livingstone, the corresponding figure represents 22% of tourism revenue in Zambia contributing approximately 0.5% to total GDP. The tourism activities in the Gorge contribute approximately 17% to the total tourism GVA in the study area. Therefore, these activities alone contribute 0.2% of the GDP in Zimbabwe and 0.1% of the GDP in Zambia.

The Batoka Gorge is estimated to contribute just less than $6.5 million in direct tourism expenditure (excluding park fees generated by the activities undertaken in the gorge) in 2018, down from the estimated $7.5 million in 2015 (Table 24). When park fees are included, this amount is just less than $7 million, down from just less than $8 million in 2015.

White water rafting is the most popular activity downstream of the Falls and is the largest contributor to tourism value with almost $3.4 million in tourist expenditure annually. Angling, birding, hiking and canyoneering are estimated to contribute over $250 000 dollars annually.

77% of staff employed in Victoria Falls were full time, 15% were part time and 8% were employed casually. In Livingstone, the findings were almost identical with 78% of staff full time, 14% part time and 8% employed casually. Full time staff numbers remain relatively constant over the year with businesses employing more part time staff and casual staff over the high season months. In Victoria Falls 75% of full time staff, 98% of the part time staff and 91% of the casual staff are originally from the area whereas in Livingstone it was indicated that 93% of the full time staff, 96% of the part time staff and 98% of the casual staff are originally from the area.

Based on ratios and multipliers from WTTC (2018a, b), the direct value added by tourism was estimated to be $148 million for Victoria Falls and $89 million for Livingstone. When the indirect impacts are considered, the total contribution of tourism in the study area is estimated to be in the order of $281 and $164 million to the GDP of Zimbabwe and Zambia, respectively.

Overall direct and indirect economic impacts of tourism in the study area (US$ millions), based on multipliers derived from the WTTC (2018a, 2018b)

Business Sales	Gross output	Direct value added	Indirect value added	Total contribution to GDP
Victoria Falls	260	148	133	281
Livingstone	167	89	76	164

Proposed Project Activities - Construction

Dam construction would not impact on broader tourism activities until the point that the dam is flooded.

Proposed Project Activities - Operation

Based on the flow descriptions and data provided in *Chapter 10: Biophysical Environment Impact Assessment*, the presence of the Project with impoundment in place (FSL 757 m amsl) is likely to affect water levels due to the flooded area from the reservoir extending well into the Victoria Falls National Park and Mosi-oa-Tunya National Park.

Sensitive Receptors

Tourism activities in Livingstone and Victoria Falls towns may be impacted by the proposed Project, however gorge based tourism is only one part of the tourism economy, and thus it is anticipated that only some tourism activities will be negatively impacted.

Impact Description

Based on the flow descriptions and data provided in Section 10.2.3 of the Biophysical Environment Impact Assessment included in the ESIA, the following was concluded about the extent to which water levels in the Gorge would change with the proposed BGHES impoundment in place (FSL 757m ASL during the wet, high-water season and FSL 730m ASL during the dry, low-water season) and the resulting economic impacts in the study area:

- Based on the hydraulic analysis the extent of the flooded area from the reservoir extends well into the Victoria Falls National Park and Mosi-oa-Tunya National Park.
- The backwater effect from the reservoir causes a rise in the natural water levels extending as far as the bottom of the third gorge (after rapid 5) during the high-water season and as far as the bottom of rapid 9/ 10 during the low-water season.
- Rafting would only operate from rapid 1 to rapid 9 or 10 during the low-water season (between August to December)
- Views of the Gorge will be severely altered downstream of the third gorge, even during the low-water season owing to vegetation die-off along inundated areas during the high-water season. Views of the Gorge from accommodation establishments such as Gorges Lodge and Taita Falcon Lodge will change.
- Flight operations offering scenic views of the Victoria Falls and the Gorge will be affected as the untouched natural vistas of the Gorge are replaced with views of a reservoir.
- Tourism activity businesses offering white water rafting, birding, hiking, camping, and angling will be adversely affected by the rising water levels and inundation in the Gorge.
- Employment associated with these businesses and any service providers linked to these tourism businesses will most likely be negatively affected.
- Knock-on effects of changes in the tourism sector will be significant.
- The overall tourism product offered in the study area will change.

It is estimated that the direct tourist spend on activities in Batoka Gorge is almost $7 million. However, the Batoka Gorge activities currently attract tourists to the area and also encourage further spend as tourists stay longer in the area to participate in a number of activities on offer, spending more on accommodation, food and services. It is estimated that the total tourist spend attributable to the activities offered in the Gorge is close to **$74 million**, about 17% of the total direct tourist expenditure in the study area. Although not all of this will be lost if the BGHES is built, it is expected that a significant portion will be as those tourists that come to participate in gorge activities will either no longer come or will stay for a shorter period of time. Other economic impacts not estimated here include the taxes and permits paid by all activity providers to operate activities in the National Parks and in the Batoka Gorge.

These fees are paid to the relative Zimbabwean and Zambian government departments and form a significant part of the expenditure paid each month by the activity businesses. Accommodation establishments and certain activity providers also pay local communities concession fees and royalties to be able to operate tourism businesses on the communal lands. These make a significant contribution to community development with the money contributing to schools, clinics and improved sanitation.

Currently the tourism product offered in Victoria Falls and Livingstone takes the form of adventure and wilderness tourism with a focus on offering unique adrenalin and nature-based tourist activities, not offered elsewhere in the region. This study has estimated that tourism in Victoria Falls contributes 29% of the value added by tourism in Zimbabwe, i.e. directly and indirectly contributing approximately 0.9% of the country's GDP. In Livingstone the corresponding figure represents 11% of the value added by tourism in Zambia contributing approximately 0.4% to total GDP. The tourism activities in the Gorge contribute approximately 17% to the total tourism GVA in the study area. Therefore, these activities alone contribute approximately 0.1% of the GDP in Zimbabwe and 0.1% of the GDP in Zambia.

The natural landscapes both above and below Victoria Falls attract tourists. Changes to these landscapes and to the activities offered in the area are expected to impact tourism significantly. Construction of the proposed BGHES will potentially alter the tourism product on offer and will also possibly alter the type of tourist expected to visit. The type of tourist will potentially change from younger more adventurous tourists to older, less active tourists interested in visiting the area mainly with the intention of viewing Victoria Falls, a trend already observed but will likely be exacerbated. This will result in fewer activity sales throughout the year as well as a decrease in the average number of days tourists spend in the area. Tourists visiting a number of countries in the region, such as Botswana, Namibia and South Africa could decide to spend longer in these countries and not visit the study area if certain activities were no longer offered. Younger tourists spoken to whilst in the study area in 2015 indicated that they enjoyed the experience of the adventure and cultural activities more than they did the viewing of Victoria Falls, and indicated that they would definitely spend less time in the area if the activities changed. One of the most popular of these adventure activities is white-water rafting which has been operating in the Batoka Gorge for more than 30 years. Construction of the proposed BGHES at the proposed FSL 757m ASL during the wet, high-water season and FSL 730m ASL during the dry, low-water season will alter white-water rafting, birding and hiking, and will change the landscape downstream of Victoria Falls permanently.

The white-water rafting industry as well as other activity providers and accommodation establishments operating in the Gorge provide employment to a significant number of people, most of which are from the communities situated along the Gorge. Based on data collected from tourism businesses that operate in the Gorge, it is estimated that between 400 and 450 staff are employed by the accommodation establishments and activity providers together. This represents a significant contribution to employment and daily household income in the study area. The majority of accommodation establishments and activity providers have been in operation for longer than 20 years and the relationships formed with local communities are well developed. Those employed in the tourism industry are able to contribute significantly to household income. Whilst in the study area, a local rafting guide who has been employed in the rafting industry for 15 years explained how rafting had contributed significantly to daily income and had also contributed positively to the livelihood of his extended family. Part time and casual employment also offers an alternative when agriculture is limited or when crops fail in seasons of poor rainfall. Loss of employment is estimated to have far reaching negative impacts in an area already struggling with low household income and unemployment.

In Livingstone the majority of tourism businesses interviewed, as well as other locals spoken to whilst on site, were against the construction of the proposed BGHES and believed that the impacts would be catastrophic for their businesses and for the tourism industry in Livingstone. For a small few, they saw the proposed dam as a way to 'kick-start' the recently lacklustre tourism industry in Livingstone. However, every person spoken to believed that the impacts of the proposed BGHES would be much greater and more widespread than anticipated. Many voiced their concerns over the possible delisting of the Falls as a UNESCO World Heritage Site as well as the international perception that the construction of the proposed BGHES will have on tourism. In Victoria Falls the tourism businesses interviewed were not as candid in their responses. One third of the businesses were of the opinion that the proposed BGHES could provide new opportunities and have some positive impact in terms of power generation and local development but also emphasised that the impacts of the dam on tourism should be kept to an absolute minimum where possible. Two thirds were of the opinion that the proposed BGHES should not go ahead and that the impacts on their businesses and on tourism in Victoria Falls would be significant. A number of these businesses were also concerned about the delisting of the Falls as a UNESCO World Heritage Site and the impact this would have on tourism in the area.

The construction of the proposed BGHES could result in a number of negative social implications resulting in economic impacts to the area. These include increased crime rates as a result of easier access between Zambia and Zimbabwe across the Gorge and the proposed reservoir as part of the proposed BGHES. Currently the river and the Gorge are very difficult to cross and illegal crossings are rare. Monitoring this and other criminal activities, such as prostitution, which will arise if new towns either side of the dam are developed and trucks are diverted to this crossing point (see Social Impact Report). These social impacts could influence new business development in the study area and would also influence tourist perceptions of the area.

Based on the above and the baseline data collected during this study, it is estimated that the local area economic impacts associated with the proposed BGHES (FSL 757m ASL during the wet, high-water season and FSL 730m ASL during the dry, low-water season) will be significant and will alter the "sense of place" and tourism product currently offered in Livingstone and Victoria Falls. Certain adventure- and nature-based activities that have been offered for more than thirty years will no longer operate and the knock-on effects of this are estimated to be large. However, tourism is adaptive and estimating the magnitude of the impact is difficult due to the uncertainty involved.

Significance of the Impact

Based on the analysis provided above, it is assessed that the economic impact relating to the construction of the proposed BGHES will be a "**Moderate - Major Impact**" pre-mitigation (refer to *Table 11.17*). This is based on the magnitude of the impact being assessed as **Medium to Large**. There is some uncertainty involved in trying to estimate the magnitude of the impacts due to the knock-on effects associated with tourism.

Table 11.17 Rating of Socio-economic Impacts (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact will be largest in Victoria Falls and Livingstone but is not completely confined to these two towns and will affect users on both sides of the river/border and the communities along the Batoka Gorge.
Duration	Permanent	The impact will be permanent.
Scale	Large	Direct and indirect economic impacts such as job losses, decreased household income, decreased business revenue and the complete loss of certain activity businesses. Possible change to tourism product and change in type of tourist visiting the area. Possible social implications as a result of the proposed BGHES could see decreased investor and business confidence in the area.
Frequency	Constant	The occurrence will be permanent once the dam is built.
Likelihood	Likely	The impact is a direct consequence of the reservoir impoundment.
Magnitude		
Medium to Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Moderate Sensitivity		
The vulnerability and importance of these resources is rated as medium, as there is some opportunity to adapt within the tourism industry.		
Significance Rating Before Mitigation		
Moderate to Major Negative Impact		

Mitigation

The tourism sector is relatively dynamic and constantly changes as a result of both local, regional and international influences and impacts, such as economic recessions and political instability. The tourism sectors in Zambia and Zimbabwe are sensitive to these changes, as experienced over the last decade. Significant changes to the current tourism product, as a result of the proposed BGHES, are estimated to have significant impacts on the current tourism market.

The only available mitigation measures for the tourism industry in the study area include developing and promoting a new type of tourism market. Most tourists are coming to the area with the intention to view the Victoria Falls. The change in the activities that are available below the Falls will change the type of tourist interested in coming to the area and may also have an impact on the overall numbers of visitors to the area.

New tourist activities could be developed and promoted in the affected area. These new business ventures would be expected to offer new employment opportunities in the area. It is anticipated that these new activities cannot simply replace the activities currently offered in the Gorge as the experience and product offered will be completely different. The new activities might be similar to the activities already on offer upstream of Victoria Falls and on Lake Kariba which is approximately 50 km away from the proposed BGHES site.

Potential activities offered on the reservoir could include houseboats, motor boat activities, dam cruises, canoeing, birding (waterfowl) and angling. All of these are on offer in the area already and it is therefore very unlikely that they will form the primary reason for tourists to visit the area like white-water rafting currently does. It is important however to ensure that the activities developed on the reservoir do not flood the market and impact negatively on the activity businesses upstream of Victoria Falls or on Lake Kariba. In order for these activities to be successful, the tourist market and visitor numbers need to be assessed to determine accurately the carrying capacity of the reservoir area and the supply and demand of the market. It is recommended that a comprehensive tourist survey be conducted during the high season months to determine accurately what activities would be the most popular amongst tourists and which activities would not. In doing so, a more focused tourism product can be developed that will attract tourists to the area and will encourage the promotion of new activities.

The construction of small to medium sized safari lodges and tented camps downstream of Victoria Falls in the vicinity of the proposed reservoir could encourage tourists to overnight in the area and to participate in new activities developed on the reservoir. These accommodation facilities would be expected to benefit local communities through employment opportunities and local community development projects.

The very limited mitigation options available focus on tourism marketing and the development of new tourism activities. As described above, these activities are not very promising, especially when compared to the current activities on offer. The businesses and people that lose out from the construction of the proposed BGHES therefore need to be fully compensated. Some of these businesses will be forced to shut down completely, whereas others may lose in the form of decreased business sales. In certain cases, compensation may be relatively straightforward to calculate, but in other cases will prove to be extremely difficult. Further consultation with these stakeholders will be required in order to establish acceptable terms.

Residual Impact

Based on the analysis provided above, it is assessed that the socio-economic impacts of the proposed BGHES will be a "**Moderate Impact**" post-mitigation (refer to *Table 11.18*). This is based on the magnitude of the impact being assessed as Medium. There will be a resultant clear difference from baseline conditions and the impacts will affect a number of people and businesses in the region but there is some ability to adapt to change brought on by the Project.

Table 11.18 Rating of Residual Socio-economic Impacts (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Regional	The impact will be largest in Victoria Falls and Livingstone but is not completely confined to these two towns and will affect users on both sides of the river/border and the communities along and downstream of the Batoka Gorge.
Duration	Permanent	The impact will be permanent.
Scale	Medium	Direct and indirect socio-economic impacts such as some possible job losses and decreased business revenue and the potential loss of certain activity businesses. Improved by the possible development of new activities and facilities surrounding the reservoir, which will have positive impacts on employment.
Frequency	Constant	The occurrence will be permanent
Likelihood	Likely	The impact is a direct consequence of the reservoir impoundment.
Magnitude		
Medium Magnitude		
Significance Rating After Mitigation		
Moderate Negative Impact		

11.4 SOCIAL BENEFITS

11.4.1 *Local Employment Opportunities*

This *Section* covers skilled and unskilled employment opportunities at the local [1] level, as well as potential for skills enhancement that will be created, directly and indirectly by the proposed Project.

[1] Local employment is for job opportunities provided within the project affected area.

Box 11.9 *Description of the Baseline Environment*

> The majority of the population are engaged in agriculture and rearing of livestock, generally on a subsistence basis, or engaged in casual labour of a temporary nature (including curio making). Few people are formally employed in the social study communities. Those that are work as drivers, guides for safari or white water rafting companies, as caterers or maids at hotels and lodges or, as staff at retail outlets.
>
> During FGDs, education and employment were commonly expressed as community development needs.
>
> Expectations are high that the Project will generate employment that will benefit the local economy and reduce unemployment levels.

Proposed Project Activities - Construction and Operation

There will be a number of direct employment opportunities created by the Project, either with ZRA or through contractors on construction and operation of the Project. It is anticipated that there will be up to 8,000 direct Project employment opportunities at the peak of construction and 1,500 direct opportunities during operation. Indirect employment opportunities will be created through the procurement of goods and services to support construction and operation and will therefore include jobs created in the Project supply chain and their suppliers or sub-contractors/service providers.

The percentage breakdown of the distribution of employment opportunities in terms of skilled, semi-skilled and unskilled positions is not currently known nor, where the workforce will be recruited from. This will be at the discretion of the contractor appointed for both phases of the project. However, it is assumed that the workforce will be a mix of locals, people from the Southern Province (Zambia) and Matabeleland North Province (Zimbabwe), as well as elsewhere in the two countries. Expatriates will be recruited where the national population do not possesses the specialised skills and experience required.

Induced employment (i.e. jobs created through spending in the local economy by direct and indirect employees on the Project may also occur.

Impact Description

Employment opportunities will result in improved income generation in the local community and in some cases security of this in the long term. This will help to improve living conditions, as more disposable income will be available for food, education and health care.

Those that secure employment are likely to benefit from enhanced work experience and skills enhancement received through on-the-job and more formal training courses. Such skills enhancement will improve the potential of these people to secure future employment once their contract with the Project ends.

Sensitive Receptors

Local community members with limited previous exposure to large scale construction projects may be disadvantaged in qualifying for employment opportunities especially if there is significant in migration by potential job seekers.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is the opinion of this ESIA that the impact will be a "**Positive Impact**" pre-mitigation (refer to *Table 11.19).*

The likelihood that the local population will be able to take up the unskilled employment opportunities provided is relatively high however, due to an absence of skills and experience in the area it is unlikely that they will be able to capitalise on many of the semi-skilled or skilled positions. The training received as part of the proposed Project will improve chances to seek employment opportunities in other developments.

Induced employment is expected to be limited in the local area due to the limited availability of goods and services and likelihood that goods and services will be sourced externally to the area, with the exception of cement and aggregate.

Table 11.19 Impacts Related to Creation of Local Employment Opportunities and Skills Enhancement (Pre-mitigation)

Type of Impact		
Direct, Indirect and Induced Positive Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact looks specifically at the possibility for local communities to benefit from employment opportunities and thus the rating of local is assigned here.
Duration	Long term	The impact will be experienced throughout the life of the Project.
Scale	Small	Only a relatively limited number of jobs will be created as a result of the Project however for those that are able to secure jobs, quality of life will be vastly improved if this allows for access to a secure income.
Frequency	Occasional	This impact will occur in line with recruitment needs.
Likelihood	Likely	Employment opportunities will definitely be created by the Project.
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Moderate Sensitivity		
The development of employment opportunities will be very welcome by local communities. Local expectations are high that they will benefit from job opportunities.		
Significance Rating Before Mitigation		
Positive Impact		

Enhancement Measures

In order to ensure that the positive impact is harnessed optimally, the following enhancement measures will be adopted.

- Develop a Local Employment Program including:
    - Skills audits, including local people, young people and woman.
    - A program of up-skilling, training and development to increase local availability of those trades with a local shortage. This can be undertaken in partnership with training and educational authorities and international organisations.
    - Job readiness training program.
    - Women's training and employment program.
    - Participation in events where potential employees can meet Project staff, learn about the Project, and register their interest for training and employment.
    - Recruitment and retention programs and strategies to attract skilled trades and supervision personnel from the local area.

- Local content strategy focusing on the Project Area, based on an accurate understanding of current and potential future business capacity.

- Targets will be set to maximise the number of Zambian and Zimbabwean nationals, local, female, disabled, unskilled, skilled and highly skilled employees from the Project Area. The local employment targets will be written into all Sub-Contractor agreements.

- The ZRA will provide all its Contractors with the requirements related to hiring for inclusion in tendering documents related to human resources database, aspirational hiring targets, auditing arrangements, and (where relevant) training requirements.

- Employment opportunities will be publically advertised in appropriate newspapers, public libraries, the District Offices and in all relevant languages. All employment requirements will be advertised in a timely manner.

- The Contractor will establish a recruitment office in Livingstone, Zambia and Victoria Falls, Zimbabwe. The offices will disseminate information (in local languages) about potential job opportunities (and procurement contract) and will also keep a database of available prospective employees, their skills levels and contact details. Workers will be preferentially recruited from this list whenever labour is required.

- There will be no requirement for applicants to make payments for applying for, or securing, employment on the proposed Project.

- No employment will take place at the entrance to the site. Only formal channels for employment will be used.

- The ZRA will also develop and implement a Training Policy and relevant programs prior to the commencement of construction. The policy will:

  - Undertake a comprehensive training needs assessment to understand skills levels in the local area;

  - Identify the particular training needs of the youth and women;

  - Identify the skills gap and initiate mechanisms to train local people to meet the company's needs;

  - Provide on-the-job and formal training (in partnership with relevant organisations) to local and regional contractors for un-skilling to allow transition of staff into operational phases.

- Internal ZRA training 'certification' or reference letter provisions to assist retrenched employees achieve employment elsewhere will be provided.

Residual Impact (Post-mitigation)

The designations will not change and the impact will remain a **Positive Impact.**

11.4.2 Local Procurement of Goods and Services

Goods and services will be procured during the construction and operation phases of the Project from a diverse range of suppliers. The extent of this procurement and source thereof will largely be at the discretion of the contractor. It is anticipated that at a minimum, basic goods and services and cement and aggregate will be sourced from the area. More specialised equipment will need to be sourced internationally.

Box 11.10 Description of the Baseline Environment

Both countries have legislation in place that promotes local procurement. In Zambia, the Citizens Economic Empowerment Act of 2006 contains provisions for the procurement of services, materials, and equipment from Zambian citizens and 'citizen-empowered companies, citizen influenced companies and citizen-owned companies' (i.e. companies that have various degrees of equity owned by Zambian nationals). Similarly, in Zimbabwe, the Indigenisation and Economic Empowerment Act of 2007 requires that at least fifty percent of the goods and services procured by Government departments, statutory bodies, local authorities and private companies to be from businesses in which a controlling interest is held by indigenous Zimbabweans.

In the social study communities in both Zambia and Zimbabwe, at the time of writing (2019) it is believed that there are only a limited number of businesses that would be able to provide the scale of goods and services required, as well as meet the stringent health and safety standards needed by the proposed Project. There is a strong dependence on the informal sector; many local businesses are not formally registered as companies and they lack experience in providing goods and services for large scale clients. It is likely however that such businesses exist in Kazungula and Livingstone (Zambia) and Hwange and Victoria Falls (Zimbabwe) as currently, a number of businesses in these areas provide goods and / or services to mining companies operating in the country.

Proposed Project Activities - Construction and Operation

The construction and operation of the proposed Project will require the purchase of equipment and other goods and services.

Impact Description

Local procurement of goods and services by the Project could assist in building a more stable and diverse economy at the local level. This could lead to other effects such as creation of jobs by companies who secure contracts, thus enhancing living conditions for those who secure employment. This impact could be further enhanced through in-migration to the area and increased spending power.

To date, the Project engineers have not been able to advise on what equipment/goods and services may be required for the Scheme and/or if these are available locally, so the full scale of this impact has not been determined. ERM does anticipate that the following equipment and materials may be required:

- Front end loaders
- Bulldozers
- Concrete plant
- Trucks
- Excavators
- Tunneler
- Crusher
- Cranes
- Small vehicles
- Fire equipment
- Concrete
- Piping
- Aggregate
- Steel
- Pavement
- Fencing
- Fuel
- Wiring and electrical
- Turbines
- Generators
- Switchyard
- Pumps
- Storage tanks
- Transmission pylons

Sensitive Receptors

Local companies may be disadvantaged by the health and safety standards enforced by the project.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is the opinion of this ESIA that the impact will be a "**Positive Impact**" pre-mitigation (refer to *Table 11.20)*

It is estimated that Project investment could be around US$ 4 billion [(2)]. Although locally owned businesses in the Project Area are unlikely to have the capacity to meet the standards required by the Project, thereby limiting the number of local businesses likely to secure contracts, with time it is anticipated that the potential exists for local / and regional businesses to develop and meet at least some of the procurement needs of the proposed Project, especially during operations.

Table 11.20 Rating of Impacts Related to Local Procurement of Goods and Services (Pre-Mitigation)

Type of Impact		
Direct, Indirect and Induced Positive Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact looks specifically at the possibility for local businesses to benefit from procurement opportunities and thus the rating of local is assigned here.
Duration	Long term	The impact will be experienced throughout the life of the Project.
Scale	Small	The impact will be constrained at the local level by the current lack of capacity.
Frequency	Occasional	This impact will occur in line with procurement needs.
Likelihood	Likely	Procurement of goods and services are necessary for the Project to go ahead.
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Moderate Sensitivity		
The development of procurement opportunities will be very welcome by stakeholders. Local expectations are high that they will benefit from contracts to supply the Project goods and / or services.		
Significance Rating Before Mitigation		
Positive Impact		

Enhancement Measures

In order to ensure that the positive impact is harnessed optimally, the following enhancement measures will be adopted.

- Develop and implement a procurement policy and plan. A Procurement Method Statement will be developed and implemented prior to the start of the construction phase. The main objective of the method statement will be to maximise local purchasing where possible in line with national legislation and tendering requirements, by directly working with local enterprises and by incentivising the Project's contractors to contract locally.

- Develop and maintain a database of all relevant local businesses that could be used as potential suppliers.

(2) http://www.comesa.int/attachments/article/842/Batoka%20Gorge%20%20-%20Project%20Profile%20130526.pdf. Accessed 16.03.2015

- Identify local procurement opportunities. This will include:
  - Undertaking an audit and due diligence of local / regional businesses and their potential capacity to provide goods and services locally.
  - The audit and due diligence of local / regional businesses will also identify business development needs and where applicable, relevant training and capacity building initiatives will be established.
  - This audit will identify the specific development needs of the youth and women, and focus on delivering pertinent training and skills development to allow the youth and women to participate in the provision of goods and services to the proposed Project.
- Sound communication of the procurement programme. This will include:
  - Procurement needs and associated programmes to be communicated to the populations of the local and regional Project areas in a transparent and culturally appropriate manner.
  - Dissemination of information regarding procurement opportunities as early as possible.
  - When advertising procurement opportunities, the requirements for goods or services will be clearly defined.
  - Local procurement will be promoted through events such as local /regional / national supplier trade shows. A small medium enterprise (SME) electronic portal will be created to facilitate the communication of contract opportunities and management training materials to SMEs providing relevant services.
  - Provision of quality standards required by the Project for the supply of goods and services to potential suppliers as requested.
  - Procurement targets will be defined in consultation with potential suppliers and key authorities and included in contractors' contracts. Where possible, targets will be set for local procurement.
- Promote capacity building to support in-country businesses to assist them with responding to tender opportunities and meeting administrative requirements of written communication, invoicing and reporting. This will be undertaken in the following manner:
  - Through a tendering process, recognised Zambian and Zimbabwean and international organisations, institutions or Non-governmental

Organisations (NGOs) will be invited to prepare and implement a programme for training, promoting and supporting entrepreneurship and small business development. This will be developed during the pre-construction and construction phases.

- In collaboration with the Ministry of Trade and other relevant organisations, the Project will promote training of local and regional suppliers to deliver goods and services. This will be developed during the pre-construction and construction phases.

Residual Impact (Post-mitigation)

The designations will not change and the impact will remain a **Positive Impact.**

11.4.3 Opportunities for Community Development

This section discusses the potential benefits to communities as a result of social development initiatives undertaken by the Project.

Box 11.11 Description of the Baseline Environment

Local challenges in Zambia and Zimbabwe include reliance on subsistence livelihoods, human wildlife conflict, high levels of unemployment and limited economic opportunities, poverty, and poor social infrastructure and social service delivery.

In order to help address development needs, there are a number of NGOs that have helped with infrastructure development through the construction of boreholes, public toilets and classrooms. They have also provided educational materials and bicycles to students to help them access schools. Other NGO programmes have included the provision of training on conservation farming, introduction of resilient crop types and cultivation of smaller parcels of land to help households enhance their agricultural productivity. Most NGO attention remains focused on healthcare provision and sensitisation to prevent the transmission of HIV/AIDS.

Despite NGO efforts, communities still suffer from poor standard of living and inadequate access to social services. Communities in the Zambia Study Area did not express large NGO presence in the area.

In terms of community needs, the following needs have been identified through the recent 2019 FGDs with affected village clusters: local employment, local electrification, provision of training and capacity building, provision and improvement of medical facilities, improvement of water supply and sanitation facilities and improved access roads.

In addition, the following key needs have been identified through the social baseline:

Aspect	Current Challenges
Education Services	• Physical terrain inhibits access to school in some communities • Shortage of trained teachers / inadequate training. At one school in the study area, only two of its seven teachers were qualified. • Insufficient teaching resources and materials. • Long distances required to access schools • Poor standard of education • Limited motivation of teachers owing to poor accommodation facilities
Health Care	• Inadequate supply of drugs • Long waiting times • Long distances to travel
Sustainable Agricultural based livelihoods	• Lack of financial resources (as well as limited access to credit) to invest in advanced forms of farming methods and seedlings • Infertile soils and financial constraints to purchase fertilisers • Late delivery of inputs • Inadequate extension services • High pest and disease incidence • Poor soil structure • Lack of water and irrigation

In term of the baseline study, ERM found that in both countries the above seem to be the key community issues most of which are education related.

Proposed Project Activities - Construction and Operation

Physical infrastructure will be developed as part of the Project that may benefit the local communities. This could include the access roads and social infrastructure in the permanent staff townships. The feasibility study for the dam will further define this.

ZRA has also committed to undertaking social development initiatives in the Project area to help support the economic and social development of directly affected and neighbouring communities. Contributions still to be made by contractors remains to be determined.

Impact Description

If implemented effectively, social investment activities undertaken by ZRA have the potential to improve the quality of life of those living in the catchment area through improved livelihood opportunities (or stability) and enhanced access to social infrastructure or services.

Sensitive Receptors

No sensitive receptors are envisaged.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is the opinion of this ESIA that the Project impact will be a "**Positive Impact**" pre-mitigation (refer to *Table 11.21*).

Table 11.21 Rating of Impacts Related to Social Development a (Pre-Mitigation)

Type of Impact		
Indirect Positive Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact is likely to fall in the local area where the main Project infrastructure is located in the Districts of Kazungula in Zambia and Hwange in Zimbabwe.
Duration	Long term	Impacts could be felt over the long term if managed adequately.
Scale	Medium	Livelihoods and standards of living will improve as a result of social development.
Frequency	Constant	Social development and investment will be ongoing.
Likelihood	Possible	This impact will depend upon resources available.
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Social development opportunities will be very welcome by local communities especially considering the lack of current development opportunities.		
Significance Rating Before Mitigation		
Positive Impact		

Enhancement Measures

The specific enhancement measures required are therefore the following:

- Allow the wider public to access social infrastructure (such as health centres, educational and recreational facilities) located within the permanent townships.

- Livelihood restoration programmes to be developed as part of the RAP and will also require implementation. These will be detailed further in this plan.

- Establish a community development programme. The Project will consult with affected communities and in partnership with them, identify community development initiatives, based on their development priorities. This will be undertaken in partnership with local NGOs and aligned to the District Development and Chiefdom Development Plans for the area so as to maximise the value that can be added. On the basis of identified community needs, the following have been identified as possible initiatives:

    - Investment in social infrastructure including educational and medical facilities. This could include the development of new facilities, offering of the relevant training to address lack of skills at these facilities, provision of equipment and maintenance of facilities.

    - Establishment of water supply and electrification infrastructure in the Project affected area.

    - Establishment of a Community Development Fund and contributions towards this.

    - Improvement and development of local roads.

    - Employment creation and sharing for locals.

Options to link up to current initiatives of the Zambezi Valley Development Fund which currently has projects underway in the areas impacted on by the Lake Kariba Project will be explored further in terms of effectiveness of the current Fund and appropriateness for the proposed BGHES. The current intention of the development fund is to alleviate the impact of the displacement of people in Zimbabwe and Zambia that were removed during the construction of Kariba Dam and includes grinding mill installation, borehole sinking, school and house construction, irrigation scheme development and medical equipment provision projects.

Currently this Fund provides for a 3% contribution of water sales (2% from each of the power utilities and 1% from the ZRA).

- It is understood, that as in the case of the Zambezi Valley Development Fund Projects, the Government Departments will take over responsibility for these community development initiatives. A further evaluation of the capacity of Government Department's to absorb these projects and ensure their sustainability will be required closer to the time of implementing these community development initiatives. Initial consideration will be given to this during the development of the programme and monitored on an ongoing basis during implementation.

Residual Impact (Post-mitigation)

The impact will remain a "**Positive Impact**". However, the implementation of enhancement measures will help to ensure social development initiatives meet the needs of local communities and make a real improvement to their quality of life.

11.4.4 Community Anger over Unmet Expectations

This *Section* discusses the potential for strained relations between the community and Project developers as a result of unmet expectations.

Box 11.12 Description of the Baseline Environment

Community expectations are high in both Zambia and Zimbabwe that the Project will create employment for local residents, provide contracting opportunities to local businesses and will make social investments in the area for social and economic development. Community members in both countries expressed concern about the potential that one country (or Chiefdom) may benefit from employment and social investment more than the other.

At community meetings, KIIs and FGDs, stakeholders including community members, traditional authorities, NGOS and local government staff, expressed a desire for schools, health clinics and boreholes, etc. to be constructed in exchange for community agreement that the Project can proceed.

Proposed Project Activities - Construction and Operation

Employment, procurement, training and social investment opportunities will be presented during the construction and operational phases of the Project.

Impact Description

Community anger and resentment over unmet expectations, be it over employment, social investment or, compensation for loss of assets or disruption to livelihoods, has the potential to strain relations and pose business and reputational risks to ZRA.

Sensitive Receptors

The majority of the population, especially men (and in particular, male youths) has particularly high expectations of waged employment and the benefits they will receive if the Project goes ahead.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is the opinion of this ESIA that the Project impact on Community anger and resentment over unmet expectations will be a "**Major Negative Impact**" pre-mitigation (refer to (*Table 11.22)*.

This impact will be predominantly experienced at the local area where households will have a greater sense of expectation due to the physical presence of Project infrastructure, which will act as a continual reminder of unmet expectations, especially in the context of employment and procurement opportunities, as well as negative impacts that may be felt by households (e.g. loss of tourism, physical displacement etc.).

Table 11.22 Rating of Impacts Related to Community Anger and Resentment over Unmet Expectations (Pre-Mitigation)

Type of Impact		
Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This impact is most likely to be experienced by households in the Districts of Kazungula in Zambia and Hwange in Zimbabwe.
Duration	Long-term	Anger and resentment associated with unmet expectations will fluctuate over the course of life of the Project; with varying intensity.
Scale	Medium	The impact will affect the majority of the local population as they all have high expectations about Project benefits however, it will not affected quality life to a great extent.
Frequency	Constant	The impact will be ongoing - the presence of the Project will act as a physical reminder of unmet expectations
Likelihood	Likely	A limited number of job opportunities, as well as poor skills levels that will restrict possible take up of such opportunities, means that this impact is likely.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
The sensitivity of the population will be high as expectations around job creation and social investment by the Project are high. It is likely that resentment will form if direct Project employment opportunities and social development initiatives are limited. This will be further exacerbated by locals competing with in-migrants for the same opportunities.		
Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation/Management Measures

The specific mitigation measures relate to management of social impacts that can benefit from the following measures:

- Implement the GRM. Refer to *Section 11.1.1*
- Adopt mitigation for employment and procurement as detailed in *Sections 11.4.1 and 11.4.2.*
- Develop a stakeholder engagement programme and hold ongoing engagement with stakeholders.
- Establish a community development programme. This will be informed by local development priorities and acknowledgement of the most vulnerable groups. Refer to *Section 11.4.3*.
- Effectively manage and implement the land acquisition process under the Resettlement Action Plan/Livelihood Restoration Plan. This will help to ensure that adequate compensation is provided for loss of assets and that livelihoods are restored in a manner that allows households to maintain or improve their standard of living. A full consultative land access process will also be adopted. Refer to *Sections 11.1.1* to *11.1.4*.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the impact will be reduced to a "**Minor Negative Impact**" post mitigation.

Table 11.23 Rating of Residual Impacts Related to Community Anger and Resentment Over Unmet Expectations (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This rating would not change and the impact would still occur at the local level.
Duration	Long-term	Anger and resentment associated with unmet expectations will fluctuate over the course of life of the Project; with varying intensity. However, relations between Project and stakeholders are expected to improve with mitigation.
Scale	Small	Isolated pockets of resentment may remain as a product of high expectations
Frequency	Occasional	With mitigation, frequency of impact may be reduced and only occur intermittently during hiring and retrenchment cycles.
Likelihood	Possible	Community anger is still possible even with sound management of social impacts due to sense of entitlement
Magnitude		
Medium Magnitude		
Significance Rating After Mitigation		
Minor Negative Impact		

11.5 IMPACTS RELATED TO IN-MIGRATION

IFC defines PIIM as the "*movement of people into an area in anticipation of, or in response to, economic opportunities associated with the development and/or operation of a new project. For most projects, project development and operations will induce, and are sometimes dependent upon, the in-migration of labour. Beyond direct Project-related employment, there is also a wide range of project-related economic opportunities that serves to draw people into the project area*"[3].

The IFC suggests that project-induced in-migration can increase the population by 10-15% annually, compared to natural population growth of around 3% for both countries.

Project Induced In-Migration (PIIM) has the potential to create a range of positive and negative risks and impacts. Likely in-migrant groups include job seekers and their families, entrepreneurs/traders, opportunistic settlers looking to qualify for resettlement entitlements and commercial sex workers.

A number of points need to be borne in mind, regarding the assessment and management of PIIM:

- In many instances, in-migration is both a positive and necessary condition for Projects to be able to make meaningful contributions to local development. Short sighted attempts to control or limit PIIM may therefore unintentionally mitigate against efforts to promote local development, by

(3) IFC Handbook for Addressing Project-Induced In-Migration, 2009.

inhibiting the establishment of a critical mass of local producers and consumers that are so integral to development.

- Attempts to control or limit in-migration and other forms of human mobility engage fundamental questions related to international human rights as well as domestic rights related to freedom of movement and the pursuit of livelihoods. It is in the interest of the Project to ensure that any efforts to control migration or human mobility remain in accordance with established legal and social norms.

Box 11.13 Description of the Baseline Environment

Population increases have been experienced by the majority of communities as a result of increasing birth rates, decrease in mortality rates and people returning to villages as a result of ruralisation, fertile soil for agriculture and .decreased economic activities in urban places.

Availability and quality of infrastructure and social services in the social study area is poor. Schools have a shortage of trained teachers, teaching resources and materials and have a high teacher –pupil ratio. Health clinics have a large catchment area and accordingly, some households have to travel up to 30km to visit them. Communities reported that health facilities tend to be under staffed, have an inadequate supply of drugs, do not always open on time and have long waiting times. Potable water is mainly accessed from boreholes. Although communities report that water quality is generally satisfactory, during the dry season it is not always available. Many villages do not have access to a latrine and therefore tend to use the bush to defecate. General waste is dumped in pits or burnt. Few villages have access to electricity and wood and charcoal is the prime source of energy used. Road networks are poor. During the rainy season, roads conditions deteriorate and sometimes become impassable.

Traditional governance system remains a strong and respected parallel administrative structure in the area. Traditional leaders are reported to retain significant influence and are viewed as essential for resolving disputes, making key decisions and representing the community.

Alcohol consumption and abuse is believed to be present in the broader community, but does not appear to be widespread. Commercial sex workers were reported to be present within the wider area, mainly operating in larger settlements such as Mukuni, Kalomo Town, and Livingstone (Zambia) and Victoria Falls (Zimbabwe). They tend to operate out of bars and serve tourists, traders, truckers and miners.

Proposed Project Activities - Construction and Operation

The construction phase is typically when the risk of Project induced in-migration is at its highest, with a key driver being employment opportunities. Expectations regarding resettlement and compensation may also influence people to migrate to the area. Improved transport links associated with the development of the Project is likely to facilitate such movement,

The majority of staff recruited directly by the Project will be housed in staff township areas. It is assumed that local residents however will reside outside of the proposed townships and remain in surrounding villages with their families.

The most likely push and pull factors for this Project will be:

- Socio-economic push factors: high levels of national and regional unemployment in Zambia and especially in Zimbabwe combined with high levels of national and regional subsistence livelihood activities across the border region will push in-migrants to the Project Area because it will be perceived as economically progressive region with employment opportunities.

- Socio-economic pull factors: In-migrants will be pulled by the perception of potential recruitment of skilled and unskilled labour directly by the project or indirectly through employment with SMEs that supply goods and services to mining companies or mining company employees.

- Urbanisation (built environment, infrastructure and services provision) pull factors: In-migrants will be pulled by the combination of the presence of existing and new urbanisations, which will have basic services, project community development activities (such as construction of health posts, schools, wells and markets) in proximity to major transport corridors.

11.5.1 *Impact on Ecosystem Services*

In-migration of people into communities may result in an impact on ecosystem services through a reduction in availability of natural resources. Reduced access to such services will create competition and potential conflict amongst local residents and newcomers to the area.

In addition to influx, land take for Project infrastructure and inundation will also place pressure on eco-system services and natural resources by reducing available land, changing fish habitats and restricting access to other natural resources (see *Section 11.1.1*and *Section 11.1.4).*

Sensitive Receptors

Local communities in general will be very vulnerable in the context of PIIM impact to ecosystem services due to their reliance on land-based livelihoods.

11.5.2 *Impact on Social Services*

The Project-related workforce and Project-induced influx of workers (and opportunists) will need access to a range of social infrastructure services including health and sanitation facilities, educational services (if people migrate with their families) and housing. Staff townships will have in-house health, water, sanitary and recreational facilities and so will not impact on these local facilities. Although most direct Project employees will be housed in staff townships and later, permanent townships, those that do not secure employment will have to find a place to live.

Increased pressure on social infrastructure could have a number of effects. For example, additional strain on health care facilities could reduce the ability of healthcare personnel to adequately deal with health issues in the Project area which is likely to affect local communities access to care and lead to a deterioration in health status. Similarly, increased pressure on educational facilities could reduce service provision and diminish educational outcomes. Pressure on housing could result in either the construction of new houses in the Project area or residents renting out available rooms to generate additional household income. It could also result in homelessness.

Informal settlements create the potential for a host of problems such as health risks associated with poor living conditions, conflict and homelessness. It can add further strain to service delivery and infrastructure as a result of unsanitary conditions from poor waste disposal to groundwater pollution and resultant diminished levels of health.

Sensitive Receptors

Local communities in general will be very vulnerable in the context of PIIM impact to social services as access to such services is already limited. The poorest community members are likely to be disproportionately affected however, as they lack the resources to seek alternative sources or to pay higher costs to access them. Those with poor health are also vulnerable as restricted access to some services could lead to further deterioration.

The district councils will be sensitive as they are tasked with the provision of social services to the Project affected communities.

11.5.3 Impact on Social Integrity

The cultural and social values of in-migrants may differ from those held within the local communities. This may cause tension and conflict, particularly among those who perceive their sense of identity and belonging to be under threat. In-migrants will not be accustomed to or bound by allegiance to the existing traditional leadership structures and thus, the power of traditional leaders may be challenged.

PIIM and staff recruitment (of a largely male workforce) is likely to increase available cash which may be associated with higher rates of alcohol and substance abuse, and solicitation of commercial sex workers, especially if there are few recreational opportunities available. It may also lead to increased incidence of teenage pregnancy and single parent households. At FGDs with women in Mukuni in Zambia it was reported that construction workers employed on the Kazungula Bridge Project left many of the young girls in their village pregnant.

The difference in income between those who manage to secure jobs and those who do not could lead to tensions and have the potential to erupt in crime and / or violence. Influx may also lead to illegal poaching as a result of competition for land and resources. Corrupt activities may emerge to facilitate undue recruitment and supply of goods and services. Illegal immigrants may also corruptly acquire local land and settlement rights to access Project benefits in the local area

Sensitive Receptors

Entire communities will be sensitive to impacts on social integrity. Traditional authorities could be particularly vulnerable as it may attack their position of influence.

Significance of Impact (Pre-mitigation)

<u>Method for Estimating PIIM Population</u>

The IFC's handbook on managing influx indicates that every formal job created within a mining project could lead to between three to ten additional jobs in the project area.

The IFC identifies a range of 3 to 10 in-migrants for every Project worker during construction and operation. However, ERM has project experience in the DRC at a site approximately 700km to the north where the in-migrant to worker ratio was 22 to 1. Zimbabwe, Zambia and the DRC have similar levels of multidimensional poverty[4]. Therefore, all three ratios will be used to estimate a PIIM range.

<u>Estimated PIIM Population</u>

Table 11.24 summarises the range of the estimated PIIM Population. It shows that during construction between Years 1 and 3, approximately 9,000 to 66,000 in-migrants may arrive in the Project district. Between Years 4 to 7, these levels are likely to remain unchanged, neither increasing or decreasing substantially, owing to ongoing construction activities. In Year 8, the first year of the operation phase, it is likely that out-migration will begin to occur as construction workers who cannot secure local jobs will depart. It is not feasible to estimate out-migration with any accuracy; therefore, a worst-case assumption was made that PIIM migration will fall 10% year on year for three

(4) UN Development Programme - Human Development Report, 2015

years before stabilising. This will result in an estimated PIIM population range in Year 10 of the Project (Year 3 of operations) of between 6,500 and 48,000.

Table 11.24: Typical In-Migration Scenarios depending on Workforce Population[5]

Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Project Year	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Phase	Pre-Cons	Cons	Cons	Cons	Cons	Cons	Cons	Cons	Ops	Ops	Ops	Ops	Ops	Ops	Ops
Planned Construction Workforce	-	500	500	3,000	3,000	3,000	3,000	3,000	-	-	-	-	-	0	-
Planned Operations Workforce	-	-	-	-	-	-	-	-	1,500	1,500	1,500	1,500	1,500	1500	1,500
PROJECT POPULATION	-	500	500	3,000	3,000	3,000	3,000	3,000	1,500	1,500	1,500	1,500	1,500	1,500	1,500
IFC BEST CASE SCENARIO JOB SEEKING IN-MIGRANTS (3:1)	-	1,500	1,500	9,000	9,000	9,000	9,000	9,000	8,100	7,290	6,561	9,000	9,000	9,000	9,000
IFC WORST CASE SCENARIO JOB SEEKING IN-MIGRANTS (10:1)		5,000	5,000	30,000	30,000	30,000	30,000	30,000	27,000	24,300	21,870	30,000	30,000	30,000	30,000
ERM WORST CASE SCENARIO JOB SEEKING IN-MIGRANTS (22:1)		11,000	11,000	66,000	66,000	66,000	66,000	66,000	59,400	53,460	48,114	66,000	66,000	66,000	66,000
TOTAL PROJECT RELATED POP IFC WORST CASE	-	8,700	11,919	26,704	33,826	44,434	61,752	62,747	69,166	70,104	71,691	77,198	81,263	86,650	93,787
TOTAL PROJECT RELATED POP IFC WORST CASE	-	12,200	15,419	47,704	54,826	65,434	82,752	83,747	88,066	87,114	87,000	98,198	102,263	107,650	114,787
TOTAL PROJECT RELATED POP ERM BEST CASE	-	18,200	21,419	83,704	90,826	101,434	118,752	119,747	120,466	116,274	113,244	134,198	138,263	143,650	150,787

Assumptions:

1. PIIM population only, does not include workforce dependants, new township workers or direct and indirect job placement in the local districts.
2. 10% year on year reduction assumed for out-migration after construction finishes end of Year 7.
3. Natural increase of existing population and PIIM population not included.

(5) IFC's Handbook for Addressing Project-Induced In-Migration, 2009

Forecast PIIM Hotspots

The characteristics of a high-risk PIIM hotspot are identified in the IFC PIIM handbook (1) as follows:

- High level of local unemployment;
- Adjacent to direct and indirect construction phase labour requirements (particularly the need for recruitment of unskilled labour);
- Proximity to construction phase demand for goods and services by the project;
- Increase in access and availability of infrastructure (roads, services, transportation, education and health), and utilities (water and sanitation);
- Increase in access and availability of resources for third parties (e.g., new roads); and
- Opportunities for land speculation associated with project development.

ERM's experience in studying PIIM has led to the identification of addition characteristics:

- Nearest settlements in proximity to major project components, especially workforce accommodation.
- Areas immediately adjacent to a major transport corridor, which is the major access, route to the Project.
- Presence of major regional urbanised areas with some basic level of services connected to the Project by roads and public transport.
- Availability of unused or under-utilised land for informal settlement.
- Communities where there is reliance on subsistence livelihood activities who welcome in-migrants as evidence that the Project will be a benefit to them.
- Community development and investment in adjacent communities to the Project in health, education and water supply.

A desktop review was undertaken of the spatial layout of the new Project components their proximity to existing urbanisations, settlements and roads. The following locations are considered as potential PIIM hotspots:

- Zambia:
  - Town of Livingstone;
  - Town of Kazungula;
  - Town of Zimba;
  - Town of Kalomo;
  - Town of Chomo;
  - Villages at and around Mukuni;
  - Villages at and around Chibule;
  - Villages at and around Tebo ;
  - Villages at and around Chilziya;
  - Proposed staff township location and surrounding area; and

(1) IFC's Handbook for Addressing Project-Induced In-Migration, 2009

- Proposed new roads and adjacent areas.

- Zimbabwe:
  - City of Hwange
  - Town of Victoria Falls
  - Villages at and around Simakade
  - Villages at and around Sidakeni
  - Villages between Ndolovu and Sacred Heart Mission
  - Proposed staff township location and surrounding areas; and
  - Proposed new roads and adjacent areas.

The following locations were identified as potential high-risk PIIM hotspots:

- The proposed staff townships in both countries;
- Adjacent to new roads in both countries;
- The villages in the vicinity of Sidakeni in Zimbabwe;
- The villages in the vicinity of Mikuni, Chibule and Tebo in Zambia; and
- The villages between Ndolovu to Sacred Mission in Zimbabwe.

Based on the analysis provided above, it is the opinion of this ESIA that the impacts associated with in-migration will be a "**Major Negative Impact**" pre-mitigation (refer *Table 11.25).*

Table 11.25 Rating of Impacts Related to In-migration – (Pre-mitigation)

Type of Impact		
Induced and Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Project induced in-migration is mainly likely to occur in the Districts of Kazungula and Hwange and place additional pressure on natural resources in this area.
Duration	Long term	Impacts of in-migration will be felt as long as the migrant population is present.
Scale	Large	Insufficient ecosystem and social services to provide for increasing population numbers has the potential for large numbers of households to be affected. The degree of change to livelihoods has the potential to be significant as quality of life and food security will be threatened. Impacts on Social Integrity may also be significant given the rural nature of the project area. It is estimated that as a worst case scenario approximately 150,000 PIIM migrations may be incurred (excluding dependants and job placements in neighbouring districts).
Frequency	Often	An influx of people to the area is not expected to happen suddenly, but rather continuously over the construction and operation period.
Likelihood	Likely	The attraction of increased job opportunities from fishing, tourism and secondary activities is considered likely to lead to an influx of people to the area.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
High sensitivity due to the reliance of the majority of households on natural resources for their livelihoods and already strained social services		
Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation/Management Measures

It is important to note that in-migration is difficult to manage in any circumstance, regardless of location or driver. This is especially the case since some of the measures that need to be taken rely on the capacity and collaboration of third parties including the government, chiefdom authorities and other companies in the area. The specific mitigation measures required are:

- Development and implementation of a PIIM Method Statement. The Method Statement will cover the following key elements:
    - Communication;
    - Minimising potential for in-migration;
    - Managing and directing influx;
    - Enhancing physical infrastructure;
    - Building human capacity to manage influx;
    - Monitoring and evaluation of in-migration; and
    - Consideration of Project closure (end of construction phase).

ZRA will partner with the national, regional and local Government agencies to implement the plan, as well as with various national and international NGOs.

- Undertake communication related to PIIM. This will include:

  - Engagement with Government authorities on issues, risks, threats, and opportunities regarding in-migration;

  - Engagement with local communities to understand their concerns, raise awareness of risks and opportunities, and identify solutions to issues relating to in-migration;

  - Development and implementation of a targeted communications plan in areas known to be potential sources of in-migration and, using migrant networks, inform potential in-migrants of the scale and nature of opportunities, manage their expectations, and where appropriate discourage them from moving to the Project area; and

  - Communication of the Project's policy of recruiting through Local Employment Offices and the locations of those offices through activities targeted at potential in-migrants.

- Ensure communities participate in pre-construction harvesting of resources as part of clearing activities in project footprint areas (excluding the area of inundation where accessing the gorge could result in more severe ecological impacts). Identify optimal methods of storing harvested materials.

- Work with Project affected communities and local authorities to assist in protecting land-based resources. This will include the provision of education for local agencies and communities related to threats to biodiversity from human activities and sustainable harvesting and grazing of natural resources.

- Ensure livelihood restoration measures, as detailed in the RPF and subsequent LRP/RAPs are implemented. See *Section 11.1.1*.

- Work in conjunction with relevant partners (e.g. health authorities, NGOs, development agencies) to develop information, education and communication campaigns around diseases and health practices related to sanitation and hygiene.

- Initiate discussions with the Ministry of Health in order to plan for anticipated increased demands on local health facilities from the Project (during construction) as newcomers to the area.

- Support government initiatives that ensure local education's capacity to meet increased pressure on schools in the area.

- Lobby relevant NGOs / Government organisation for infrastructure improvements to support management of in-migrants.

- Explore ways in which to support local policing if there is increased pressure on the limited resources as a result of the Project.

- Allow the wider public to access health facilities located within the construction camps for a fee.

- In collaboration with local government monitor in-migration rates.

- Engage new migrants' close to Project worksites in a timely manner about ZRA's hiring policies.

- Implement employment policy forbidding informal labour hire.

- Agree with local government on designated areas for new migrant settlements and work with them to discourage informal settlement.

- Liaise with government regarding the location of the staff townships.

- Assist with the identification and demarcation of transitional zones for settlement, business, and informal trading in anticipation of an influx of people and associated housing demands, with the aim of directing future settlement patterns.

- Support community-based and inter-village youth programmes for sport, arts, and culture. This will serve to establish recreational facilities that deter negative social behaviours.

- Ensure community awareness and safety in terms of Project operational areas, hazardous areas, and future development areas. This will prevent inappropriate and unsafe settlement near to Project activities.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the impact will be "**Moderate Negative Impact**" post mitigation.

Table 11.26 Rating of Residual Impacts Related to In-migration (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This rating would not change and the impact would still occur at the local level.
Duration	Long term	This rating would not change and would be experienced throughout the project whilst the migrant population is present.
Scale	Medium	Diversification of livelihood opportunities may reduce the scale of the impact.
Frequency	Constant	This rating will not change.
Likelihood	Possible	Good management of PIIM through the implementation of the mitigation measures is likely to reduce the potential for strain on ecosystem and social services and preserve social integrity.
Magnitude		
Medium Magnitude		
Significance Rating After Mitigation		
Moderate Negative Impact		

11.6 IMPACTS ON HEALTH AND SAFETY

This *Section* looks at ways in which the health, safety and security of the local communities within the Project area of influence could be impacted during the life of the proposed Project. This includes consideration of disease transmission, access to health care and accidents and injuries. Security risks as a result of increased access to the Project area are also considered here.

11.6.1 *Increased Incidence of Communicable Disease*

Communicable diseases include acute respiratory infections (ARI) and tuberculosis (TB), as well as sexually transmitted infections (STIs) including HIV/AIDS.

Box 11.14 Description of the Baseline Environment

Communicable diseases are reported to be common across the Project area. Diarrhoea is common, especially amongst children, and incidences of tuberculosis have also been reported. Respiratory infections, eye disease, dental problems and heart disease were all reported. Malaria and malnutrition were also prevalent throughout the Project Area,

Health representatives in the areas noted that poor housing and sanitation contribute to health problems, such as diarrhoea and TB. Although communities reported that in general, water quality is satisfactory, during the dry season it is not always available.

Community FGDs and interviews with health professionals, revealed that STIs, including HIV/AIDS, syphilis, genital ulcers, and gonorrhoea, were common health problems. Although stigma surrounding STIs is reported to be decreasing, some villages reported that there was still shame and secrecy surrounding the disease. Hospitals and rural health clinics, as well as some NGOs offer tests for HIV/AIDS free of charge, as well as counselling and antiretroviral (ARV) therapy for those infected.

STI prevalence is attributed to multiple sexual partners, unprotected sex, and limited recreational and livelihood opportunities available for youth, which has led to increased alcohol consumption and high risk sexual activity.

Community members and health workers noted that prostitution is present in communities, especially in those within Kazungula District (Zambia) and Hwange District (Zimbabwe). This was attributed to their status as both tourist and transit districts, which provided a constant market for commercial sex workers. Health representatives in both countries were worried about the potential for the Project to increase the prevalence of STIs in the area.

Health workers noted that as a result of educational campaigns, community members are generally aware of how communicable diseases are transmitted however, due to poor socio-economic conditions, they are not always able to translate knowledge into behaviour that promotes good health outcomes.

Communities lack adequate access to health care services, with most households having to walk over an hour by foot to access clinics. Quality of care is hampered by inadequate medical supplies and limited number of qualified healthcare personnel. Communities reported long waiting times when accessing services.

Proposed Project Activities - Construction and Operation

As a result of Project development, in particular during the construction phase when the workforce is likely to be greatest and when in-migration may peak, the rate of transmission of diseases may increase. This will be largely due to:

- Interactions between the Project workforce and local communities.
- Potential for overcrowding as a result of increased pressure on existing housing infrastructure, water and sanitation services.
- In-migrants and the Project workforce coming to the area bringing new diseases or varying disease profiles compared to the existing community.

- Greater disposable incomes increasing a risk of engaging in high risk sexual activities with commercial sex workers both in local communities and on transit routes to / from site, acting as a vector for the disease.

- Transport drivers, who typically have higher rates of HIV or STIs than the general population, may engage in casual high risk sexual activity along the transport route and at their end destination. The construction of access roads and subsequently, an improved transport network may increase the mobility of the population, which may serve to further increase potential for liaisons with infected people.

- The presence of commercial sex workers with higher rates of STIs and HIV, may increase near construction sites and while they are better able to negotiate safe sex practices, they may waive this for a fee.

Impact Description

The presence of the Project workforce could facilitate increased transmission of communicable diseases as well as introduce new diseases (e.g. pandemic influenza and meningococcal meningitis) into the area. Poor access to, and quality of, health care services could contribute to the rapid spread of these diseases if people fail to seek treatment in a timely manner.

If not treated in time, communicable diseases can affect the long-term health of those who contract them, leading to death in the worst case scenario. Although stigma surrounding HIV/AIDs has decreased in recent years due to educational and awareness raising campaigns, there is the potential that any residual prejudice against those infected with STIs may discourage people from seeking testing, treatment and care, all of which will affect health outcomes. The increased incidence of communicable diseases may impact on the availability of the Project workforce, by increasing absenteeism and staff turnover, leading to subsequent impacts on productivity and costs.

Sensitive Receptors

Poorer sectors of the community are more vulnerable to diseases as they are more likely to live in overcrowded, poor quality houses, which lack access to water and sanitation. Children, the elderly and those with poor health are sensitive due to weaker immune systems. Carers are also at risk of contracting the disease themselves.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, the impact will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 11.27*).

Increased prevalence of communicable diseases would largely be attributable to the presence of the construction workforce and of opportunistic in-migrants. Most influx however will take place in close proximity to the tourist capitals of both Zambia (Livingstone) and Zimbabwe (Victoria Falls), which are both located on major transport links. The presence of tourism already facilitates such transmission and therefore the Project's potential to change the existing risk profile will be contained to a degree.

Table 11.27 Rating of Impacts Related to Increased Spread of Disease – Pre-mitigation

Type of Impact		
Direct and Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to Regional	The transmission of diseases has the potential to extend beyond the Project Area given the presence of migrant workers. However, it is expected that it will be felt most in Kazungula District (Zambia) and Hwange District (Zimbabwe) as this is where workers will be accommodated and where the greatest concentration of in-migration will occur as a result of the Project.
Duration	Medium term	Impacts will occur for the duration of the construction period.
Scale	Large	Following any increase in the incidence of communicable diseases, there is a risk of on-going increased prevalence as well as long-term health consequences for those affected.
Frequency	Constant	The possibility of transmission will exist for the duration of the Project
Likelihood	Likely	Project induced in-migration as well as the presence of the Project workforce combined with the baseline conditions mean that the impact is likely.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
High Sensitivity		
High sensitivity due to poor access to healthcare facilities and reportedly poor service of healthcare establishments (e.g. long waiting times, inadequate drug supply, etc.).		
Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation/Management Measures

The specific mitigation measures that will be required are detailed below.

Mitigation measures will be implemented by the Project in collaboration with other agencies (i.e. development agencies, NGOs or health authorities). The Project will proactively seek and manage these partnerships to ensure that impacts are being mitigated in a timely manner and to measure and monitor outcomes based on KPIs.

- Health awareness training will be provided to all employees. This will include knowledge and awareness around how communicable diseases are transmitted, diseases to be aware of, their symptoms and the benefits of early treatment. Health awareness training will be provided as part of workers induction with refresher courses provided annually.

- Pre-Employment screening measures will be developed and implemented for workers, which will cover appropriate diseases. Individuals found to be suffering from communicable diseases will be provided with treatment prior to mobilisation to site.

- TB prevention measures will be implemented including free testing and free treatment for all personnel working on the Project. This approach will be explained clearly to the workforce along with making it clear that there are no consequences for their employment.

- Develop Emergency Prevention, Preparedness and Response Plans. In collaboration with the local and regional Government and local emergency providers and local health care facilities, Emergency Prevention, Preparedness and Response Plans (EPPRPs) will be developed. These would cover all incidents presenting risks to public safety and the affected communities in proximity to the various Project Sites and the environment. The EPPRPs will:

    - Be applicable to all contractors and subcontractors as well as local communities;

    - Consider access to health care, major incidences, exposure to hazardous materials, multiple casualty events, epidemics and pandemics; and

    - Make provisions for awareness-raising activities and emergency response training to the communities that are considered to be at higher risk.

The existing Dam Safety Plan for the BGHES is attached in *Annex O*. This Dam Safety Plan includes the Emergency Preparedness Plan (Framework Plan) for the Project, which includes a description of the types of emergencies; how to identify emergencies; the actions to be taken during an emergency; preparedness and emergency response; and a dam break analysis. To note, this is a framework plan that will need to be finalised as part of final design of the BGHES.

- Monitor the emergence of major pandemics through WHO alerts. If the WHO Pandemic Alert Scale reaches level 4 the Project will develop and implement the relevant Emergency Response Plans.

- Ensure sufficient health services are available to meet the day to day needs of Project personnel without impacting on access to health care for communities. This will include the provision of a health clinic with trained medical personnel at construction camps or sites.

- Develop agreements with health clinics or hospitals that the Project intends to use. This will refer to care that cannot be treated at the in-house Project facilities. These agreements will include support to increase capacity (health personnel, equipment, drugs etc.) to ensure that there is no loss of access for community members.

- Develop a recruitment strategy for employment of medical staff to avoid taking resources from the local area and prevent a negative impact on local health care.

- Operate staff township areas in accordance with international good practice. This will include prevention of overcrowding, access to clean water and sanitation and enforcing high levels of food hygiene standards within the camps to minimise disease transmission. The Project will encourage the early reporting of illness and 'stop-work' when amongst food handlers.

- Develop and Implement a Workforce Code of Conduct. The Workforce Code of Conduct will be adhered to by all Contractors and ZRA employees. Any employee or Contractor found in violation of the Code should face disciplinary hearing, which will potentially result in dismissal. All Project personnel (including contractors and subcontractors) will be trained in the Workforce Code of Conduct. The key elements of the Code of Conduct will cover:

    - Provision of training on disease awareness and specific prevention training covering malaria, STIs (including HIV/AIDS), TB and other diseases as appropriate.

    - Zero tolerance of illegal activities by all personnel including:

        - Forbidding the use of prostitution;
        - Forbidding the illegal sale, purchase or consumption of drugs and alcohol; and
        - Forbidding gambling and fighting.

- Commit community investment funds to public health initiatives being implemented by regional/local Government and /or relevant NGOs. Such initiatives may include upgrading existing facilities, education and awareness campaigns, vaccination campaigns etc.

- A baseline for workers and residents of the affected communities will be prepared in line with the requirements of the International Council of Mining and Metals (ICMM)'s *Good Practise Guideline on HIV/Aids, Tuberculosis and Malaria.* This will include the collection of data, where required to supplement previous data collection, relating to:

    - Demographics, such as population size, gender distribution and age distribution of the workforce and host community.
    - Burden of disease (the level of morbidity and mortality caused by a disease, within a given area or target population) and epidemiology of HIV in the community and workforce.

- General standard of living within the study area, with the identification of vulnerable groups.
- Existing health services in terms of type, mix, quality, location, access and equity.
- Socio-economic status (variably defined as a mix of income, material, assets, status indicators, education, and occupation).
- Workforce housing, accommodation type and location.
- Ethnicity, if it influences health.
- Access to clean water and sanitation.
- Gender equality and female literacy rates.
- Food consumption and nutrition.
- Policy environment and political factors, such as levels of support for social services and health care services in the area.
- Government capacity to provide services.
- Details on existing workforce and/or community programs targeting HIV/Aids.

- The ZRA will develop a policy and method statement to reduce the transmission of STIs, including HIV/AIDS. This method statement will need to detail financial and personnel resourcing and will present an itemized budget and timeline for implementation. The key elements of a workforce HIV/AIDS prevention programme are presented in *Box 11.14* below.

Box 11.15 Key Elements of a Workforce HIV/AIDS Prevention Programme

Prevention:
- Raise awareness (address the facts and fiction of HIV transmission);
- Get the message out (make use of local languages or non-written forms of communication);
- Go beyond the workplace;
- De-stigmatise the disease;
- Peer education (train and support peer educators);
- Review occupational health and safety procedures;
- Condom distribution;
- Circumcision promotion;
- Voluntary HIV testing and counselling;
- Post exposure prophylaxis programme for all employees with potential exposure to blood or body fluids;
- Prevention of Mother-to-Child Transmission; and
- Training of managers and supervisors - to improve programme success.

Treatment and Care:
- Anti-Retroviral Treatment (ARV);
- ARV programme for family members infected;
- Adherence promotion;
- Preparation for treatment;
- Controlled dispensing of medication;
- On-going adherence monitoring promotion;
- Provision of nutritional programme; and
- Terminal and home-based care.

- The strategy will:
  - Make provision for awareness, counselling and testing for all Project personnel, including voluntary testing for STIs and HIV/AIDS as part

of any health screening program (workers will not be denied employment or discriminated against in any way based on their HIV status.).

- Provide support to workers to access treatment for HIV/AIDS through existing health facilities or NGO campaigns or programmes.

- Ensure there is access to free condoms (including female condoms) at all worker sites and accommodation (including transit routes) to promote safe sexual practices.

- Ensure that all Project personnel are given specific HIV and STI prevention training. This will be given on induction and refresher training. The contractor and subcontractors commitments to this training will be stipulated in the contracts with specific time allocations for this training per employee skills level being provided and as such committed to.

- In partnership with local health officials and relevant NGOs, undertake information, education and communication campaigns around safe sexual practices and transmission of STIs and HIV/AIDS. These campaigns will make use of roadshows, radio and small group discussions.

- Support local school education initiatives by government and NGOs regarding sexual education. Health experts agree that education and awareness is an important tool for reducing the spread of disease.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the impact will be reduced to "**Minor Negative Impact**" post mitigation.

Table 11.28 Rating of Residual Impacts Related to Increased Incidence of Communicable Diseases (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local to Regional	The rating will not change and will remain at the local to regional level.
Duration	Long term	Increased transmission of communicable diseases is likely to occur for the duration of the Project
Scale	Medium	The scale of the impact will be reduced with mitigation
Frequency	Constant	The possibility of transmission will exist for the duration of the construction period
Likelihood	Likely	Project induced in-migration as well as the presence of the Project workforce combined with the baseline conditions mean that the impact is likely.
Magnitude		
Medium Magnitude		
Significance Rating After Mitigation		
Minor Negative Impact		

11.6.2 Increased Incidence of Malaria and Other Vector Borne Diseases

Box 11.16 Description of Baseline Environment

Malaria is endemic in both Zambia and Zimbabwe. Although malaria rates have decreased in the last two years in the local study areas of both countries, due in large to the effectiveness of preventative measures such as spraying and use of mosquito nets, it is still reported as one of the most common health complaints by villages.).

Health representatives and communities noted that awareness on routes of transmission and modes of prevention were high, due to repeated government campaigns and educational awareness programmes by health facilities and NGOs.

Malaria testing, via rapid diagnosis tests (RDTs) are available at the vast majority of health centres and clinics. Health workers noted that malaria treatment is available at the clinics.

No other vector borne diseases were reported in the local study areas.

Proposed Project Activities – During Construction

Modifications to the physical environment (e.g., creation of quarries, trenches civil works) can create small water pools (e.g., in wheel ruts and footprints) offering new mosquito breeding grounds and leading to increased vector density and increased human vector (mosquito) interaction. Modifications to the environment may change the breeding patterns of mosquitoes extending the high risk season for transmission.

The in-migration of people may play an indirect role in increasing the malaria burden through an increase in pressure on medical facilities, inadequate waste management and establishment of make-shift housing (reducing natural protection to mosquitoes).

Proposed Project Activities – During Operation

The establishment of a reservoir, as well as the reduction of water flow velocity upstream has the potential to create new mosquito breeding grounds. For deeper waters in particular, there is the potential for water to become stagnant. Potholes may also develop along roads used by Project staff, which could collect pools of stagnant water in which mosquitoes breed.

As with the construction phase, there is the potential for other vector borne diseases to develop if different mosquito species are attracted to the area as a result of the creation of breeding sites.

Impact Description

Large dams (defined as water infrastructure with a crest height greater than 15 m or a storage capacity exceeding 3 million cu for heights between 5-15m) are recognised as enhancing malaria transmission within 5km of the reservoir. The impact of dams on malaria beyond this is considered to be negligible due to the limited flight range of mosquitos.

This is particularly true in areas where malaria transmission is considered to be unstable (1). In a review of malaria transmission rates associated with existing large dams, the effect of dams on annual malaria cases was 3.5-4.5fold higher in areas of unstable transmission compared to areas with stable transmission. Furthermore, malaria cases in areas of unstable transmission were on average 3.2 times greater in communities living close to reservoirs compared to those living more than 5km from them. The malaria prevalence was reported to increase between 2.3-24.5 times (odds ratio). In the vicinity of reservoirs in stable and unstable areas on average reservoirs associated with large dams contribute to 47% of malaria cases of communities living within 5km of them.

A potential explanation is that malaria in stable areas is broadly continuous and as such dams simply add to the array of existing breeding habitats available, where as in unstable transmission malaria is seasonal and the lack of breeding habitats in the dry season is a limiting factor in transmission. As such, reservoirs create conditions suitable for malaria transmission throughout the year leading to increased potential for transmission.

There is limited evidence that increased transmission of malaria has been successfully managed on dam Projects although four approaches are suggested:

1) dam placement – to avoid malarial areas;
2) dam design and reservoir sizing - to minimise ability of mosquitos to breed;
3) dam operation and habitat modification to suppress larval development; and
4) environmental controls such as introduction of larvivorous fish.

(1) Unstable areas are areas where the annual P. Falciparum Infection Rates (PfIR) are between 0 and 0.1 cases per 1000 population. Where there are more than 0.1 cases per 1000 population malaria is considered to be stable

In addition, public health measures such as bed nets, mosquito proofing housing and improving local health facilities can all contribute to reduced disease transmission

It can therefore be seen that the creation of the dam for the Batoka Gorge Project will contribute to the increased transmission of malaria for existing communities within 5km of the dam (as well as any migrants that come to the area). However, the design of the dam (deep, with relatively low residence for water) will help minimise the creation of breeding grounds for larvae.

Although malaria is currently the only vector borne disease of concern in the local communities there is a risk that others, such as yellow fever, dengue fever or lymphatic filariasis, may develop as a result of the creation of mosquito breeding grounds that could attract different species of mosquitoes in to the area. As such diseases are currently uncommon, if they do develop, they may initially be misdiagnosed which could result in ineffective treatment being prescribed, thereby leading to poor health outcomes.

As with communicable diseases, malaria can lead to long term ill health, with death in the worst case scenario. It may also impact upon the availability and productivity or the workforce, and place a greater burden on health care facilities.

Sensitive Receptors

Communities at large will be vulnerable to any potential negative change to the prevalence of vector borne diseases; however, children will be most vulnerable due to weaker immune systems, as well as pregnant women and those suffering from other diseases and conditions that affect the immune system, such as HIV/AIDS. Those residing within 5 km of the proposed Batoka inundation area are at the highest risk of transmission.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is the opinion of this ESIA that increased transmission of malaria will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 11.29).*

Table 11.29 Rating of Impacts Related to Increased Incidence of Malaria and other Vector Borne Diseases (Pre-Mitigation)

Type of Impact		
Direct and Indirect Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The extent of the impact will be local, as it will be limited to the Project Area (predominantly within 5 km of the area of inundation), impacting local residents and ZRA's workforce.
Duration	Long-term	The impact will be experienced throughout the duration of the Project

Scale	Large	The scale of the impact is based on the fact that contracting malaria or other vector borne diseases can lead to long term health effects and in the worst-case scenario, death.
Frequency	Constant	Frequency will be constant due to the presence of a reservoir all year around. The impact is more likely to occur during the rainy season.
Likelihood	Likely	Without mitigation, the potential to contract malaria will be increased as a result of modifications to the environment, including creation of the reservoir and reduced water flow.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Moderate Sensitivity		
Contraction of vector borne diseases will lead to worse health outcomes and project induced in-migration will threaten access to health care for those seeking treatment. Sensitivity/vulnerability is limited to a degree however by high awareness of prevention methods. Health workers and communities have also noted that malaria is currently under control due to use of bed nets and spraying programmes.		
Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation/Management Measures

The same construction mitigation measures will be applied during operation, with measures being applicable to the permanent staff townships. The following measures will also be required:

- Development and implementation of an Integrated Malaria Control, Prevention and Treatment Programme. The programme will include the following key aspects:
    - Vector Management:
        - Avoid the creation of mosquito breeding conditions through creation of proactive surface water management during construction activities e.g., excavation for road building, leaking water pipes and engineering works that interfere with the natural lines of water drainage.
        - Reduce or elimination of mosquito breeding habitats e.g., level ground, appropriate drainage, and vegetation clearance.
        - Reduce the presence of standing water onsite through strict environmental controls and source reduction to avoid the creation of new breeding grounds. Such measures include repairing leaking pipes, dewatering of open excavations and effective drainage systems along access roads.
    - Control or Reduction of Individual Risk:

- Personal protection and behaviour modification measures e.g., awareness raising and education programmes, and mandating compliance with appropriate anti-malarial chemoprophylaxis for employees when recommended.

- Reduce the potential for mosquito-human interactions in workforce accommodation, office space and other buildings through the use of screens at windows and doors, application of air conditioners and fans, the use of bed nets and other measures.

- Ensure that the workforce has access to prompt, accurate and effective diagnosis and treatment while working on site or in remote areas.
- Develop and disseminate a malaria information booklet and training material for the workforce. These materials will be used as part of a new employee induction, as well as part of annual refresher training sessions on malaria.

- Limit Effect of Infection:

    - Partnership and collaboration in community programs with key external stakeholders to ensure community collaboration and enhance program sustainability.

    - Ensure availability of malaria treatment at all clinics used by the workforce and local communities. This will be achieved through a partnership with the Ministry of Health and / or relevant NGOs.

- Maintain the health centres/hospitals that will be developed as part of the permanent townships. ZRA will ensure that the health facilities are well-equipped with adequate medication, equipment and sufficient number of trained staff in order to be able to treat all ZRA employees and contractors.

- Allow wider public to access health centres located within the permanent townships. This will enable any individuals (regardless of whether they are employed on the Project or not) to seek treatment, for a fee, should they contract malaria or be infected by other vector borne diseases.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the impact will be reduced to a "**Minor Negative Impact**" post mitigation.

Table 11.30 Rating of Residual Impacts Related to Increased Incidence of Malaria and other Vector Borne (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The rating will not change.
Duration	Long-term	The impact will be experienced throughout the duration of the Project
Scale	Medium	Even though the numbers at risk of infection would significantly decrease after mitigation there would be a significant degree of change in the lives of those who contract diseases, some may not be able to provide for their households while other people will require additional care.
Frequency	Constant	The possibility of transmission will exist over the life of the Project.
Likelihood	Possible	Mitigation measures will reduce the likelihood of the impact occurring.
Magnitude		
Medium Magnitude		
Significance Rating After Mitigation		
Minor Negative Impact		

11.6.3 Impacts to Community Security

Impacts to community security could occur as a result of clashes between security personnel and community members or due to increases in crime associated with the establishment of border posts

Box 11.17 Description of the Baseline Environment

In general, it was reported that villages were safe places, with few conflicts or crimes being committed. However, a few community members in Zimbabwe reported that cattle had been stolen from them by people who had illegally crossed the Zambezi River from Zambian settlements.

The African Development Bank notes that corruption and illicit trade is extremely high at most African border posts. Immigration officers and companies/traders often find themselves engaged in acts of bribery and the under-declaration of goods as means to "facilitate" payment (1)

Human rights abuses have been committed by both private and government security forces in Zambia and Zimbabwe.

Proposed Project Activities - During Construction and Operation

The dam site will act as a border between Zambia and Zimbabwe and as part of the Project, check points for incoming trucks, custom and immigration offices will be established in both countries either side of the river.

(1)AfDB (2012). Border Posts, Checkpoints, and Intra-African Trade: Challenges and Solutions. Available at http://www.afdb.org/fileadmin/uploads/afdb/Documents/Publications/INTRA%20AFRICAN%20TRADE_INTRA%20AFRICAN%20TRADE.pdf. Accessed 20/07/2015

In addition, security personnel, who will potentially be armed, will be employed to guard Project infrastructure, during construction and operation. It is not known whether security personnel will be privately hired or whether government forces will be engaged. Use of government forces may mean that the Project has less control over the action of their security personnel.

Impact Description

If not properly managed, border control can compromise community (and even national) security. Illegal border crossings may occur, including the entry of criminals or others who pose threats and illegal goods may be smuggled into the country, including weapons, drugs or simply goods that have not been paid for (i.e. excise tax and levies). Improper management of border posts may also increase levels of cattle rustling. The impact has the potential to threaten safety levels in the country as a whole, as well as act an impediment to livelihoods and trade.

There is the potential for negative interactions between communities and Project security. Poverty levels and unemployment may result in attempts at theft from the Project site. In addition, tensions between local communities and the Project related to lack of beneficiation or employment, disruption to livelihoods (e.g. tourism / white water rafting or as a result of land take), environmental degradation, migrant influx, etc. may lead to community dissatisfaction that erupts in protests and demonstrations. The use of inappropriate force by security personnel in the event of any incident could lead to injuries or fatalities and compromise the human rights of community members, such as violations of the right to life and right to liberty and security. This in turn could have impacts on the reputation of ZRA, eroding trust in the Project.

Sensitive Receptors

Communities as a whole are considered sensitive to this impact.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is the opinion of this ESIA that the impact will be a "**Moderate Negative Impact**" pre-mitigation *Table 11.31.*

Table 11.31 Rating of Impacts Related to Community Security (Pre-Mitigation)

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact will be contained in the local area where Project security personnel will be located.
Duration	Long term	The impact will be experienced throughout the construction and operation period

Scale	Medium	Although few people are likely to be affected the outcomes could be severe including loss of life and reputational damage and erosion of trust across a number of communities.
Frequency	Occasional	Potential for impact is occasional and is closely linked to community lack of beneficiation from the Project.
Likelihood	Possible	Presence of security personnel and creation of border post means this impact is possible.
Magnitude		
Medium Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Medium sensitivity based on limited community access to redress (either through the Project or legal channels), fear of the consequences of reporting any human rights abuses, as well as likely limited capacity and knowledge around how to report such abuses. Furthermore, in the event of any injury, access to adequate health treatment will be restricted due to the poor state of infrastructure.		
Significance Rating Before Mitigation		
Moderate Negative Impact		

Mitigation/Management Measures

The specific mitigation measures include:

- Development of a Security Method Statement that will set out the process for recruitment and management of security personnel. This will include:

    - Conducting background checks on security personnel to ensure that they have no records of human rights abuse;
    - Provision of training on upholding community and employee rights and appropriate use of force; and
    - Provisions for investigating any unlawful or abusive behaviour and appropriate disciplinary action, including potential termination of contract. Unlawful and abusive acts will be reported to the appropriate public authorities.

- Management of security providers in line with the Voluntary Principles on Security and Human Rights. The Voluntary Principles guide companies in maintaining the safety and security of their operations within an operating framework that ensures respect for human rights and fundamental freedoms.

- Implement and disseminate information on the Grievance Redress Mechanism. The GRM will provide a clear process for informing stakeholders of the process for reporting complaints about security personnel and addressing any such complaints in a timely manner. Refer to *Section 11.1.1*

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the impact will be reduced to a "**Minor Negative Impact**" post mitigation.

Implementation of mitigation measures will help to avoid a negative impact; however, there remains the potential for security issues on the ground to go awry in the event of local unrest or intervention by third parties.

Table 11-32 Rating of Residual Impacts Related to Community Security (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact rating will not change and will remain at the local level.
Duration	Long term	The impact will be experienced through the construction and operation period
Scale	Small	Mitigation measures will help to ensure that security personnel are managed and trained to uphold community security and minimise any infringement of their human rights.
Frequency	Rare	Frequency of impact will reduce with mitigation.
Likelihood	Unlikely	Implementation of mitigation measures should ensure that Project personnel comply with standards that will avoid impacts to community security and reduce the likelihood of incidents occurring
Magnitude		
Small Magnitude		
Significant Rating After Mitigation		
Minor Negative Impact		

11.6.4 Worker Health and Safety Impacts

Box 11.18 Description of the Baseline Environment

Both countries have legislation in places that sets out conditions of employment, including working hours, occupational health and safety, the protection of wages of employees, the control of employment agencies, and compensation of workers disabled by accidents or diseases contracted in the course of their employment (1). Zambia and Zimbabwe have also both ratified the International Labour Organisation's (ILO) Occupational Safety and Health Convention (No. 155), and several other ILO conventions relation to labour conditions including the Abolition of Forced Labour Convention (No. 105) and Worst Forms of Child Labour Convention (No. 182).

Despite the legal measures in place, research by international organisations claims that companies (especially those in the construction, agricultural and mining sectors) do not adequately prevent accidents and long-term health effects in the workplace. In addition, the population tends to lack knowledge of labour laws including health and safety standards (2).

(1) Such legislation includes the Employment Act Cap 268, the Compensation Act (No 10 of 1999), and the Minimum Wages and Conditions of Employment Act (2012) in Zambia. In Zimbabwe it includes the Labour Act (Chapter 28:01) as amended by Labour Act [Chapter 28:01] 2006 and the Labour Amendment Act, 2005 (Act 7/2005),
(2) The Human Rights and Business Country Guide available at: http://hrbcountryguide.org/. Accessed 06/03/2015

Proposed Project Activities - During Construction and Operation

Construction is one of the most dangerous occupations in the world and the construction of Project infrastructure has the potential to put the Project workforce (including contractors and subcontractors) at risk of exposure to health and safety incidents due to the nature of the work. During construction workers will be susceptible to falling from heights, coming into contact with hazardous materials (e.g. through blasting), being struck by falling objects, experiencing excavation accidents, and being electrocuted, etc.

The Project workforce will be housed in staff townships. Poor accommodation standards could expose workers to health and safety risks.

During the operation phase, the risk of workforce exposure to health and safety hazards will be significantly reduced and mainly relate to maintenance of the dam.

Directly employed Project workforce and their families will be accommodated in the permanent townships, which are equipped with medical facilities.

Impact Description

Exposure of workforce to health and safety incidents could lead to serious injury or even death. Individuals who are injured are at risk of losing their jobs through inability to physically undertake required activities. They may also struggle to undertake other livelihood activities due to their ill health. This can have knock on effects on their household income, food security and standard of living.

According to international reports, labour laws are poorly enforced in Zambia and Zimbabwe. Accordingly, contractors and suppliers may be unprepared to meet national and international requirements, placing employees at risk. Typically the lower down in the 'subcontractor hierarchy' a supplier is, the greater the risk for failures in implementing health and safety standards and therefore higher risk of exposure of workers to health and safety hazards.

ZRA is committed to complying with Zambian and Zimbabwean occupational health and safety legislation, as well as international requirements including the relevant IFC Guidelines and Performance Standards. Where national regulations differ from the levels and measures presented in the employment and occupational health and safety guidelines, the proposed Project will be expected to achieve whichever is more stringent.

Sensitive receptors

Employees sourced from the local area are likely to be more sensitive than international employees, as they are less likely to have a good understanding of health and safety standards which may leave them more at risk of unsafe behaviours.

Significance of Impact (Pre-mitigation)

Based on the analysis provided above, it is the opinion of this ESIA that the Project impact will be a "**Moderate Negative Impact**" pre-mitigation (refer to *Table 11-33*).

Table 11-33 Rating of Impacts Related to Exposure of Workforce to Health and Safety Incidents (Pre-Mitigation) – Construction and Operation

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	The impact will be contained to the local area where workforce is employed
Duration	Long-term	Without mitigation and management measures the impact may continue for the life of the operation.
Scale	Large	Depending on the type of health and safety incident experienced changes to quality of life may substantial and could even result in death, in worse case scenarios.
Frequency	Constant	The risk of impacts to the health and security of staff will be present on an ongoing basis.
Likelihood	Possible	Labour legislation in place will regulate labour and working conditions somewhat.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium Sensitivity		
Receptors with heightened sensitivity may include employees who have a poor understanding of the requirements of OHS standards.		
Significance Rating Before Mitigation		
Moderate Negative Impact		

Mitigation/Management Measures

The specific mitigation measures required are therefore the following:

- Develop and implement an Occupational Health and Safety Method Statement. The goals of the OHS Policy will primarily be to ensure that there is zero harm to employees through visible health and safety leadership; enhancing the capability of employees and contractors to recognize and control the potential impact of their activities; identification, management and monitoring of health and safety risks and the provision and development of adequate resources and expertise to manage health and safety performance. The OHS Method Statement will include:
    - Hazard identification and risk assessment procedure;
    - A 'fitness for work' programme to ensure that all employees are physically able to undertake their work without impact to their health;

    - An occupational health and safety monitoring and surveillance programme;
    - Mandatory OHS training programmes (including awareness-raising of disease vectors) provided to all employees, including contractors to ensure staff are aware of the health and safety guidelines;
    - Specific OHS training programmes provided for workers assigned to tasks associated with particular H&S risks;
    - Development of workforce management protocols that reflect ZRA's OHS standards and contractually require all contractors to comply as minimum standard;
    - The provision and enforcement of use of appropriate Personal Protective Equipment (PPE) based on task based hazard analysis;
    - Visual warning signs in place, including those for the electrical and mechanical equipment safety warnings, and chemical hazard warnings;
    - Regulated working hours in accordance with national legislation and international guidelines.
    - Toolbox talks or health and safety meeting on a daily basis to ensure that procedures are being adhered to, and to discuss any incidents that have occurred.

- Engage with workforce on health and safety incidents. All workers (including those of primary and secondary third party contractors) will have contracts that clearly state the OHS terms and conditions of their employment and their legal rights, with copies provided in relevant local languages. Contracts will be verbally explained to all workers where this is necessary to ensure that workers understand their rights. This engagement will include OHS induction and training. ZRA will implement a worker feedback mechanism and OHS event reporting system that allows workers (including contractors) to report health and safety events or issues.

- Contractor auditing and supply chain management. A contractor audit and supply chain method statement and policy will be developed and implemented. All contractors and suppliers will be expected to sign agreement to comply with the standards it specifies. Failure to meet the standards will result in consequences up to and including termination of contract, to be decided on a case by case basis. The method statement will include requirements for:

    - All contractors to be audited on a quarterly basis for adherence to the relevant national laws and the Project's international OHS standards.

    - All contracts for primary and secondary contractors should specify OHS performance and monitoring in their contracts and should be required to action gaps in an agreed period.
    - All primary suppliers will be audited on a bi-annual basis for adherence to both national requirements and ZRA's OHS standards. Regular auditing will serve to monitor ZRA's primary supply chain and identify any significant changes or new risks arising.
    - Where significant health and safety risks are identified related to supply chain workers ZRA will introduce specific procedures and mitigation measures to address these risks over a specified time period. If risks are not addressed ZRA will look to change the primary supply chain by selecting suppliers that comply with their OHS standards and national requirements.
    - A central part of supply chain management will consider identifying potential risks related to significant safety incidents, damage to the environment or use of child or forced labour.
- Develop and implement a Blasting Method Statement. As part of this plan, the following measures will be required:
    - Local residents and communities will be advised of the planned blasting schedule ahead of time.
    - Monitor the effects of blasting activities up and downstream of the blast zone.
    - Ammonium-nitrate based explosives will not be used due to the production of toxic by-products.
    - The explosives storage area will be designed and constructed by an accredited and approved professional engineer.
    - Explosives will be stored in such a way so as to avoid uncontrolled reactions or conditions resulting in fire or explosion. This will be achieved through:
        - Storing explosives in separate areas, away from main work areas. In addition, storage will be designed so as to prevent explosion situations from affecting main work areas.
        - Searching all employees entering the explosives storage area. Persons entering the explosives storage area will not possess tobacco, matches, cigarettes, lighters or other devices capable of generating heat or spark sources. Moreover, no radio transmitters

or cellular telephones will be permitted in the explosives storage area.

        - The storage area will be fenced and will contain a guarded entrance.

    - The handling of explosives will be undertaken as follows:

        - All explosives handled will be free of foreign material.

        - All reasonable precautions will be taken to prevent the spillage of explosives during their handling.

        - Explosives will be conveyed as soon and as carefully as possible and precautions will be taken that will effectively guard against any accidental ignition or explosion.

        - Only containers provided for the conveyance of explosives will be used for transporting explosives. These containers will at all times be kept clean, free from grit and in a good state of repair.

        - Vehicles containing explosives will only be left unattended in designated areas.

        - Except for drying purposes, the use of planned explosive activity or testing, explosives will not be exposed to direct rays of the sun or to rain.

        - The transport of explosives from the storage area to the site of planned detonation must be undertaken.

        - Vehicles carrying the explosives will be washed in a designated area as the water could contain elevated ammonia concentrations from residual ammonium nitrate and is unsuitable for the direct discharge into a receiving water body. This water will be collected (e.g. in a sump) and treated in the appropriate manner. The target water quality range for acceptable nitrate levels 0 to 6 mg/.N

    - No person will use any explosive material for blasting purposes unless that person is trained and authorised to use blasting material.

    - No person will bury, dump, hide or abandon any explosive.

- Develop and implement an Emergency Response Plan (ERP). An ERP will be developed that will identify the appropriate response to incidents using a comprehensive response matrix. The ERP will provide a detailed procedure should an emergency evacuation of the staff townships and Project site be ordered. As part of ZRA's and its contractor's emergency preparedness, they will be required to have trained personnel and emergency equipment in place in the event of any emergency and all site personnel, including contractors, are to be trained in the appropriate responses for fire and accident emergencies.

- Develop and implement a Worker Grievance Redress Mechanism. A grievance redress mechanism specifically for ZRA workers and their contractors will be developed and implemented. The grievance redress mechanism will be publicly advertised by the Project to the workforce. It will be easily accessible by workers, free of retaliation and will allow anonymous complaints to be raised and addressed.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the impact will be reduced to "**Minor Negative Impact**" post mitigation.

Table 11-34 Rating of Residual Impacts Related to Exposure of Workforce to Health and Safety incidents (Post-Mitigation) - Construction

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	This rating would not change and would only affect ZRA's workforce (including contractors).
Duration	Long term	The rating will not change and will be present over the whole of the construction period.
Scale	Medium	A potential reduction in the number of employees that are exposed / experience the impact.
Frequency	Occasional	Decline in the frequency of the potential for the impact to occur with appropriate mitigation.
Likelihood	Possible	Despite mitigation, there is still a likelihood that the impact may occur.
Magnitude		
Small Magnitude		
Significance Rating After Mitigation		
Minor Negative Impact		

11.6.5 Impacts associated with Unexploded Ordnance

There is a risk of unexploded ordnance being present in the Project Area on the Zimbabwean side of the Zambezi River. Accordingly, the ZRA raised this as a concern with the then Zimbabwean Ministry of Energy and Power Development. In a letter dated 10 September 2014 (refer to *Annex Q*) the Zimbabwe Ministry of Defence states that this portion of the Project Area is located in an area that is situated approximately 3 to 5 kilometres away from a former mined area. There have been no reports of any mine incidents around the locality of the proposed BGHES. Moreover, the Zimbabwean BGHES access road cuts across a former minefield, which was cleared in 2000.

Although the Zimbabwean Ministry of Defence deems the Project Area as being free of mines, the ZRA will still go through an additional independent verification processes to verify this.

11.7 CHANGE TO CULTURAL HERITAGE RESOURCES

The following activities associated with the construction and operation of the proposed BGHES are likely to result in impacts to

i) physical cultural heritage (includes archaeological and palaeontological sites, historic structures and cultural landscapes) and/or

ii) 'living' heritage which includes a tangible component (heritage site and/or object) and an intangible component (the tradition associated with the site/object) (e.g. sacred pools, funerary sites, ritual sites/shrines, historic refuges, sacred baobab trees):

- Ground preparation (vegetation clearance/grading) and construction works in the area of the new dam and associated infrastructure: powerhouses, transformers, switching station, access roads and tunnels;

- Groundworks associated with route widening of existing roads/tracks connecting different elements of the proposed scheme;

- Groundworks associated with the construction of the new worker settlements planned to the north and south of the gorge;

- The inundation of the Gorge once the dam is complete may lead to the submergence and subsequent damage to sites of both physical and living heritage sensitivity;

- Clearance and construction of the new electrical transmission lines in Zambia and Zimbabwe;

- Increased human activity resulting in accidental damage or destruction of heritage resources.

11.7.1 *Impact on Sites of Physical Cultural Heritage Sensitivity*

This section assesses the likely effects of the Batoka HES proposals, as far as they can be assessed at present, on known or likely sites of physical cultural heritage significance including but not limited to surface and/or buried sites of archaeological value, rock-art and historical structures.

Box 11.19 Description of the Baseline Environment

The key categories of physical heritage identified in the baseline assessment are as follows:

Early Stone Age:
The only ESA sites identified in the vicinity of the proposals occur on the north side of the Zambesi. Substantial numbers of these sites, with Oldowan and Acheulian stone tools have been found on the 'older gravels' around Victoria Falls and adjacent to the gorges immediately to the south. An important site which produced tools of this period was excavated at Songwe Point, at the confluence of the Songwe and Zambezi. In addition to these well-known sites around Victoria Falls, a series of ESA sites are on record around the fringes of the valleys of the Songwe and Momba most of these are found in association with MSA material. Three scatters of heavily weathered ESA are also recorded close to the proposed location of the BGHES, on the plateau edge overlooking the Chibonga. Some known sites are located in the power line corridor. While it appears that none of these sites are *in situ* (*in situ* ESA sites are extremely rare) they are sufficiently unusual to be of interest. If any remains of this period are identified *in situ* and/or within a sealed stratified sequence, they would be of **high** (national and probably international) sensitivity.

Middle Stone Age:
There were more MSA sites than of any other period found during the various surveys carried out in support of the Batoka HES. In total 75 sites with MSA material were identified by the various surveys. A substantial portion of these sites was found on the plateau edge on either side of the Gorge running eastwards from Batoka Gorge for at least 28km. There seem to be a hiatus of MSA sites directly to the north of the Zambezi where raw material is absent or where systematic surveys have not been done yet. This is not the case on the southern side closer to the Falls where marked clusters of MSA sites are recorded next to the Gorge. On the Zambian side of the river, several sites could be impacted on by the proposed proposals. Most of these are scatters of weathered/rolled tools. There is a significant concentration of sites at the base of the Kalahari sands palaeodunes forming the northern and southern sides of this depression. Some of these may represent MSA quarrying or knapping sites, associated with the silicified limestone/chalcedony deposit that underlies the Kalahari Sands. A further group of MSA sites was recorded to the south of the river in the area of low, dissected basalt ridges to the north of Kasikiri village. Several of these sites are located in the proposed footprint of Alternative Township A (Zimbabwe). These are largely deflated scatters of weathered tools, which may indicate a true distribution of ancient settlement, or may simply be redeposited from eroded Pleistocene gravel terraces. Similar sites were also identified in similar terrain on the northern side of the river. Individual tools and redeposited artefacts would be of low sensitivity; denser scatters of artefactual material found in association with Pleistocene gravel would be of **medium** sensitivity, while in situ/stratified sites would be of **high** sensitivity.

Late Stone Age
Some 43 Late Stone Age sites were identified by the Batoka HES heritage surveys. Due to the ephemeral nature of LSA sites, LSA artefact clusters might mark settlements rather than isolated finds, especially where there is some sort of spatial or temporal integrity. Therefor LSA scatters are generally being considered to be of higher significance. A large number of LSA sites are on record in Alternative Staff Township A on the Zambian side. This area is marked by a dissecting basalt plateau with various valleys and several perennial drainage systems. Clay soils cover large areas with Pleistocene gravels being exposed by sheet erosion, mostly on higher lying areas on basalt ridges. These were utilised by LSA communities for raw material in the manufacturing of tools. Similar to the MSA sites, there are numerous groups of LSA material found in gravel and alluvium on the edges of the gorge extending south and eastwards from Victoria Falls. Very few LSA sites are on record in the Zimbabwe side with a single LSA site located in the footprint of Alternative Staff Township A.

Farming Community/Iron Age Iron Age settlement sites are strongly concentrated at the base of Kalahari palaeodunes, close to water sources and fertile soils. These sites may be affected by construction activities and there is also potential for Iron Age burials to be found in the vicinity of such sites. Individual artefacts, redeposited material and disturbed/damaged sites of this period are likely to be of **low** sensitivity; individual burials, and small or partially-preserved sites will be of **medium** sensitivity, while large, well-preserved buried settlement, ritual and/or funerary sites are of **high** sensitivity.

Proposed Project Activities - During Construction and Operation

The different effects of the various construction and operational impacts are likely to have on physical cultural heritage remains are addressed here by considering these activities separately under broad categories.

Dam Infrastructure Construction

The construction of the dam wall and the associated power-generation infrastructure on each side of the Gorge will involve major groundworks, including extensive blasting and tunnelling. Additional quarries will also be required.

Sensitive Receptors

No archaeological sites have been recorded in the immediate vicinity of the dam wall. This area is characterised by dissecting basalt plateaus of steep and broken relief, is not congenial to human settlement, and appear to have been void of significant archaeological sites. This area is still sparsely occupied. On this basis, no archaeological sites of sensitivity are expected in this area.

Significance of Impact (Pre-mitigation)

Given the scale of the proposed works, it is reasonable to assume that any cultural sites within or close to the footprint of the construction/quarrying works around the new dam will be destroyed. Based on the analysis provided above, it is the opinion of this ESIA that the Project impact will be a "**Minor to Moderate Negative Impact**" pre-mitigation (refer to *Table 11.35)*.

Table 11.35 Rating of Impacts Related to Destruction of Physical Cultural Heritage – (Pre-mitigation) During Construction of the Dam and associated infrastructure

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Impacts will be limited to the areas where the ground surface will be physically disturbed.
Duration	Permanent	Any impacts on physical cultural heritage in these areas will be permanent.
Scale	Large	The extent of damage on physical cultural heritage is like to be complete.
Frequency	n/a	
Likelihood	Likely	Any sites within the affected area will be destroyed.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low to Medium Sensitivity		
Most sites likely to comprise weathered scatters of Stone Age tools		
Significance Rating Before Mitigation		
Minor to Moderate Negative Impact		

Mitigation/Management Measures

A detailed cultural heritage management strategy is set out in the cultural heritage section of the CESMP (refer to *Volume II*). Key elements of the strategy applicable to the impacts summarised above are as follows:

- Additional Pre-Construction Survey. This will only be carried out once the feasibility stage of the project has been completed. As soon as this information is available, an archaeological survey will be carried out, with the involvement of local archaeologists from the relevant host countries, focussing on the areas that will be directly affected. Surveys will be systematic and intensive, with the objective of identifying sites that will be affected. Adhering to local heritage legislation, international best practise and IFC Performance Standard 8.

- Redesign/Avoidance. In the case of sites of high cultural significance, consideration will be given as to whether adjustment of the design can avoid unnecessary impacts before any other form of mitigation is considered.

- Further Mitigation Fieldwork. Should sites of medium or high archaeological sensitivity be identified by these pre-construction surveys, time and resources will be provided to permit more detailed recording/investigation ahead of the commencement of the construction process. This could involve any of the following methods of investigation:

    - Systematic surface collection;

- Trial trenching (using mechanical excavators to save time if necessary/appropriate);
- Test Excavation;
- Non-invasive techniques such as ground penetrating radar (GPR); and
- Archaeological monitoring/watching briefs.

- Chance Finds Procedure. The CESMP provides for a Chance Finds Procedure including the following procedures:

  - Unexpected discoveries made during construction to be reported;
  - Clear definition of roles and responsibilities and communication channels to report the finds to the authorities;
  - Allowance for the temporary suspension of construction work in the vicinity of the change finds until they could be assessed by a specialist, should discoveries require further investigation;
  - Agreed repositories for finds in Zambia and Zimbabwe
  - All procedures to be agreed in advance with NMMZ/NHCC.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the impact will be "**Minor Negative Impact**" post mitigation.

Table 11.36 Rating of Residual Impacts Related to Damage to Sites of Physical Cultural Heritage Significance during the Construction of the Dam and associated Infrastructure (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Unchanged.
Duration	Permanent	Unchanged.
Scale	Medium	Destruction of any affected sites would still be complete, unless avoidance can be achieved. The overall level of effect will be diminished if archaeological fieldwork takes place that records in advance any remains that are destroyed.
Frequency	n/a	
Likelihood	Likely	Unchanged
Magnitude		
Low Magnitude		
Significant Rating After Mitigation		
Minor Negative Impact		

Reservoir Inundation

The largest physical effect of the development will be the flooding of a substantial portion of the Batoka Gorge to a maximum level of 757 m amsl.

Sensitive Receptors

As of yet no sites of physical cultural heritage significance have been identified within Batoka Gorge; however, a thorough survey of the gorge has not been undertaken yet. The gorge itself has generally been written off as having low cultural sensitivity. This is largely because of its character as a deep, steep-sided feature, into which access is extremely difficult and hostile to any form of longer term human settlement. In addition, the scouring and erosive effect of repeated seasonal flooding could have impacted on surface indications of archaeological sites within the Gorge.

Literature of the area indicates that known refuge sites occur in the Gorge for example at Chimamba rapids where locals sheltered from Ndebele raids on their villages in the 19th century. Therefore caves in the Gorge (such as those on the Zambian side near Taita Lodge) could be of heritage significance. There is also a possibility that Stone Age remains might survive within gravel terraces if any occur. Owing to safety and access issues, the Gorge itself has yet to be fully explored. If any such site is found it is anticipated that they would be of **medium** sensitivity.

Significance of Impact (Pre-mitigation)

Inundation of such sites for an indeterminate period should certainly be considered as a **large** magnitude of impact, to be equated with total destruction. Based on the analysis provided above, it is the opinion of this ESIA that the Project impact will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 11.37)*.

Table 11.37 Rating of Impacts Related to Destruction of Physical Cultural Heritage – (Pre-mitigation) - Construction

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Impacts on sites below maximum water level equate to destruction.
Duration	Permanent	Any impacts on physical cultural heritage in these areas will be permanent.
Scale	Large	The extent of damage on physical cultural heritage is like to be complete.
Frequency	n/a	
Likelihood	Likely	Any sites within the affected area will be destroyed.
Magnitude		
Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Medium to High Sensitivity		
While no sites have yet been identified in the Gorge, the likely nature of any such sites – prehistoric remains in rock-shelters or on elevated terraces – should they exist would be of **medium to high** sensitivity.		
Significance Rating Before Mitigation		
Major Negative Impact		

Mitigation/Management Measures

The specific mitigation measures to be implemented will be:

- Additional Pre-Construction Survey. A survey of the base of the Gorge from the dam wall to the west, focussing on areas like Chimamba rapids and other "hot spots." Due to safety and access issues "hot spots" could be identified by a drone survey of the gorge and these areas targeted by a pedestrian survey. This is likely to involve gaining access to inaccessible areas of the gorge, perhaps with use of boats and/or climbing equipment.

- These surveys will be undertaken as soon as possible and, carried out with the involvement of local archaeologists from the relevant host countries. The surveys will aim to reach all sites with potential remains of human activity that could be inundated as a result of the dam construction. Surveys will be conducted adhering to local heritage legislation, international best practise and IFC Performance Standard 8.

- Further Mitigation Fieldwork. Should sites of medium or high archaeological sensitivity be identified by the pre-construction survey of the gorge, time and resources will be provided to permit more detailed recording/investigation ahead of the commencement of the construction process. This could involve any of the following methods of investigation:

    - Systematic surface collection;
    - Trial trenching (using mechanical excavators to save time if necessary/appropriate);
    - Test Excavation;
    - Non-invasive techniques such as ground penetrating radar (GPR);
    - Archaeological monitoring/watching briefs.

- Chance Finds Procedure. The CESMP provides for a Chance Finds Procedure including the following procedures:

    - Unexpected discoveries made during construction to be reported;
    - Clear definition of roles and responsibilities and communication channels to report the finds to the authorities;
    - Allowance for the temporary suspension of construction work in the vicinity of the chance finds until they could be assessed by a specialist should discoveries require further investigation;
    - Agreed repositories for finds in Zambia and Zimbabwe; and
    - All procedures to be agreed in advance with NMMZ/NHCC.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of the impact will be "**Moderate Negative Impact**" post mitigation.

Table 11.38 Rating of Residual Impacts Related to Damage to Sites of Physical Cultural Heritage Significance from Reservoir Inundation (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Unchanged.
Duration	Permanent	Unchanged.
Scale	Medium	Destruction of any affected sites would still be complete. The overall level of effect will be diminished if archaeological fieldwork takes place that records in advance any remains that are destroyed.
Frequency	n/a	
Likelihood	Likely	Unchanged
Magnitude		
High Magnitude		
Significant Rating After Mitigation		
Moderate Negative Impact		

Staff Township Construction

On both the Zambian and Zimbabwean sides of the Gorge, new worker settlements will be constructed and preferred locations for these have been selected by the Engineers and ZRA and detailed in *Chapter 2*. It should be recognised that such settlements may attract unplanned peripheral development. The influx of people could also impact on heritage sites, resulting in accidental disturbance / destruction of heritage resources.

Sensitive Receptors

The project will impact on Stone Age sites consisting of scatters of artefacts as well as Farming community sites marked by concentrations of ceramics. On the Zambian these sites are of **low** to **medium** sensitivity. The sites dating to this period on the Zimbabwean side are of **no** to **low** sensitivity**.**

Significance of Impact (Pre-mitigation)

Impacts on any sites within the staff township areas would be considered **medium** or **high**. Based on the analysis provided above, it is the opinion of this ESIA that the Project impact will be a "**Moderate to Major Negative Impact**" pre-mitigation (refer to *Table 11.39)*.

Table 11.39 Rating of Impacts Related to Destruction of Physical Cultural Heritage – (Pre-mitigation) During Construction of Staff Townships

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Sites within the staff township are likely to be disturbed or destroyed without mitigation.
Duration	Permanent	Any impacts on physical cultural heritage in these areas will be permanent.
Scale	Medium-large	The extent of damage on physical cultural heritage will vary given the precise nature of the structure in question.
Frequency	n/a	
Likelihood	Likely	Any sites within the affected areas will be disturbed or destroyed.
Magnitude		
Medium to Large Magnitude		
Sensitivity/Vulnerability/Importance of the Resource/Receptor		
Low to Medium Sensitivity		
While relatively few sites have been identified within the settlement areas, sites of medium sensitivity have been identified around the fringes of the Kalahari palaeodunes as well as Basalt Ridges.		
Significance Rating Before Mitigation		
Moderate to Major Negative Impact		

If these sites cannot be preserved or avoided they should be archaeologically mitigated. This could involve any of the following methods of investigation:

Mitigation/Management Measures

- On the Zambian Side the following mitigation will be conducted pre construction.

    - Site 151: Surface sampling, mapping and analysis.

    - Site 155: Surface sampling, mapping, test excavations and analysis.

    - If impacted on by the access road, Site 167 and 168 will require the following mitigation: Surface sampling, mapping, test excavations and analysis.

    - Archaeological monitoring/watching briefs for both sides.

    - Pre-construction survey of the access routes in Zimbabwe as this was not conducted yet.

    - Settlement A in Zimbabwe must be re-assessed and suitable mitigation measures proposed on the sites within the footprint. Although these sites are of no to low significance, the magnitude of the impact necessitates additional mitigation measures on certain sites including surface sampling and analysis.

- Chance Finds Procedure. The CESMP provides for a Chance Finds Procedure including the following procedures:

    - Unexpected discoveries made during construction to be reported;

    - Clear definition of roles and responsibilities and communication channels to report the finds to the authorities;

    - Allowance for the temporary suspension of construction work in the vicinity of the chance finds until they could be assessed by a specialist should discoveries require further investigation;

    - Agreed repositories for finds in Zambia and Zimbabwe; and

    - All procedures to be agreed in advance with NMMZ/NHCC.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of any impacts will be "**Minor Negative Impact**" post mitigation.

Table 11.40 Rating of Residual Impacts Related to Damage to Sites of Physical Cultural Heritage Significance from Staff Townships (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	If sites are identified and avoided the extent of damage should be significantly reduced.
Duration	Permanent	Unchanged.
Scale	Medium	Destruction of any affected sites would still be complete. The overall level of effect will be diminished if archaeological fieldwork takes place that records in advance any remains that are destroyed.
Frequency	n/a	
Likelihood	Likely	Unchanged
Magnitude		
High Magnitude		
Significant Rating After Mitigation		
Minor Negative Impact		

Quarries

During January 2019, the areas associated with Project quarries were assessed for any significant archaeological and other cultural heritage resources in the proposed footprints of these areas.

No archaeological or other cultural heritage resources were identified in the proposed quarry areas. Furthermore, no fossils, graves, sacred or traditional sites were discovered in these areas. This is largely attributed to the fact that the proposed quarry sites are unlikely to have attracted past human habitation, as the area in question is generally hilly, rocky and rugged and not suited to human settlement. As such, there is little chance of finding cultural heritage remains.

11.7.2 Living Cultural Heritage

This *Section* assesses the likely effects of the Project proposals, as far as they can be assessed at present, on known or likely tangible sites/objects of living cultural heritage significance: funerary sites (cemeteries, graves), ritual sites (such as Chemapoto Hill), sacred baobab trees, sacred pools etc.

Box 11.20 Description of the Baseline Environment

The key categories of living heritage identified in the baseline assessment are as follows:

Sites associated with the river/gorge: traditionally there were numerous ritual/sacred sites associated with the Zambezi, including Chemapoto Hill, Chimamba Rapids and ritual significance for Moemba Falls;

Village sites: Some traditional settlements in the area have associated ritual sites including cemeteries and sacred baobab trees.

Proposed Project Activities - During Construction and Operation

All aspects of the scheme construction - dam infrastructure, inundation, staff townships, quarries access roads, transmission lines – have the potential to have impacts on sites of living heritage significance. This would cover both direct disturbance of such sites, and also the creation of impediments to access to such sites.

Sensitive Receptors

Few sites of living heritage significance have been identified close to the proposed construction impact areas. The dam itself is well away from any contemporary or historic settlements, meaning that there are few sites of living heritage significance in this area. Within the Gorge, the most important and well-known site that will be affected is Chemapoto Hill. In addition, two other sites Chimamba rapids and Moemba falls will also be impacted on.

The rise in water levels associated with the scheme will most probably flood the site of Chimamba rapids. In terms of Chemapoto Hill it will not affect the surface or upper portion of the hill, but it will lead to flooding of low ground to the west and east of the hill, substantially changing its relationship with the surrounding landscape. It will also change its accessibility, making it much easier for visitors to access the site by boat.

The staff townships are unlikely to affect sites of living heritage value.

Living heritage sites are generally of **medium** to **high** importance, given their significance to contemporary communities.

Significance of Impact (Pre-mitigation)

The significance of construction activities that disturbs or destroys sites of living heritage impact will be a "**Major Negative Impact**" pre-mitigation (refer to *Table 11-41*).

Table 11-41 Rating of Impacts Related to Destruction of Living Cultural Heritage – (Pre-mitigation) During Project Construction

Type of Impact		
Direct Negative Impact		
Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	Sites within the footprint of the scheme could be damaged or destroyed. Access to them could also be made more difficult or made easier, with potential negative consequences
Duration	Permanent	Any impacts on living cultural heritage in these areas will be permanent.
Scale	Medium-large	The extent of damage on living cultural heritage will vary given the precise nature of the site in question.
Frequency	n/a	
Likelihood	Likely	Without mitigation precautions, living heritage sites are likely to be disturbed

Magnitude
Medium to High Magnitude
Sensitivity/Vulnerability/Importance of the Resource/Receptor
Medium to High Sensitivity
Sites of living heritage value are generally of medium to high sensitivity
Significance Rating Before Mitigation
Major Negative Impact

Mitigation/Management Measures

Key elements of the strategy applicable to the impacts summarised above are as follows:

Chemapato Hill: this site, owing to its importance and the fragile nature of the remains on it, requires special and specific management. This will be based on further consultation with local communities, with a focus on Toka-Leya groups, who are believed to have been historically the most important group associated with the Hill's ritual use. The information gathered from this consultation will be used to develop a method statement in consultation with the NMMZ. The key objectives of this method statement will be, in keeping with its traditions and significance to the local population,

i) to document the site's current condition;
ii) to document its historic significance and use;
iii) to protect the site from future looting and disturbance.

It will probably be necessary to set up a long-term, sustainable management and protection regime for the site, perhaps linked into the management of the Victoria Falls National Park/World Heritage Site.

A similar approach will be required for Chimamba Rapids and Moemba Falls.

- Additional Pre-Construction Surveys. Once the final design for the scheme has been decided, it is very important that thorough surveys be carried out among the affected local communities to identify which sites of living heritage significance, if any, could be disturbed by the proposals. The access road on the Zambian side could impact on the following sites: 136, 141 and 142. Written Schemes of Investigation for this work will be agreed in advance with relevant regulatory organisations (the NMMZ in Zimbabwe and Livingstone Museum/the NHCC in Zambia).

- Redesign/Avoidance. Wherever possible, construction designs will be adapted in order to avoid unnecessary impacts on sites on living heritage significance. On the Zambian side this includes site 169 and 170 as per the request of Chief Mukuni.

- Memoranda of Understanding. Where impacts on sites on living heritage sites cannot be avoided, memoranda of understanding will be agreed with affected local communities setting out procedures for the relocation of sites of living heritage significance.

Residual Impact (Post-mitigation)

Based on the implementation of the proposed mitigation measures, the significance of any impacts will be "**Minor Negative Impact**" post mitigation.

Table 11.42 Rating of Residual Impacts Related to Damage to Sites of Living Cultural Heritage Significance from project construction (Post-Mitigation)

Rating of Impacts		
Characteristic	**Designation**	**Summary of Reasoning**
Extent	Local	If sites are identified and avoided the extent of damage should be significantly reduced.
Duration	Permanent	Unchanged.
Scale	Medium	The scale of impacts should be kept to a minimum if the recommended mitigation procedures are adhered to.
Frequency	n/a	
Likelihood	Likely	Unchanged
Magnitude		
Small to Medium Magnitude		
Significant Rating After Mitigation		
Minor Negative Impact		

12 *CUMULATIVE IMPACTS*

The IFC Performance Standard 1 (Paragraph 5) defines the broader Project area to include "*… areas potentially impacted by cumulative impacts from further planned development of the Project, any existing project or condition, and other project-related developments that are realistically defined at the time the Social and Environmental Assessment is undertaken.*"

In addition, the IFC Performance Standard 1 (Paragraph 6) states that the "*… assessment will also consider potential trans-boundary effects, such as pollution of air, or use or pollution of international waterways, as well as global impacts, such as the emission of greenhouse gases.*"

Cumulative impacts are those impacts that act together with other impacts (including those from concurrent or planned future third party activities) to affect the same resources and/or receptors as the proposed BGHES. Cumulative impacts are therefore generally impacts that act with others in such a way that the sum is greater than the parts. This is, however, not always the case – sometimes they will simply be the sum of the parts, but that sum becomes significant.

This *Chapter* considers the cumulative impacts that would result from the combination of the proposed BGHES and other actual or proposed future developments in the broader Project Area.

12.1 *DEVELOPMENT CONTEXT*

In addition to the proposed BGHES, the broader Project Area may experience cumulative impacts as a result to the following proposed developments that have been identified or raised by stakeholders for further consideration:

- North-South Water Carrier (NSC), Botswana;
- Pandamatenga Farms and Francistown, Botswana;
- Bulawayo pipeline via Gwaai Dam, Zimbabwe;
- A sugar plantation at Kasaya, Zambia;
- The Katambora Barrage;
- The Ndlovu Housing Project in Zimbabwe and its associated resettlement and host site of Mvutu forest;
- Provision of water via the Gwayi-Shangani pipeline to Hwange-based industrial water users;
- Construction of a new power station at Hwange;
- Development of a new water pipeline to Hwange from the Deka Pump Station;
- Jambezi Housing Scheme;
- Dam and irrigation scheme in Chikamba;

- Development of an eco-tourism project between Rapid 18 and Msuna and the creation of a 2 km buffer zone between the Zambezi River water front and the communities along the Zambezi to facilitate this;
- Numerous infrastructure development projects including: secondary school in Chidobe, secondary school and teachers cottage in Lumbora, and Early Childhood Development Institutions in Makala village;
- Nutrition gardens in Makala, Lumbora and Sidinda;
- Development of the 50 to 80 MW Ngonye Falls Hydroelectric Project on the Zambezi River, upstream of the proposed BGHES; and
- Projects proposed in line with the Strategic Development Plan for the Mukuni Chiefdom.

A synopsis of each of these proposed developments is provided below.

Several large-scale water diversion schemes have been mooted in the Zambezi River Basin over the years, some of which are located within the vicinity of the Project site. These include the Chobe-Zambezi Water Transfer Scheme in Botswana, that proposes to abstract water from the river in the Kazungula area (upstream of Victoria Falls) and convey it via the Dikgatlhong reservoir to be used for commercial agriculture and industrial/potable supply in the greater Gaborone area as part of the North-South Carrier (NSC) Water Project.

Botswana currently has rights to abstract some 495 million m^3 per year of water from the river (approximately 1.5 % of the present runoff at Victoria Falls) under this scheme, and is currently in the process of constructing the first stage that will involve supplying approximately 350 million m^3 of water per year for irrigated agriculture (including rice farming) in the Pandamatenga area.

There are also plans to supply Bulawayo under the Matabeleland Zambezi Water Project (MZWP) via an offtake situated close to the Deka River confluence (a short way downstream of the BGHES site), which would convey water via a pipeline to a dam near the Gwayi-Shangani confluence. The objective of the MZWP is to address water shortages in Matabeleland North province. Although a key factor of the MZWP is to alleviate Bulawayo's chronic water scarcity, the project is mooted to facilitate substantial agricultural development in Matabeleland North and in Matabeleland West. However, this project has been in gestation and discussion for a number of years and would seem very unlikely to be constructed in the near future, if at all.

With regards the sugar plantation at Kasaya, in Zambia, in April 2011 the Government of Zambia concluded an exclusive MoU with a consortium for the establishment of a greenfields sugar and bio-energy project in southern Zambia. The proposed phased development comprises a greenfield's sugar cane processing facility, including some 15,000 ha of sugar cane and an integrated process plant to produce bio-ethanol, together with a 13MW power plant. The scheme is mooted to create 7,000 direct jobs, with further opportunities for an outgrower scheme. Little movement has been made on this project since the feasibility study was prepared in 2014.

The Katambora Barrage is a proposed electricity generation project some 60km upstream of the Victoria Falls. Katombora would serve to stabilize water levels for firm energy production at two large power plants located downstream of the Victoria Falls – a 390 MW station on the north bank (Zambia) to replace the existing Victoria Falls power plant and a second 300 MW station on the south bank (Zimbabwe). As reported in this ESIAs Comments and Response Report (CRR), this development is unlikely to go ahead, due primarily to the potential impacts this development would have on water flows and hence on the Victoria Falls itself; this project is not even given a ranking of proposed new generation projects by SAPP, (as reported in SP, 2015).

The Ndlovu Housing Project in Zimbabwe is intended as a satellite town to be established 40 km outside of Victoria Falls and in close proximity to the airport; this housing project is proposed to enhance employment and infrastructure development. This project has necessitated the resettlement of households to Mvutu Forest that previously occupied land in the footprint of the Ndlovu Housing Project.

Downstream irrigation and water use projects include:

- The Gwayi-Shangani pipeline for the provision of water from the Zambezi to Hwange: The Gwayi-Shangani Dam is the 1st phase of the Matebeleland Zambezi Water Project. The dam will be located about 6 km downstream of the confluence of the Gwayi and the Shangani rivers.
- New water pipeline to Hwange from the Deka Pump Station: this pipeline will replace the existing leaking pipeline, but with the capacity to extract additional water.
- Further power station development at Hwange Colliery.

There are also several social development projects that may have a cumulative social impact including:

- Initiatives associated with the Strategic Development Plan for Mukuni Chiefdom which identifies tourism as a major economic base and seeks to maximise opportunities associated with this; proposes the development of social infrastructure and roads and proposes projects to focus on HIV/Aids.
- New schools in Chidobe, Lumbora and Makala.
- Nutrition gardens in Makala, Lumbora and Sidinda using boreholes and reducing dependence on river water.

In anticipation of the BGHES, the Hwange District Council has declared a 2 km buffer – no residential zone – between the Zambezi River and the neighbouring communities. It is intended to reserve this area for ecotourism activities linked to Batoka Gorge. This is also further elaborated on in *Section 12.2.4* of this *Chapter*. Access to this area will be restricted. Restricted access will be managed through controlled access points for tourists and fishermen. Lakeside property development will be encouraged through the guidance of the Hwange District Council.

Given the limited detail available regarding such future developments, the assessment that follows is necessarily of a generic (qualitative) nature and focuses on key issues and sensitivities, and how these might be influenced by cumulative impacts with other planned developments. Many of the recommendations emerging from this analysis are relevant to the Governments of Zimbabwe and Zambia, the local administration and future private developers and may not be commitments or actions for the proposed BGHES, or at least not in isolation.

Moreover, the proposed 50 to 80 MW Ngonye Falls Hydroelectric Project is a run-of-river scheme upstream of the proposed BGHES.

These developments may exacerbate or enhance the impacts identified in *Chapters 10* and *11*. Where these impacts may be intensified by these cumulative factors they are discussed in the following sections.

12.2 IDENTIFIED CUMULATIVE IMPACTS

The cumulative impacts that would result from a combination of the proposed BGHES and other actual or proposed future developments discussed above for the broader Project Area include:

- Impacts to Surface Water (Hydrology);
- Impacts to Surface Water Quality;
- Impacts to the Ecological Environment;
- Impacts to the Social Environment; and
- Widespread resettlement.

Each of these potential cumulative impacts is described below.

12.2.1 Hydrology

Basin-Wide Abstractions

Cumulative Impact

The Upper Catchment of the Zambezi above Victoria Falls is predominantly rural and the largest abstractions from the river and its tributaries are for irrigated agriculture. The total estimated direct abstractions in 2010 in the Upper Catchment (around 86 million m^3 per year) represent approximately 0.3 % of the annual average runoff at Victoria Falls (World Bank, 2010).

Table 12.1 indicates the potential future development of irrigated agriculture in the upper basin, both in the short to medium term (where projects or programmes were already identified in the 2010 study) and in the long-term if the sub-basins are developed to their full agricultural potential. Taking into account the capacity of existing water regulation systems, it was estimated that the former would require the development of an additional 55 million m^3 per year of regulation in the catchment (a small percentage of which may have occurred since 2010), and the latter some 480 million m^3 per year. This represents approximately 0.2 % and 1.4 % respectively of the annual average runoff at Victoria Falls.

Table 12.1 Projected Irrigation Development in Upper Catchment (World Bank, 2010)

Sub-basin	Irrigated Area (ha/year) [1]		
	Current	Current + identified [2]	Upper limit potential [3]
Cuando/Chobe	765	1,215	19,215
Barotse	340	12,753	30,466
Luanginga	1,000	6,000	18,500
Lungue Bungo	1,250	1,875	14,375
Upper Zambezi	3,250	8,250	20,750
Kambompo	595	11,314	28,328
Upper Catchment total	*7,200*	*41,407*	*131,614*
Zambezi River Basin total	*259,039*	*773,680*	*2,795,800*

[1] Total cropped area per year (includes multi-season cropping).
[2] Includes irrigation projects and programmes identified but not yet constructed.
[3] Estimate of total area suitable for irrigated development.

Source: The Zambezi River Basin: A Multi-Sector Investment Opportunities Analysis, World Bank, 2010.

Aside from potential large-scale water transfers (as described above), other direct water abstractions in the basin are relatively insignificant in volumetric terms in comparison to agriculture. The aforementioned 2010 study estimates that net industrial surface water use across the entire Zambezi River Basin is less than 25 million m^3 per year (i.e. a tiny fraction of the estimated 130 km^3 per year of runoff at the Zambezi Delta) and potable water supply from surface water sources was estimated to be around 175 million m^3 per year in large urban areas, and 24 million m^3 per year in rural areas. Moreover, only a very small proportion of these abstractions are from the largely rural Upper Catchment.

Measures for Consideration

Based upon the best estimates discussed above, the combination of increased upstream abstractions and the potential reduction in yield due to future climate change could lead to a reduction of 5 to 6% in the average annual runoff at Victoria Falls in the next 20 to 30 years, although in the worst case scenario it could be as high as 10% or more. Moreover, superimposed on this is the long-term cyclical pattern of 15-20 year droughts that has been observed in the Upper Zambezi flow record over the last century (see *Chapter 8*, *Section 8.1.4*).

The combination of these effects could be a gradual reduction in power generation capacity at the BGHES over the next 20-30 years, with the shortfall potentially most noticeable in the late dry and early wet season due to a later onset of flooding due to climate change. Although other schemes such as Kariba, with a larger storage capacity than the proposed BGHES are designed to make up for a drop in the generation potential of the BGHES during the dry season, climate change, through a reduction in spills in the wet season could in turn have implications for downstream river conditions in the event that the dam operating procedures are subsequently modified to offset any future reduction in inflows, for example by reducing the environmental flow release requirements.

The most effective mitigation against the potential reduction in river basin yield at the BGHES in the next 20 to 30 years will be to factor this into the design of the Project itself and thus ensure its future sustainability. That is, to adjust the hydrological inflow series used in the power generation model for the scheme to take account of a potential reduction in yield over time, taking into account the gradual effects of climate change, and the potential 'step' changes as the various phases of the *Chobe-Zambezi Water Transfer Scheme* are constructed. Overall, the aim would be to design the scheme based upon the best estimates for future scenarios, but test its sensitivity to worst-case scenarios. Moreover, the hydrological calculations that are undertaken for dam spillway design should also be tested and verified against the potential effects of increased future rainfall intensities in the Upper Zambezi due to future climate change.

12.2.2 Water Quality

Water Quality Discharges from the Growing Urban Centres of Victoria Falls, Livingstone and Kasane

Cumulative Impacts

One of the main observations in all of the water quality datasets is that there has been no significant change in the chemical constitution of the water above Victoria Falls in recent decades, and that water quality conditions at that point are generally indicative of a largely unpolluted, undeveloped catchment. This would be anticipated given the limited industrial development that has occurred in the upper catchment over this period.

A slow increase in some water quality parameter concentrations is, however observed. This includes the presence of occasional high lead concentrations detected in some of the earlier water quality surveys, including both upstream and downstream of the Falls. These have been previously attributed to a combination of spillage from the outboard engines of pleasure craft upstream of the Falls, and also the untreated disposal of waste oils from industrial centres in Livingstone and Victoria Falls (ZRA, 1998).

In terms of organic pollution, there is a noticeable increase in phosphorus, nitrate and BOD levels in the earlier survey data from upstream of the Falls to the BGHES site, and similarly a marked increase in microbiological contamination. This has been largely attributed to the inflow of poorly treated or untreated sewage effluent from the population centres at Victoria Falls and Livingstone (ZRA, 1998), as well as Kasane in Botswana, further upstream. Given the population increases in these centres, and the likely increases in population in these centres as a result of in-migration, the establishment of the Ndlovu Housing project etc., the volume of untreated sewage entering the river is likely to have increased, and will likely increase in future once the populations of Victoria Falls and Livingstone increases.

Measures for Consideration

The most effective mitigation measure to maintain good water quality conditions in the reservoir of the proposed BGHES will be to minimise and control upstream pollution sources wherever possible. Primarily, this would involve a sustained programme of investment to upgrade municipal and industrial wastewater treatment facilities and sewerage systems in the main urban centres of Victoria Falls and Livingstone, and preferably also in Kasane.

The investment required for this new infrastructure could potentially come from sources such as the African Development Bank's (AfDB) Zimbabwe Multi-Donor Trust Fund (ZimFund) that currently includes the rehabilitation of sanitation systems in certain target municipalities. Similarly, bi-lateral donors such as the Danish International Development Agency (DANIDA) are making significant investments in this sector in Zambia (such as the Kafubu Sustainable Water and Sanitation Improvement Project). Neither of these programmes currently covers the project area, although future phases of investment could be sought.

In addition to upgrading sewerage and wastewater treatment facilities, a more specific measure would be to initiate and promote a formal waste oil collection and recycling programme for the tourism and industrial sectors in all three urban centres. There are numerous examples of commercial enterprises operating such schemes on a successful and profitable basis, particularly when the necessary economies of scale can be achieved and the correct financial (e.g. tax) incentives are in place.

Finally, the above water quality control measures should also be accompanied by a routine programme of water quality monitoring in the reservoir, as currently performed by the ZRA for Lake Kariba, with both physical and biological indicators included. The latter should include the sampling and analysis of fish tissue for the potential accumulation of toxic pollutants, in particular lead.

12.2.3 *Ecological Environment*

Connectivity of the Riverine Habitat

Cumulative Impact

The construction of large dams on the Zambezi River are converting long stretches of flowing riverine habitat to broad standing water pelagic habitat. Hydropower Schemes on Lake Kariba and Cahorra Bassa have created reservoirs with lengths of approximately 220 km and 250 km respectively. The Victoria Falls presents a natural barrier to the movement of fish, but the loss of habitats associated with the river, such as riparian vegetation creates a significant fragmentation effect to a large number of species, such as lesser mammals, birds and reptiles. Insect life associated with river habitats is lost and forms a continuous food source that is key to the movement of migratory birds along river corridors. Impacts to fish species have been addressed in the impact assessment.

Disruption to Natural Flow Regimes

Cumulative Impact

The natural flow regime of the Zambezi River is being affected by a number of hydropower schemes that currently exist, are under construction or are planned for the near future. A World Bank study of the Zambezi River Basin [(1)] provides an overview of eight existing hydropower schemes and an additional 12 new hydropower or extensions of existing schemes. Additional hydropower schemes have been planned since that report, such as the Kabompo Gorge and Ngonye Falls in the Upper Zambezi. Some schemes, such as the Victoria Falls Power Plant are based on a run-of-river and have no impact on the natural flow regimes, whereas others such as Kariba and Cahora Bassa have vast reservoirs with a major impact on flow regimes.

Major impacts of flow regime changes include:

- The loss of downstream flooding events, for example in the lower Zambezi, which is affecting recruitment of riparian woodlands as being observed in the Mana Pools National Park, leads to irreversible change to formerly important grazing lands.

- Alteration to the sediment flow regime, which affects fertility of floodplains, habitats for niche bird, fish and invertebrate species and unintended sedimentation of reservoirs.

- Salinity changes to the Zambezi Delta in Mozambique, which has led to the loss of extensive mangrove habitat there.

- Decline in fish abundance due to loss of spawning (breeding) habitat, disrupted seasonal cycles in flow changes and fish strandings due to rapid fluctuations in water levels from hydropower-peaking. Fish have an important role in many food chains, such as regulating their invertebrate prey and as a source of food for larger vertebrate predators. Fishing is also an important ecosystem service that supports many fishing communities.

There are many impacts to wetlands in tributaries of the Zambezi River, such as the Kafue Floodplain, the eastern Chobe floodplains and the Barotse Floodplain, but cumulative impacts associated with the BGHES will have no bearing on those situations.

(1) Zambezi River Basin Multi Sector Investment Opportunities Analysis, 2010

Measures for Consideration

The above cumulative impacts influence large areas and are the cause of a multitude of factors. There are no simple actions that will alleviate these impacts, although the following measures are important:

- Operation of the proposed BGHES must adhere to the regulated release of water flows for maintenance of the downstream environment, as described in detail in the Environmental Flow report (*Annex J*).

- Environmental Flow releases should be investigated holistically, not just per scheme. To this effect, the ZRA should liaise with their counterparts in Mozambique and project developers upstream of the BGHES to investigate and finalise Environmental Flows looking at the cascade of hydropower projects along the length of the Zambezi River.

- The ZRA should however collaborate with environmental departments, non-governmental organisations and academic institutions of the riparian states and surrounding countries to raise the understanding of these impacts. Access to data and transparency in decision-making must be retained.

Loss of Taita Falcons

Cumulative Impact

The Batoka Gorge has for a long time been recognised as the global stronghold for Taita falcons, which is a very rare falcon that exists in low densities in widely separated habitats. Little is known about the ecology of Taita falcons, but there is concern that current land use changes and tourism-related helicopter activity are currently causing a decline in the population. Development of the BGHES will alter the aquatic ecology, and there is concern that this change will impact the food chain resulting in a decline in the insect-eating birds that Taita Falcons feed on, resulting in further decline. The key concern is that large impacts to the Batoka Gorge could expose the Taita Falcon to a much greater risk of extinction in the wild.

Measures for Consideration

The status of the Batoka Gorge Taita Falcon population needs to be better documented, and greater insights into the ecology of this falcon is required, to better understand the impacts and develop mitigation strategies to prevent a loss of the species. Better surveys are required and the species specialists need to brought together to develop collaborative approaches to save the species.

12.2.4 *Social Environment*

Project Induced In-Migration

Cumulative Impact

The proposed Project is expected to cause some in-migration into the Project Area and surrounds related to the arrival of opportunistic economic migrants and migrant labour. Other developments in the project area, specifically the Ndlovu and Jambezi Housing Schemes in Zimbabwe, which are intended as satellite towns to be established 40 km outside of Victoria Falls and in close proximity to the airport, which is proposed to, enhance employment and infrastructure development. This may increase the scale and likelihood of this in-migration due to a perception that more benefits are available in the area. The creation of a buffer for ecotourism by the Hwange District Council also highlights the anticipated in-migration expectation to the area. This increased in-migration is likely to contribute to in-migration related impacts including service delivery by the District Authorities and additional strain on already in adequate education and medical facilities.

Measures for Consideration

The following management consideration should be implemented to help mitigate or enhance negative and positive cumulative impacts related to in-migration respectively.

- **Capacity Building of Hwange District and Kazangula Administration:** project developers should agree a holistic approach to providing support to the Hwange and Kazangula government to build the capacity of its staff to plan effectively for future development. Administrative capacity building could include training, provision of equipment and the provision of technical support (e.g. information technology support). The potential benefits may include improved local governance and greater efficiency in capacity development initiatives.

- **Increasing Human Capital among the Local Population:** the residents of Hwange and Kazangula are not in a position to access many of the potential benefits from economic activity related to the BGHES and other proposed developments. Increasing the capacity of the local population will allow for increased local benefits and increase the local resilience to potential in-migration related impacts. Early efforts to increase human capital through training and capacity building would assist in putting local inhabitants in a position to be employed or start business enterprises to service future developments.

Increased Local Economic Benefits

<u>*Cumulative Impact*</u>

Positive benefits associated with the proposed BGHES include increased employment, purchase of local goods and services and social investment and community development. These may be enhanced by other projects in the area provided that these also promote the employment of local people and procurement as far as possible. Both the Hwange District Council in Zimbabwe and Chief Mukuni's chiefdom in Zambia are compiling plans to maximise and enhance local tourism economic benefits wherever possible. Combined and focussed social investment strategies, not compiled in isolation could also assist communities as a whole.

<u>*Measures for Consideration*</u>

The following management consideration should be implemented to help enhance positive cumulative impacts related to employment, local procurement of goods and services and social investment opportunities respectively.

- **<u>Increasing Human Capital among the Local Population</u>:** as detailed above

- **<u>Dialogue and planning with Local and District Authorities</u>:** District Development Plans should take into consideration the proposed initiatives and opportunities presented by the projects. Discussions should be held with the local and district authorities as to how best to co-ordinate social development initiatives between various developers so that benefits to the affected communities are maximised and joint investments can be made if feasible.

- **<u>Availability of supplier/goods procurement database:</u>** A list of potential suppliers is to be compiled as part of the BGHES and this should be retained at the Local and District Municipality Offices for circulation to any further developers in the area.

Increased Risk of Road Traffic Accidents

<u>*Cumulative Impact*</u>

Existing vehicle traffic is not currently significant in the project area with few motor vehicles readily available to the local communities. Settlements including schools and businesses tend to be located close to existing roads and young children and livestock roam freely and are unsupervised.

The proposed Project will increase light and heavy vehicles using the local roads throughout the duration of the construction period (9 years). There are portions of new road development proposed, but for the most part, existing roads will be surfaced and widened to serve movements to the dam wall construction site. Access will also be required along the length of the transmission line alignment. With potential in-migration to the area as a result of both the BGHES and other potential developments (in the case of Zimbabwe, the Ndlovu Housing Project and Jamezi Housing Project and in the case of both countries a new border crossing point) traffic safety incidents and traffic levels are likely to increase for both the construction and operation of the dam. Currently increased traffic levels are not known, but should be considered in more detail.

Measures for Consideration

In addition to the specific measures highlighted in *Chapter 11* that will manage the contribution of the BGHES to this risk, the following management considerations should be implemented to help mitigate potential cumulative impacts from other developers related to traffic accidents.

A specialist and integrated Road Traffic Risk Assessment should be undertaken to consider any cumulative risks related to the BGHES, the new border crossing and other developments in the project area during both the construction and operational phases of the dam. This assessment should assist in planning and coordination of road traffic reducing risks related to traffic accidents.

12.2.5 *Widespread Resettlement in the Project Area*

Cumulative Impact

Resettlement is proposed as part of the Ndlovu Project in Zimbabwe and may be required for the BGHES. Negative press releases have been noted recently with regard to the Ndlovu Project Resettlement process and this could impact negatively on how resettlement is viewed for BGHES. Precedence may be set by either of the processes and community dissatisfaction expressed where there are differences in the principles applied.

Measures for Consideration

The BGHES RAP will be compiled to meet international good practise and will ensure that negotiated compensation/replacement packages are provided. Communication is vital to ensuring that this is understood by the local communities and those impacted by resettlement. The RAP Process and its contents should be disclosed to all other potential developers in the area and discussions held with these parties in the early stage of the RAP Process so as to ascertain the status and level of their resettlement commitments.

12.2.6 *Opportunities for Community Development*

Cumulative Impact

Physical infrastructure will be developed as part of the BGHES Project that may benefit the local communities. This could include the access roads and social infrastructure in the permanent staff townships. The feasibility study for the dam will further define this.

ZRA has also committed to undertaking social development initiatives in the Project area to help support the economic and social development of directly affected and neighbouring communities. Contributions still to be made by contractors remains to be determined.

If implemented effectively, social investment activities undertaken by ZRA have the potential to improve the quality of life of those living in the catchment area through improved livelihood opportunities (or stability) and enhanced access to social infrastructure or services.

Measures for Consideration

Options to link up to current initiatives of the Zambezi Valley Development Fund which currently has projects underway in the areas impacted on by the Lake Kariba Project should be explored further in terms of effectiveness of the current Fund and appropriateness for the proposed BGHES. The current intention of the development fund is to alleviate the impact of the displacement of people in Zimbabwe and Zambia that were removed during the construction of Kariba Dam and includes grinding mill installation, borehole sinking, school and house construction, irrigation scheme development and medical equipment provision projects.

Currently this Fund provides for a 3% contribution of water sales (2% from each of the power utilities and 1% from the ZRA).

- It is understood, that as in the case of the Zambezi Valley Development Fund Projects, the Government Departments will take over responsibility for these community development initiatives. A further evaluation of the capacity of Government Department's to absorb these projects and ensure their sustainability will be required closer to the time of implementing these community development initiatives. Initial consideration should be given to this during the development of the programme and monitored on an ongoing basis during implementation.

12.3 IMPLICATIONS OF UNCERTAINTY

The cumulative environmental and social impacts described in this *Chapter* were assessed on the basis of the information available at the time, using information collected through desktop research, site visits and consultation with district authorities. The cumulative impact assessment has a certain level of uncertainty, which is inevitable with a study of this type. Uncertainties are associated with the following:

- There is little detailed information available for the other projects.
- The nature and extent of impacts based on human responses to events and changes that are not definite or predictable.

- Environmental flow analysis is based on modelling and multiple variables, but is not a precise science. Many ecological variables are complex and comprise a multitude of species with intricate interactions between one another and their environment. Responses may not conform to predictions from a computer model, and some responses may not have been foreseen.

- The severity and future impacts of climate change are not well understood. Climates are constantly changing, and there remains a great deal of speculation about the underlying causes of climate change. Potential impacts of climate change, particularly a decline in the annual rainfall across the Zambezi River Basin could have an over-riding influence over the majority of identified and cumulative impacts.

13 CONCLUSIONS AND RECOMMENDATIONS

PLEASE NOTE:

It is not possible to provide an accurate and meaningful summary / deduction of the environmental and social implications of the BGHES as a standalone for each Project component. Accordingly, the objective of this Conclusion is to present a holistic summary of the environmental and social findings and suggested way forward for the entire BGHES Project.

Both Zambia and Zimbabwe currently have an electricity deficit where demand exceeds the available supply.

In both Zambia and Zimbabwe, a number of new generation options are either being planned or commissioned. The proposed BGHES would provide electricity at a cost that would be considerably lower than most of the reasonable alternatives.

In Zambia, the proposed BGHES:

- Is expected to generate the fourth cheapest electricity option of the seventeen planned power plants in Zambia (SP, 2018).
- Is only slightly more expensive than the cheaper options.
- Is the largest planned power generation plant estimated to produce electricity at less than half the price of electricity produced by the Lower Kafue Gorge HPP, the other large planned power station.

In Zimbabwe:

- The cost of electricity generation from large coal fired power stations (such as CASECO and Hwange) would be up to four times higher than the proposed BGHES. These coal fired power stations are associated with ongoing and significant carbon emissions.

The economic assessment undertaken as part of this ESIA shows that the proposed BGHES is a financially feasible scheme (at a FSL of 757 m amsl) with an Internal Rate of Return (IRR) of 28%, a Benefit Cost Ratio (BCR) of 4.74 and a Nett Present Value (NPV) of US$ 10,643 million (Stratecon 2019). In terms of the macro-economic benefits to both Zambia and Zimbabwe, in aggregate, the proposed BGHES would have added a cumulative US$ 771 million to the GDPs of the two countries by the end of construction, and by 2040, this cumulative contribution is estimated at US$20,237 million (Stratecon 2019). Moreover, the Project has the potential to provide social benefits at national, regional and local levels through employment opportunities and procurement of local goods and services.

The proposed BGHES does also come at a potential cost, with impacts to both the regional and local economic, social and biophysical environments, as elaborated in this report. These need to be weighed up together with the positive contributions the BGHES will provide to both countries.

Key Social Issues

Key social issues include management of land access and associated displacement impacts, and livelihood restoration for those economically affected. Moreover, stakeholder expectations are high with respect to employment and local procurement opportunities this Project will make available to local communities, and the social development benefits it will bring, including rural electrification.

In addition to the above, the Project will require land acquisition for impoundment and for Project infrastructure. The Project proposes to permanently acquire the associated land. Land acquisition will result in physical and economic displacement of affected people. Project Resettlement Policy Frameworks (RPFs) have already been compiled (*Annex P*). These RPFs are aligned with the regulatory requirements of Zambia and Zimbabwe, and the requirements of IFC PS5 and WB ESS5. The preparation and implementation of a Project Resettlement Action Plans (RAPs) to address physical displacement will be done in accordance with the requirements of the RPFs. The RAPs will also need to include a Livelihood Restoration Plan (LRP) to ensure that the livelihoods of all the directly Project affected peoples (PAPs) are at least maintained if not improved.

In addition, should tourist levels decrease by a third of current levels as a result of the BGHES, this would equate in an approximate loss of 2,700 jobs. Disruption to the white water rafting and other associated activities would have a resultant economic impact and those working in the industries may be exposed to retrenchment and loss of employment. Moreover, the economic impact of this to the regional economy would be significant, as direct tourism expenditure in the Project Area us US$ 6.9 million per annum (for activities alone) (which represents approximately 64% of the total direct tourism value attributable to the Zambezi River and Batoka Gorge area and excludes indirect expenditure loss). For white water rafting associated activities to continue as viable business activities the BGHES would need to be built to a height that would prevent backwater and inundation up the gorge. With a reduction to the FSL to 730 masl during the rafting season, rafting would be available for approximately 136 days per year, between August and December, and would include rafting from rapid 1 to rapid 9/10. Although rafting can still take place, rafting companies operating under these conditions would need to downsize and therefore retrench some employees. The white-water rafting companies not providing alternative activities will be the most impacted.

Please Note:

ERM has undertaken LRPs for the BGHES Access Road in Zimbabwe and for the BGHES Staff Villages in both Zambia and Zimbabwe. RAPs for these Project components are not required, as construction of these Project components will not affect any primary residential structures and therefore will not result in physical displacement.

Separate RAPs/LRPs will be commissioned by the ZRA for those Project components that are outside of ERM's current scope, including for –

- Displacement (physical and economic) of upstream / downstream water users;
- Displacement (physical and economic) of Project affected peoples in footprints associated with BGHES transmissions lines; access road in Zambia; quarries; and other BGHES associated infrastructure.

To Note – RAPs/LRPs for upstream water users (specifically tourism operators), will only be undertaken at a later stage, as inundation of the Batoka Gorge (filling of the BGHES reservoir) is proposed in 2027 / 2028.

These separate RAPs/LRPs commissioned by the ZRA will be undertaken in accordance with the regulatory requirements of Zambia and Zimbabwe, and the requirements of IFC PS5 and WB ESS5.

Impacts associated with Dam Height and Operating Rules

The proposed BGHES shall be operated as a baseload plant on a runoff river regime with limited capacity for peaking for environment compliance. The efficiency of the proposed BGHES increases if the peak load could be generated and exported at a premium to the Southern Africa Power Pool (SAPP). When comparing a daily peaking scenario versus a run of river scenario, the benefit-cost ratio (BCR) and internal rate of return (IRR) increases to 5.19 and 32% (from 4.71 and 28%) respectively. Daily peaking may, however result in significant impacts on riverine ecosystem due to flow disturbance, reducing the ecological status downstream; however, this will depend on the final operating rules selected for the Project. In an effort to arrive at operating rules for the BGHES that meets both the environmental and the engineering objectives, four operating scenarios were derived. Of the scenarios tested three: AddPM01, AddPM02 and Add PM03 achieved the engineering criteria and met the criterion of no more than a 1.5 class drop in Overall Ecosystem Condition in the downstream river, i.e., from A/B to no less than a mid-C category. Only one of the scenarios tested, AddPM04, matched the engineering criteria and met both of the environmental criteria of no more than a 1.5 drop in overall ecosystem integrity and no more than a 25% reduction in abundance for 90% of the fish species represented in the DRIFT model. Accordingly, the ZRA have agreed that the proposed BGHES is only operated as a hydro-peaking scheme during the wet season (Feb-Aug) in accordance with the operating rules established by scenario AddPM04, namely:

AddPM04	DRY Season (**Sep-Jan**): Baseline flows; no sediment flushing. WET Season (**Feb-Aug**): QMin with one 6-hour peak a day.

Many of the impacts identified in this report can be minimised through the application of appropriate mitigation measures, as elaborated in the project specific ESMPs for construction and operation. However, some impacts are a direct consequence of the reservoir impoundment and the only available mitigation is to alter the operational water levels at the dam (either permanently or seasonally), and in so doing reduce the extent of the upstream effects. An integrated summary of the physical, biological, social and economic impacts as a direct consequence of reservoir impoundment at various Full Supply Levels (FSLs) is presented below.

The preferred and adopted mitigation option selected by the Project is to ***seasonally*** adjust the operating level at the dam as follows:

- Reduce the **low flow** season (in rafting terms, from August to January) operational level to 730 masl, thereby freeing a reach of river for rafting during this dry (low flow) period (typically when flows are less than 500 m^3/s) that extends all the way from the Victoria Falls downstream to around rapids 9 and 10, which is the current limit of half-day rafting trips on the river; and

- Increase the operating level during the **high flow** season (February to July) operational level to 757 masl under normal flow conditions in the river, and to 762 masl under high flow conditions, defined as the flow above which the Victoria Falls Power Station would normally begin to flood (at approximate flows of 3,000 m^3/s).

The potential benefits of this flexible operational regime would be to maximise power generation during the high flow season whilst facilitating full half-day rafting trips in the river for the majority of the rafting season, and minimising (and potentially avoiding [(1)]) any incremental effects from flooding at the Victoria Falls Power Station.

Operating the BGHES at less than capacity (at lower FSLs) during the dry season reduces the economic efficiency of the scheme by 3% to 4%. In this case, the NPV would drop (when compared to running the scheme at a FSL of 757m amsl) from $ 11,485 million to $10,995 million, the BCR would reduce from 3.98 to 3.77, and the IRR from 28% to 25% (Stratecon 2015). The economic impact of this alternative is not noticeably significant as the BGHES must be operated in conjunction with the Kariba HPPs, where the BGHES (with its relatively small impoundment) will produce maximum power at high flows, with the Kariba HPP (given its huge storage volume) will continue producing power at low flows.

(1) The higher dam operating level would only kick-in at times when the Victoria Falls Power Station would normally flood under present conditions. However, the effect of operating the impoundment at the higher level may exacerbate flood levels at the power station and thereby compromise power production further than at present. This effect would therefore need to be examined during detailed design in order to determine a suitable flow threshold for the higher operational level that balanced power gains at the dam versus losses at the power station.

However, changing the operating level of the dam by some 27 metres on a regular basis such as this will clearly have consequences for both ecological and aesthetic conditions in the impoundment zone. Moreover, there will be periods during the filling and emptying of the reservoir at the beginning and end of the high flow season, when downstream patterns of flow will be disrupted. This may have consequences for downstream users, and in particular aquatic ecology, and again, these operating rules will need to be finalised to minimise disruptions and impacts to downstream users.

Key Biodiversity Issues

The Batoka Gorge qualifies as a Critical Habitat for Taita Falcons based on the large unique environment that it present, its status as a key biodiversity area the presence of two national parks and the UNESCO Natural and Mixed World Heritage Site. Critical habitats represent the highest levels of ecological sensitivity and both World Bank and IFC standards stipulate stringent requirements that need to be met where critical habitats are impacted, such as demonstrating a net gain for the components that trigger a critical habitat status.

A large area of the Batoka Gorge critical habitat will be transformed through inundation by the BGHES reservoir, and there are no direct measures that mitigate this loss and demonstrate net gain of the critical habitat components. The World Commission on Dams report states for the majority of large hydropower schemes: "it is not possible to mitigate many of the impacts of reservoir creation on terrestrial ecosystems and biodiversity" (1). An offset to compensate this loss provides the only option to address the impact; however, the magnitude of such an offset would need to be large to adequately compensate this impact.

A recent update (6 February 2019) to guidance notes to the IFC Performance Standard 6 (paragraph GN55) states that projects impacting UNESCO Natural and Mixed World Heritage Sites "will not be acceptable for financing, with the possible exception of projects specifically designed to contribute to the conservation of the area".

The World Commission on Dams suggests the establishment of trust funds through grants from developers to manage parts of the revenue stream and use it for environmental purposes as a means to compensate ecosystem and biodiversity loss. (2) This approach does not align with the World Bank Environmental and Social Standards, and may therefore need a specific approval from financial institutions committing to financing development of the BGHES. A waiver of the IFC interpretation provided by guidance note GN55 (Feb-2019) to the Performance Standard 6 may also be required.

(1) Findings and Lessons (pg 93) within Chapter 3: Ecosystems and Large Dams - Environmental Performance. In: *Dams and Development - A New Framework for Decision-making. Report of the World Commission on Dams.* Nov 2000. Available at: www.unep.org/dams/WCD/report/WCD_DAMS%20report.pdf

(2) Box 3.1 Mitigating and compensating for terrestrial impacts (pg 75). In: *Dams and Development - A New Framework for Decision-making. Report of the World Commission on Dams.* Nov 2000.

Summary

The importance of the BGHES to the economies and growth of both Zambia and Zimbabwe is recognised; however, the significant challenges with balancing the needs of environmental protection with the economic and developmental needs of both countries are also recognised.

This Project is not immune to these challenges. This ESIA (together with the ESIAs for other BGHES Project components) has therefore attempted to describe both the benefits of the proposed Project as well as the environmental and social sensitivities associated with it. Where impacts are identified, detailed mitigation measures to reduce the significance of these impacts are described; also, where impacts may not be mitigated, this too has been described. In the case of positive impacts, measures to enhance such positive impacts are provided.

ERM recommends that the decision makers consider both the benefits and the sensitivities associated with the BGHES, so that an informed decision is made in this regard.

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