Itezhi-Tezhi HydroElectric Project

Environmental and Social Impact Assessment

November 2012

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Fieldstone Africa (Proprietary) Ltd

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Glossary of Abbreviations

Abbreviation	Meaning
AfDB	African Development Bank
AMSL	Above mean sea level
ANZECC	Australian and New Zealand Water Quality Standards
BOD	Biological Oxygen Demand
CBOs	Community Based Organisations
COD	Chemical Oxygen Demand
CRBs	Community Resource Boards
DBH	Diameter at breast height
dB	Decibel
dBA	Decibel A-weighted filter
ECZ	Environmental Council of Zambia
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
AfDB	African Development Bank
Fieldstone	Fieldstone Africa Pty Ltd
FSL	Full Supply Level
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GMA	Greenhouse Gas
H^2S	Hydrogen sulphide gas
Ha	Hectare
HDI	Human Development Index
Hp	High Pressure
HRMP	Human Resource Management Plan
HRPPM	Human Resources Policies and Procedures Manual
IFC	International Finance Corporation
IFC PS	IFC Performance Standards
ITPC	Itezhi-Tezhi Power Corporation Limited
ISO	International Organisation for Standardisation
ITT	Itezhi-Tezhi

IUCN	International Union for the Conservation of Nature
kg	Kilogram
KNP	Kafue National Park
kV	Kilo volt
kW	Kilo watt
L_{Aeq}	Equivalent continuous A-weighted sound pressure level
M_L	Richter Scale Magnitude
m	metre
m^2	square meter
m^3	cubic metre
m^3/s	cubic metres per second
mg/kg	milligram / kilogram
MW	Megawatt
NDT	Northern Diversion Tunnel
PEL	Probable Effects Level
PS	Performance Standard
SADC	South Africa Development Community
SAPP	Southern African Power Pool
SEP	Stakeholder Engagement Plan
SDT	Southern Diversion Tunnel
SO_2	Sulphur dioxide
STP	Sewage Treatment Plant
TATA	Tata Africa Holdings
TCE	TCE Consulting Engineers Limited
tCO2eq	Tonnes of carbon dioxide equivalent
TDS	Total Dissolved Solids
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UTM	Universal Transverse Mercator
WGS	World Geodetic System
WHO	World Health Organisation
WMP	Waste Management Plan
ZEMA	Zambian Environmental Management Agency

ZESCO	Zambian Electricity Supply Corporation Limited
µS/cm	Micro Siemens per centimetre
TDS	Total Dissolved Solids
µm	Micrometers

1 INTRODUCTION

1.1 Brief Overview

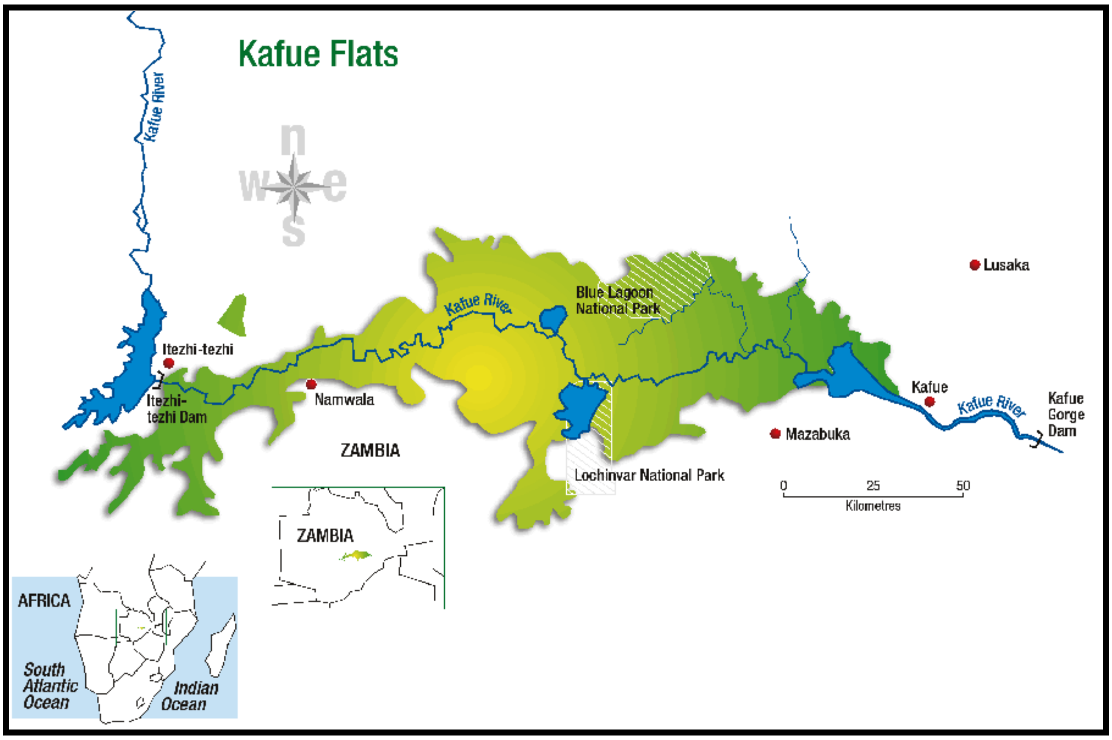
Itezhi-Tezhi Power Corporation Limited (ITPC) are proposing to develop a 120MW hydroelectric power station at the Itezhi-Tezhi dam on the Kafue River in Central Province, Zambia (hereafter referred to as the 'Project'). ITPC is a public-private partnership and a 50:50 joint venture agreement between the Zambian Electricity Supply Corporation Limited (ZESCO) and Tata Africa Holdings (TATA).

This ESIA report describes the existing environmental conditions, the potential impact upon these conditions as a result of the proposed development works and the recommended mitigation measures to minimise as far as practicable the identified risks and impacts. The ESIA report provides an objective and independent environmental and social assessment of the proposed development to assist the decision making process as to whether and in what circumstances, the proposed Itezhi-Tezhi Hydropower Project should proceed.

1.2 Itezhi-Tezhi Dam

The Itezhi-Tezhi dam is located on the Kafue River, approximately 300km upstream of the confluence of the Kafue River with the Lower Zambezi River. The dam was built across the Kafue River near Itezhi-Tezhi in 1978 to provide seasonal regulation to the flow of the Kafue River and permit expansion of the downstream Kafue Gorge Hydroelectric Project (approximately 260km downstream of the Itezhi-Tezhi dam) (**Figure 1-1**). By storing water the dam is able to provide a constant flow of water to the Kafue Gorge Hydroelectric Project downstream in both wet and dry seasons.

Figure 1-1: The Kafue Flats, Itezhi-Tezhi Dam and Kafue Gorge Hydroelectric Project



The Itezhi-Tezhi reservoir is impounded by a rock fill dam with a maximum height of 51m, a crest length of approximately 1,400m and a total reservoir storage volume of almost 6,000Mm^3. The main spillway over the dam wall consists of three gates capable of discharging at nearly 3,000m^3/s.

During the original construction of the Itezhi-Tezhi dam, two river diversion tunnels (northern and southern diversion tunnels) were constructed at the base of the dam, capable of discharging at 300m^3/s. Following completion of the dam, the southern diversion tunnel was closed to flow by a concrete seal plug. A radial regulation gate was installed on the northern diversion tunnel to provide a "Low Level Outlet" for the reservoir to ensure that flows for the Kafue Gorge Hydroelectric Project continued when dam water levels dropped below the level of the main spillway.

A Feasibility Study undertaken in 2008 (TCE, 2008) considered options for the provision of a hydroelectric power plant at Itezhi-Tezhi to take advantage of the steady stream discharge associated with operation of the dam. The study recommended that the dam would be suitable for the construction of a 120MW power generation plant.

1.3 Project Description

The proposed Project will upgrade the existing dam to incorporate a 120MW hydroelectric power house. The power house plant will utilise the existing, but currently un-used, southern diversion tunnel and intake to draw water from the base of the reservoir to feed the power plant. A new section of tunnel (approximately 330m long) will be connected up to the existing tunnel to divert water to the power house. The power house itself will be built immediately adjacent to the southern embankment of the existing dam, on its eastern side (**Figure 1-2**). The power house will be built into the side of the existing hill at this location. The town of Itezhi-Tezhi is approximately two kilometres to the north of the Project site.

Figure 1-2: Location of Itezhi-Tezhi Power House Site and Off-Site Ancillary Facilities

(Aerial image © 2012 Google; Image © 2012 Cnes/Spot Image;Data SIO, NOAA, U.S. Navy, N.G.A, GBECO)

Two 60MW Kaplan turbine generator units will be installed in the power house. Water from the reservoir will be drawn through the southern diversion tunnel and will pass through these turbines producing up to one TW-hrs per year. A switching yard and a surge shaft will be installed directly adjacent to the power house. The generated electrical power of the power plant is proposed to be exported to the Zambian National Electrical Grid by a double circuit 132 kV transmission line to Mumbwa town and then onto Lusaka by a 330 kV transmission line. The construction and operation of this proposed transmission line is not considered part of the Project, and is not assessed within this ESIA.

The water discharge from the turbines will return to the Kafue River, via a short tailrace channel, approximately 300m downstream of the dam wall and existing discharge point of the northern diversion tunnel.

In addition to the power house, tunnel upgrade, switching yard and surge shaft, during construction a number of other on-site associated facilities will be established at the power house site, including:

- A rock crushing area;
- An explosive magazine;
- A concrete batching plant; and
- A construction workshop.

For the purposes of this report, the power house site refers to power house, switchyard and the onsite facilities. It is anticipated that approximately 50 ha of vegetation will be required to be cleared to facilitate this development. As the power house is to be built into the side of an existing hill, rock blasting will be required as part of construction activities. There are no sensitive receptors within 500 m of the power house site.

In addition to the on-site works a number of ancillary facilities will be established off-site to facilitate both the construction and operation of the power house. These include:

- A worker accommodation camp (single storied housing to the south of Itezhi-Tezhi, designed to accommodate 46 staff);
- A water treatment plant (which will provide potable water to the worker accommodation camp and the town of Itezhi-Tezhi); and
- A sewage treatment plant servicing the accommodation camp.

Both the power house site and off-site facilities will be accessed by road; connecting directly onto the D769, the road that connects Itezhi-Tezhi to Lusaka (north) and Mongu (south).

During the construction phase approximately 500 workers will be required. During operation, this will be reduced to approximately 50 workers. All works will take place within land currently owned by ZESCO. No land acquisition or resettlement will be required as part of the Project development.

A detailed description of the Project components and activities is given in **Section 3**.

1.4 Proponent Details

Fieldstone Africa Pty Ltd (Fieldstone) commissioned this ESIA for the Project to be prepared by URS Infrastructure and Environment. The Project is being developed by ITPC (a public-private partnership between the ZESCO and TATA).

Fieldstone is a financial advisory service provider, specialising in the infrastructure and energy sectors. They provide objective, unbiased, and independent advice to their clients to facilitate and inform transaction and decision making across the entire range of transaction classes (e.g. public offers, project financing, restructuring, mergers and acquisitions.).

ZESCO is the national, government owned, energy supplier for Zambia. Its remit is to generate, transmit and distribute electricity to all industrial, commercial and household customers across Zambia. ZESCO has been in operation for over 40 years and has installed an electricity production capacity of over 1700MW with the national grid. As part of its structure, it has a section responsible for the planning, designing and implementation of power Projects.

TATA is a wholly-owned subsidiary of the US$ 70.8 billion Tata Group. TATA has been active within Africa for over three decades, entering into joint ventures and partnerships with many African companies to help develop local resources and talent. The organisation today employs over 750 people and operates in major industrial sectors such as information systems, engineering, services, materials, consumer products and chemicals. Major Tata Africa subsidiaries include Tata Zambia, Tata Holdings Moçambique Lda, Tata Holdings (Tanzania) and Tata Ghana. The Tata Group is a signatory of the United Nations Global Compact, a strategic policy initiative for businesses that are committed to aligning their operations and strategies within ten universally accepted principles in the areas of human rights, labour, environment and anticorruption[1].

[1] Principles of the United Nations Global Compact:

- Principle 1: Businesses should support and respect the protection of internationally proclaimed human rights; and

The contact details for the relevant organisations are provided in **Table 1-1**.

Table 1-1 Organisation Details

Organisation	Contact Address	Contact and Position
Fieldstone Africa	Fieldstone Africa (Pty) Ltd P.O Box 781589 Sandton, 2146 SOUTH AFRICA Contact Phone: +27 11 775 2000 Contact Email: forbes@fpcg.co.za	Forbes Padayachee *Mangangá Director*
ITPC	ITPC Post Net 239, Private Bag E891, Manda Hill, Lusaka, ZAMBIA Contact Phone: +260 211 230 461 Contact Email: jloongo@itpc.co.zm	Justin Ch. Loongo *Project Director*
URS Infrastructure and Environment	URS Global Development 6-8 Greencoat Place London, UK SW1P 1PL Contact Phone: +44 207 821 4312 Contact Email: louise.porteus@urs.com	Louise Porteus *Director – Global Development*

1.5 Project History and Purpose of the Report

This ESIA report has been prepared to assess the environmental and social impacts associated with the development of the proposed Itezhi-Tezhi Hydroelectric Power Plant. In particular, this report has been prepared specifically to meet IFC Performance Standards for

- Principle 2: make sure that they are not complicit in human rights abuses.
- Principle 3: Businesses should uphold the freedom of association and the effective recognition of the right to collective bargaining;
- Principle 4: the elimination of all forms of forced and compulsory labour;
- Principle 5: the effective abolition of child labour; and
- Principle 6: the elimination of discrimination in respect of employment and occupation.
  Principle 7: Businesses should support a precautionary approach to environmental challenges;
- Principle 8: undertake initiatives to promote greater environmental responsibility;
- Principle 9: encourage the development and diffusion of environmentally friendly technologies; and
- Principle 10: Businesses should work against corruption in all its forms, including extortion and bribery.

Environmental and Social Sustainability and international lenders requirements in regards to environmental and social impact assessments.

Prior to the preparation of this report, an Environmental Impact Assessment (EIA – the Zambian equivalent of an ESIA) for the ITT Hydropower Project was undertaken by ZESCO, to assess the potential impacts of the project for approval by the Zambian Government. This EIA was prepared in accordance with Zambian legislative requirements and standards. Approval for the Project from the Zambian Government, based on this ZESCO EIA, was granted on January 26, 2009. It is noted that this EIA was produced both prior to the formation of recognised international standards, and before the need for international financing for the Project was confirmed. As such, the ZESCO EIA does not satisfy IFC Performance Standards 2012 (IFC PS).

Subsequently, in November 2011, URS was contracted by Fieldstone, at the request of ITPC, to prepare an ESIA for the project in-line with IFC PS. In order to do so, URS first undertook a Gap Analysis (**Appendix A**) outlining the short-comings of the ZESCO EIA in relation to the IFC PS. This ESIA report has been prepared to meet the gaps identified, while utilising and drawing heavily upon the substantial body of work already undertaken for the ZESCO EIA. As Zambian National approval for the Project has already been granted through the ZESCO EIA, this ESIA has not been submitted to the Zambian National Government for review, and therefore the EIA document preparation/submission/approval process described in Section 2 has not been necessary.

In all other respects, this ESIA report has been prepared in-line with local, provincial and national Zambian legislative standards, as well as the international best practice Performance Standards of the International Finance Corporation.

The aims of this ESIA are to:

- Identify the positive and negative environmental and socioeconomic impacts potentially arising from the development of the project; and
- Identify and describe appropriate mitigation measures to be implemented in order to minimise the potential environmental and socio-economic risks and impacts identified.

As this ESIA report is, in essence, an updated version of the previous environmental assessment, the report draws heavily upon works undertaken, and reports prepared, for the ZESCO EIA. Where possible, this report indicates where information from ZESCO EIA has been utilised, and where it has been updated to meet international standards.

1.6 Benefits of the Proposed Development

Zambia is one of Africa's fastest growing economies with a high rate of industrial development, largely driven through the expansion of its mining sector. The main objective of the Project is to provide additional energy to meet the growing demand of this rapidly developing economy. By supplying an addition 1.05 TW-hrs per year the project will provide valuable baseload energy supply, lowering the social and economic costs associated with load shedding and reducing the need to import energy from neighbouring countries. In particular, the development of this resource will significantly contribute to the future development of the Itezhi-Tezhi District as well as the western provinces of Zambia as a whole.

In addition to the economic and social benefits associated with supply of a reliable source of energy the project will:

- Provide employment opportunities for the local communities during construction and operation;
- Provide a reliable source of potable water for the residents of Itezhi-Tezhi; and

- Reduce dependency on carbon intensive fuel sources (e.g. woodfire, coal-based electricity), reducing the Zambian contribution to greenhouse gas emissions.

It is also noted that if the Project is not developed the shortfall in electricity demand will need to be met either through importing energy or through the construction of alternative power plants. As the Project will utilise an existing water body, the environmental and social costs are likely to be significantly lower than if a new reservoir had to be established.

1.7 Potentially Significant Impacts

The key environmental and social impacts identified during the preparation of this ESIA which may result from the proposed hydropower plant include:

Water Quality – The operation of the dam will lead to the discharge of significant volumes of water from the base of the Itezhi-Tezhi reservoir. These waters are likely to differ in their physico-chemical parameters from current discharges. In particular, waters will typically be colder, anoxic, and may contain elevated levels of nutrients and heavy metal concentrations. While regular discharges of similar waters are made under current conditions, this ESIA assesses the potential impacts associated with long-term discharge of such waters on the down-stream environment. Provided appropriate mitigation measures are implemented the risk of water quality contamination downstream is considered to be manageable.

Ecology – The Kafue Flats are an internationally recognised wetland area located immediately downstream of the proposed hydropower project. These wetlands have been significantly altered since the construction of the dam in 1978 due to changes in hydrodynamics and flooding. The proposed power house will not significantly alter the existing flow regime that has been established since the operation of the dam. However, any changes in water quality associated with operation of the hydropower plant will have direct ecological impacts (e.g. bioaccumulation of copper has previously been observed in species within the Itezhi-Tezhi reservoir).

Social – The development of a major infrastructure project in the area may lead to in-migration and increased stress on local resources. It is also noted, that given the dependence of many local and regional communities on the Kafue River, any impacts on water quality and or ecology will also have social impacts (e.g. depletion of fish stocks inhibiting livelihoods). The improvement of local infrastructure and services (**Section 1.6**) is also likely to attract in-migration and development of the area. In addition, the standard risks and impacts associated with construction sites (e.g. traffic and road safety) may affect local communities and residents.

Other impacts expected to arise as a result of this proposal and assessed within this ESIA include:

- Air Quality;
- Climate and Climate Change;
- Cultural heritage;
- Ground water;
- Hydrology and Flooding;
- Land Contamination;
- Landscape and Visual Impacts;
- Lighting;
- Noise and Vibration;
- Project Hazards and Risks;

- Solar Access;
- Traffic and Transport;
- Transbounary Impacts;
- Topography, Geology and Soils; and
- Waste and Waste Management.

The extent of these impacts and appropriate recommended mitigation measures are detailed in **Sections 6 - 8**.

1.8 Reporting

1.8.1 Reporting Standards

Under Zambian legislation the Project is deemed to be of sufficient magnitude to warrant environmental and social assessment. This ESIA report has been prepared in accordance with Zambian legislation, in particular, the Environmental Protection and Pollution Control Act – Environmental Impact Assessment Regulations, Statutory Instrument No. 28 of 1997 which defines the EIA process and sets out what aspects are required to be addressed (Section 2.2).

In addition to Zambian legislation, the ESIA is also being undertaken to the World Bank Group's International Finance Corporation (IFC) Performance Standards and the supporting applicable IFC Environment Health and Safety (EHS) Guidelines.

Details of these reporting requirements are presented in **Section 2**.

1.8.2 Report Structure

The ESIA report is structured as follows:

- **Section 1: Introduction;** Background and Report Structure.
- **Section 2: Legislative Context;** a summary of the relevant Zambian legislation including international treaties and conventions ratified by Zambia and the associated national strategies and actions plans; international standards being adopted for the Project.
- **Section 3: Detailed Project Description;** a detailed description of the proposed project development.
- **Section 4: Environmental and Social Impact Methodology;** a detailed summary of the methodologies followed when defining baseline conditions; evaluating impacts and proposing both environmental and socioeconomic mitigation measures;
- **Section 5: Stakeholder Engagement;** a summary of the consultation process, consultation to be undertaken during the scoping and ESIA phase and feedback recorded from stakeholders during consultation;
- **Section 6: Environmental Impact Assessment - Major Risks;** includes a detailed assessment of the potentially major impacts identified. Each topic identified as being a major impact will include a detailed description of the baseline conditions and how these conditions were determined, an assessment of the potentially major impacts to stakeholders and the environment, proposed mitigation measures and an assessment of residual impacts.
- **Section 7: Environmental Impact Assessment - Minor Risks;** includes an assessment of the potentially minor impacts identified. Each topic identified as being a minor impact will include a description of the baseline conditions, an assessment of the minor impacts to stakeholders and the environment, proposed mitigation measures and an assessment of residual impacts.

- **Section 8: Social Impact Assessment;** a description of the baseline socio-economic conditions within the area and the anticipated impacts upon the identified stakeholders. Where possible, practicable mitigation measures are provided.
- **Section 9: Cumulative Impact Assessment;** an assessment of the cumulative impacts associated with the project, taking into consideration existing and proposed developments across the country and internationally.
- **Section 10: Labour and Working Conditions;** a high-level review of current practices to international standard requirements in regards to labour and working conditions. Actions required to ensure compliance are detailed.
- **Section 11: Recommendations for Environmental Safeguard and Management Measures;** provides a summary of the mitigation measures and residual impacts outlined in **Sections 6 - 8** and sets forth a Framework Environmental and Social Management Plan. This will outline the manner in which the mitigation measures, monitoring and environmental controls will be implemented by ITPC to manage the potential impacts from the Project, maintain relationships with the local community, and deal with community grievances; and
- **Section 12: Conclusions;** summarizes the significance of residual impacts, the cumulative impacts and the overall conclusion of the ESIA.

2 LEGISLATIVE CONTEXT

The Project required an Environmental Impact Assessment (EIA) as stipulated in the Government of Zambia's existing national laws. This has been completed. As the Project will also require international funding, an Environmental and Social Impact Assessment (ESIA) will also be required to be undertaken in compliance with internationally recognised standards. This ESIA report has been prepared to comply with both International Financial Corporation's Performance Standards and Zambian national standards.

The Project is also required to comply with relevant international environmental and labour regulations that have been ratified by Zambia.

This section identifies the relevant Zambian legislation and statutory obligations as well as international requirements, with which the ESIA will need to comply.

2.1 National

2.1.1 Zambian Governance Structure

Zambia follows a Republican form of government elected through universal suffrage once every five years. The parliament has a single house with 150 elected members and usually eight, maximum ten, nominated members.

Zambia is divided into nine provinces- Northern, Eastern, Luapula, Copperbelt, Central, Lusaka, Southern, North-Western, Western. The proposed Project is located in the Central Province.

The nine provinces are divided into 72 Districts each of which have a Council presided over by a district secretary. Districts are further sub- divided into wards, each of which elects a council member through a democratic process. Elected council members along with the parliamentary representative of the particular district go on to constitute a district council. The proposed Project is located in the Itezhi-Tezhi District.

Besides the formal elected structure, there is a 'House of Chiefs' which acts as an advisory body and is constitutionally empowered to comment on traditional matters and customary matters and other any other issues referred by the President.

2.1.2 Key Environmental Institutions

At the national level, the Zambian Environmental Management Agency (ZEMA) (formerly Environmental Council of Zambia (ECZ) is the nodal agency for the review of Environmental Impact Assessment (EIA) reports and strategic environmental assessment reports. Its remit is broadly defined under the Zambian Environmental Management Act 2011 (EMA) and includes the responsibility for ensuring the sustainable management of natural resources and protection of the environment, the prevention and control of pollution, and undertaking environmental auditing and monitoring.

2.1.3 Environmental and Social Assessment Legislation

The EMA Act (2011) details and describes the process required to obtain environmental clearance from ZEMA, prior to the on-set of construction, and the role ZEMA will play in this process. In particular Section 29 of the Act requires that no project with the potential to have an effect on the environment will be undertaken without written approval from ZEMA. Further, the Act outlines requirements for:

- Final determination of a project's Terms of Reference (ToR) for an Environmental Impact Assessment;
- The holding of public meetings on EIA findings and disclosure of EIA through media;

- Review of EIAs and issue of approvals; and
- Conducting compliance audits and ensuring general administration of EIA regulations.

The EMA Act replaces and repeals the former Environmental Protection and Pollution Control Act (EPPCA) Cap 204 of 1990. The Regulations established under the Environmental Protection and Pollution Control Act, remain enforced under the EMA Act.

2.1.4 Environmental Impact Assessment Regulation

The key regulation in regard to environmental assessment under the EMA Act (2011) is the Environmental Impact Assessment Regulation (SI 28 of 1997). The Regulation provides specific guidelines for conducting environmental impact assessments and for the evaluation of environmental impact statements. An EIA is required to be prepared in accordance with the guidelines set out in the fourth schedule of the Regulations and any other applicable guidelines as stipulated by ZEMA. Specifically, the Regulation requires that the EIA process seek the views of the people in the community to be affected by the project and in this process the developer shall:

- Publicise the intended project, its effects and benefits, in the mass media, in a language understood by the community, for a period of not less than fifteen days and subsequently at regular intervals throughout the process; and
- After the expiration of the period of fifteen days hold meetings with the affected community in order to present information on the project and obtain the views of those consulted.

Further, the Regulation states that all EIAs undertaken are to include:

- A description of the project, and reasonable alternatives, which may begin or increase operations to provide materials or services to the proposed project;
- A description of the proposed site and reasons for rejecting other alternative sites;
- A description of the site and the surrounding environment specifying any information necessary to identify and assess the environmental effects of the project;
- A description of the raw material inputs into the project and their potential environmental effects; description of the technology and processes that shall be used; a description of the products and by-products of the project;
- A environmental effects of the project, and reasonable alternatives, including the direct, indirect, or cumulative, short-term and long-term effects;
- The socio-economic impacts of the project, such as resettlement of affected people;
- An impact management plan containing a description of measures proposed for preventing, minimising or compensating for any adverse impact, and enhancing beneficial effects, and measures to monitor effluent streams or important environmental features that may be affected by the project; and
- An indication of whether the environment of any neighbouring state is likely to be affected.

Under the regulations, a developer is required to submit an EIA to ZEMA if:

- The project is listed under the second schedule to the Regulation; or
- The project is not specified in the Second Schedule, but the Council determines a project brief should be prepared.

This Project is considered to fall within the listed projects of the Second Schedule and as such requires an Environmental Impact Assessment under Zambian legislation.

In addition to this legislation, Zambia maintains a range of additional legislation pertaining to the environment, land-use and development planning, and resource management. **Table 2-1** summarises the legislation considered of relevance to the Project.

Table 2-1 Key Zambian Environmental and Planning Legislation

LEGISLATION	KEY ELEMENTS (INCLUDING REGULATIONS)	RESPONSIBLE AUTHORITY
Zambian Environmental Management Act 2011 and Environmental Impact Assessment Regulations (SI No. 28 0f 1997)	Provides for the protection of the environment and the control of pollution. It outlines specific guidelines for conducting environmental impact assessments in Zambia.	ZEMA
Zambia Wildlife Act, 1998	The Act provides for the establishment, control and management of National Parks; Conservation and protection of wildlife and objects of interest in National Parks, the establishment of Game Management Areas; The licensing of hunting; Control of possession of trophies and control of bush fires.	National Parks and Wildlife Service
The National Heritage Conservation Commission Act, 1989	Provides for the conservation of ancient, cultural and natural heritage, relics and other objects of aesthetic, historical, pre-historical, archaeological or scientific interest.	National Heritage Conservation Commission
Natural Resources Conservation Act, 1970	Monitor and control the management and use of natural resources outside forest reserves and national parks.	Ministry of Tourism, Environment and Natural Resources
Forest Act, No. 7 of 1999	Establishment and management of national and local forests, conservation and protection of forests and trees and the licensing and sale of forest products through joint forestry management with the communities.	Forest department, Ministry of Tourism, Environment and Natural Forests
Town and Country Planning Act, 1962	Control of development and subdivision of land. The Act does not, however, apply to Trust (State) Land, land in reserves, or land in mining areas that fall under regional plans	Ministry of Agriculture, Food and Fisheries
Fisheries Act, 1974	Development of commercial fishing, control of fishing and the participation of local communities in natural resource management	Ministry of Agriculture, Food and Fisheries
Agricultural Lands Act, 1990	Protection of agricultural land	Ministry of Agriculture, Food and Fisheries
Water Act, 1949	Control, ownership and use of water, excluding that of the Luangua, Luapula and Zambezi Rivers, which form international borders. Regulates the use of public water,	The Water Board Ministry of Energy and Water Development

LEGISLATION	KEY ELEMENTS (INCLUDING REGULATIONS)	RESPONSIBLE AUTHORITY
	protecting it against pollution.	
The Local Government Act, 1991 and Local Government (Amendment) Act 2010	Provides for the establishment of local, municipal and district councils, and specifies the functions and powers of the local government, including pollution control and environmental management.	Ministry of Local Government and Housing
Public Health Act, 1995	The Act relates mainly to the control and notification of infectious diseases. Parts of the Act (Part IX) relate to sanitation and housing.	Ministry of Local Government and Housing
Air Pollution Control (Licensing and Emission Standards) Regulations, 1996 (SI No. 141 of 1996).	Outlines the license required for discharge of air pollutants, as well as setting out air quality guidelines and long term emissions limits for parameters.	Zambia Environmental Agency (ZEMA), formerly Environmental Council of Zambia
Water Pollution Control (Effluent and Waste Water) Regulations, 1993 (SI No. 72 of 1993)	Sets out the licensing requirements for effluent and wastewater discharges to the environment and provides effluent and wastewater discharge limits.	ZEMA
Hazardous Waste Management Regulations, 2001 (SI No. 125 of 2001)	Sets out requirements for the control and management of hazardous waste. The regulation applies to the control and monitoring of generation, collection, storage, transportation, pre-treatment, treatment, disposal, export, import and trans-boundary movement of a wide range of hazardous wastes.	ZEMA
Waste Management (Licensing of Transporters of Waste and Waste Disposal Sites) Regulations, 1993 (SI No. 71 of 1993)	Sets out the licensing requirements for transportation of solid non-hazardous waste and operations of solid non-hazardous.	ZEMA
Draft national policy on wetlands conservation, September 2001	Holistic programme of action to promote the conservation and wise use of wetland ecosystems. It acknowledges the importance of wetland ecosystems in Zambia in providing major fisheries, and as important habitats for various wildlife species	Environmental council of Zambia, Ministry of Tourism, Environment and Natural Forests
National Energy Policy, 1994	Supply and demand of the various energy resources- information on the current energy situation, policy measures for each energy sub-sector and outlines strategies for implementation, and the institutional and legal reform necessary to implement the Policy	Department of Energy, Ministry of Energy and Water Development

In addition to the Acts, Regulations and Policies mentioned in **Table 2.1**, the following strategies and plans are also applicable to the project.

The National Conservation Strategy is the main policy document on the conservation of environment and natural resources in Zambia. The strategy outlines national policies and

plans for Zambia's environmental and social conservation. The main objectives are: to ensure the sustainable use of renewable natural resources; to maintain and conserve biological diversity; and to maintain essential ecological processes and life support systems.

The National Environmental Action Plan (NEAP) is a comprehensive plan to address the main issues of environmental degradation in Zambia. The NEAP aims to identify major environmental issues, analyse their causes and further recommend mitigation measures and actions in order to address such issues.

The National Biological Diversity Strategy and Action Plan's aim is ensure the conservation of Zambia's natural ecosystem and to establish a legal, policy and institutional framework that promotes the conservation, management and sustainable development of Zambia's biological resources by all sectors of the population.

The National Forestry Policy's main aim is to ensure the sustainable management of Zambia's forest ecosystems and biodiversity as well as regulating exploitation and ensure efficient use of forest resources and products.

The National Policy on the Environment's aim is ensure the harmonisation of environmental and social strategies in Zambia and avoid conflict of interest from sectors. It also aims to rationalise legislation that addresses the use and management of the environment "in order to attain an integrated approach to development through a national cross-cutting consensus".

2.1.5 Energy Sector Legislation in Zambia

The Department of Energy is responsible for the management and administration of electricity production and distribution within Zambia. It administers the Electricity Act (1995), which regulates the generation, transmission, distribution and supply of electricity. As such, the operation of the Project will fall directly under the jurisdiction of the Department of Energy and will be required to be compliant with the conditions of the Electricity Act.

In 1994 Zambia promulgated the National Energy Policy recognising the critical role that energy plays in socio-economic development and poverty reduction. In 1997, the Energy Regulation Board (ERB) was established under the Energy Regulation Act of 1995. The ERB was established to regulate undertakings/utilities in the energy sector including electricity, fossil fuels (petroleum) and other forms of energy such as solar and coal, through issue of specialised licences. Currently, regulated utilities in the electricity subsector include ZESCO, Copperbelt Energy Corporation and Lunsemfwa Hydro Power Company.

The ERB has various functions related to licensing of commercial producers, pricing, designing of safety standards, etc. The ERB in coordination with ZEMA 'formulates measures to minimise the environmental impact of production and supply of energy and the production, transportation, conversion, storage and use of fuels and enforce such measures by the attachment of appropriate conditions to licences held by the undertakings' (Source: Energy Regulation Board of Zambia)[2].

In addition, the Zambia Electricity Supply Corporation (ZESCO), partial owner of the Project, is an operating member of the Southern African Power Pool (SAPP) with the obligation to utilize its spare transmission capacity to provide power for other Operating Members.

2.1.6 The EIA Process in Zambia

The major stages in the Zambian EIA process as prescribed in the legislation are as follows:

[2] http://www.erb.org.zm/content.php?viewpage=rtes accessed on July 4, 2012

Stage 1 – Screening - Determination of whether the Project is listed within the Second Schedule to the Environmental Impact Assessment Regulation (SI 28 of 1997) or whether the potential construction or operation associated with the Project will, in the opinion of ZEMA, affect the existing environment and society.

Stage 2 - Project Scoping - An initial investigation into the key characteristics of the project-affected area and identification of the environmental aspects that are most likely to be impacted by the proposed development. Ultimately this forms the basis of a Terms of Reference agreed upon by ZEMA for a subsequent EIA.

Stage 3 - Baseline studies and Impact Assessment - Undertake necessary baseline studies, including specialist studies where necessary, according to the approved terms of reference.

Stage 4 – Impact Assessment - Conduct impact assessments for each anticipated impact with reference to the magnitude, duration, probability of occurrence, and the sensitivity of the receiving environment and stakeholders.

Stage 5 - Identification of mitigation measures: Identification of appropriate mitigation measures in order to eliminate negative impacts.

Stage 6 – Disclosure of EIA – Completion of an EIA document provided to ZEMA for review and publically disclosed to allow stakeholders the opportunity to provide comment on the impacts identified and the proposed management and mitigation measures.

A key aspect of the EIA process within Zambia is public participation and contribution to the overall decision making process. The Zambian EIA regulations specify public participation to be sought in at least two stages of the EIA:

- The proponent is to arrange a public consultation process involving government agencies, local authorities, NGOs community based organisations (CBOs) and interested and affected parties, to contribute to deciding on the scope of work when undertaking the EIA (i.e. in the Project Scoping Phase); and
- Before submitting the final EIA report the proponent needs to present the EIA findings either through the media or by presenting/ displaying the report in public buildings or by arranging a public consultation process when significant environmental impacts are anticipated.

It is noted that, this process, was completed for the ZESCO EIA (2008). However, this ESIA report, prepared on behalf of Fieldstone Africa, has not been submitted to ZEMA nor has it been publically disclosed. Stakeholder engagement and public consultation activities undertaken as part of preparation of this report are detailed in Section 5.

2.2 International

The proposed development should comply with international environmental and labour regulations ratified by Zambia, the 2012 International Financial Corporation Performance Standards and the Environmental, Health, and Safety Guidelines.

2.2.1 International Conventions Ratified by Zambia

Zambia has ratified several international conventions that deal with environmental protection and labour regulations which may be of relevance to the Project. **Table 2-2** lists the relevant conventions and protocols to which Zambia is a signatory.

Table 2-2 Environment and Labour Regulations Ratified by Zambia

NAME OF TREATY/ CONVENTION	YEAR OF RATIFICATION/ ASCENSION	OBJECTIVES
On Environment:		
Convention on Biological Diversity	1993	As a party to this convention Zambia[3] aims at the conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of the benefits arising out of the utilization of genetic resources.
Vienna Convention for the protection of the Ozone Layer, 1985	1990 (Accession)	A state must be a party to the Vienna Convention to be a party to the Montreal Protocol and agrees to take appropriate action to protect the Ozone layer
Montreal Protocol on substances that deplete the Ozone Layer	1990 (Accession)	Committed to the protection of the ozone layer from depletion by phasing out the production of a number of substances believed to be responsible for ozone depletion
The United Nations Framework Convention on Climate Change-UNFCC	1993	Seeks to reduce the anthropogenic causes of global warming, and to cope with whatever temperature increases are inevitable
Kyoto Protocol	2006	Has ratified without setting up emission targets
Convention on International Trade in Endangered Species-CITIES	1981	Monitor and control the international trade in specimens of wild life and plant species such that their survival is not threatened
Convention on Wetlands of International Importance Especially As Waterfowl Habitat (Ramsar)	1991	To stem the progressive encroachment on and loss of wetlands now and in the future, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value
South Africa Development Community (SADC)	1992	As a party to SADC[4], Zambia is committed to the following protocols relevant to the project: 1. Protocol on Shared Watercourse systems- to develop a monitoring policy for shared watercourse systems; to promote the equitable utilisation of shared watercourse systems; to formulate strategies for the development of shared watercourse systems; to monitor the execution of integrated water resource development plans in shared

[3] http://www.biodiv.be/zambia/convention/cbd/ratification/ Accessed on 5 July 2012
[4] http://www.sadc.int/english/key-documents/protocols/ Accessed on 5 July 2012

NAME OF TREATY/ CONVENTION	YEAR OF RATIFICATION/ ASCENSION	OBJECTIVES
		watercourse systems 2. Protocol of Wildlife Conservation and Law Enforcement 3. Protocol on Mining 4. Protocol on Forestry
The United Nations Convention to Combat Desertification- UNCCD	1996	Aims at combating desertification and mitigating the effects of drought by promoting effective action through innovative local programmes and supportive action to international partnerships
Basel Convention on the Control of Trans- boundary Movements of Hazardous Wastes and their Disposal	1994 (Accession)	Reduction of trans-boundary movements of wastes, environmentally sound and efficient management of waste, to minimize the amount and toxicity of wastes generated and ensure their environmentally sound management
On Labour: **Zambia has ratified 39[5] International Conventions on Labour Standards. These are reflected in Zambia's nationally legislated Labour Laws that are directly applicable to the project, including:**		
Employment Act, Cap 268		Legislation on employment of persons, protection of wages of employees
Industrial and Labour Relations Act, Cap 269		Regulations on the formation of federations of trade unions and federations of employers organisations, recognition and collective agreements, settlement of disputes, strikes, lockouts, essential services
Employment of Young Persons and Children's Act, Cap 274		Regulates the employment of young persons, and children. Definitions: a child- person under the age of 14 years; young person- more than 14 and less than 18 years. The law prohibits the employment of persons under the age of 16 years
Minimum Wages and Conditions of Employment Act, Cap 276		Regulation on minimum wage level and minimum conditions of employment and provides for different forms of wage determination: through Collective Bargaining for all workers who belong to a trade union; through Statutory Instruments issued by the Minister of Labour and Social Security for all non-management workers that do not belong to trade unions
Factories Act, Cap 441		Regulation of the condition of employment in factories and other places as regards the safety, health and welfare of persons

[5] http://www.ilo.org/dyn/normlex/en/f?p=1000:11200:634936838945630::NO:11200:P11200_COUNTRY_ID:103264 Accessed on 5 July 2012

2.2.2 IFC Performance Standards

ITPC is committed to applying the IFC Performance Standards (2012) and the relevant EHS Guidelines to the Project, to ensure its environmental and social impacts are minimised as far as practicable and the Project's benefits maximised. In essence, the IFC Performance Standards set out the underlying principles of sustainable project management, including impact/ risk assessment, mitigation strategies, public consultation and performance monitoring. **Table 2-3** summarises the requirements of the IFC Performance Standards, 2012 and their relevance to the Project.

Table 2-3 IFC Performance Standards of Relevance to the Project

TITLE	SUMMARY	RELEVANCE
IFC PS 1: Assessment and Management of Environmental and Social Risks and Impacts	Establishes requirements for social and environmental performance management throughout the life of a project through initial baseline studies and risk/impact assessment, identification of mitigation options, stakeholder consultation and application of management system to monitor and improve performance.	*The nature of this project requires an ESIA to be undertaken.*
IFC PS 2: Labour and Working Conditions	Highlights the need for workers rights regarding income generation, employment creation, relationship management, commitment to staff, retention and staff benefits. It identifies and outlines the need to provide workers with a safe and healthy working environment. This Performance Standard is guided by international conventions, in particular those of the ILO that have been ratified by Zambia.	*The construction and operation of the proposed plant will require a large workforce. Labour and working conditions for all workers will be complied with.* *It is understood that the construction contractor is the foreign-owned Sinohydro. Sinohydro practices will need to comply to work practices and conditions detailed in this standard.*
IFC PS 3: Resource Efficiency and Pollution Prevention	Defines an approach to pollution prevention and abatement in line with current internationally disseminated technologies and good practice. It deals with ambient and cumulative considerations, resource conservation and energy efficiency, hazardous materials and waste management, pesticide use and management, and emergency preparedness and response provisions.	*A significant volume of waste will be generated that needs to be managed effectively as a result of both construction and operation. In addition, attention needs to be paid to management of fuels and lubricants and the hazardous materials that may be used on-site.*
IFC PS 4: Community Health, Safety and Security	Specific requirements for mitigating any potential for community exposure to risks and impacts arising from equipment accidents, structural failures and releases of hazardous materials. In addition, communities may be affected by impacts on their natural resources, exposure to diseases, and the use of security personnel.	*The working and storage areas of the site will need to be secured, as will the construction workers' camps. Consideration needs to be given to the health and safety of both workers and the local community in relation to a range of issues.*
IFC PS 5: Land Acquisition and Involuntary Resettlement	Recognises that project related land acquisition and restrictions could have adverse effect on communities or persons that use the land and outlines a policy to avoid or minimise involuntary	*No land acquisition or involuntary resettlement shall be required as all Project land is owned by owned by*

TITLE	SUMMARY	RELEVANCE
	physical resettlement as a consequence of development. Where unavoidable, involuntary resettlement should be minimized and appropriate measures to mitigate adverse impacts on displaced persons and host communities through appropriate compensation for any economic displacement such as loss of subsistence or commercial livelihood.	*ZESCO.*
IFC PS 6: Biodiversity Conservation and Sustainable Management of Living Natural Resources	Sets out an approach to protect and conserve biodiversity, including habitats, species and communities, ecosystem diversity, and genes and genomes, all of which have potential social, economic, cultural and scientific importance.	*Areas of woodland will be required to be cleared.*
IFC PS 7: Indigenous Peoples	Recognises that Indigenous Peoples can be marginalised and vulnerable (e.g. if their lands and resources are encroached upon by or significantly degraded by a Project). Their languages, cultures, religions, spiritual beliefs, and institutions may also be under threat.	*Not applicable.*
IFC PS 8: Cultural Heritage	Aims to protect irreplaceable cultural heritage and to provide guidance for protecting cultural heritage throughout a Project's life cycle.	*Disturbance of lands during construction may impact on currently unidentified cultural heritage items.*
IFC EHS General Guidelines	Sets out set specific minimum standards in regard to common issues relating to environmental protection, occupational health and safety, and community health and safety throughout the project life cycle impacts	*Provides parameters that the project must operate within.*

2.2.3 Environmental, Health, and Safety Guidelines

The World Bank EHS Guidelines were designed to define the international industry good practices and set specific minimum design and operating standards with regard to the environment, occupational health and safety, community health and safety throughout the project life cycle impacts.

The detail in these standards is generally derived from globally recognised sources (such as the WHO) and are basically intended for application where host the government's legislation is either not available or is potentially deficient in regards to good international practice.

The General EHS Guidelines are designed to apply to all projects and all sectors, but the detailed requirements can be superseded by sector guidelines, where factors such as facility size, technology and associated impacts merit specific attention.

3 DETAILED PROJECT DESCRIPTION

3.1 Introduction

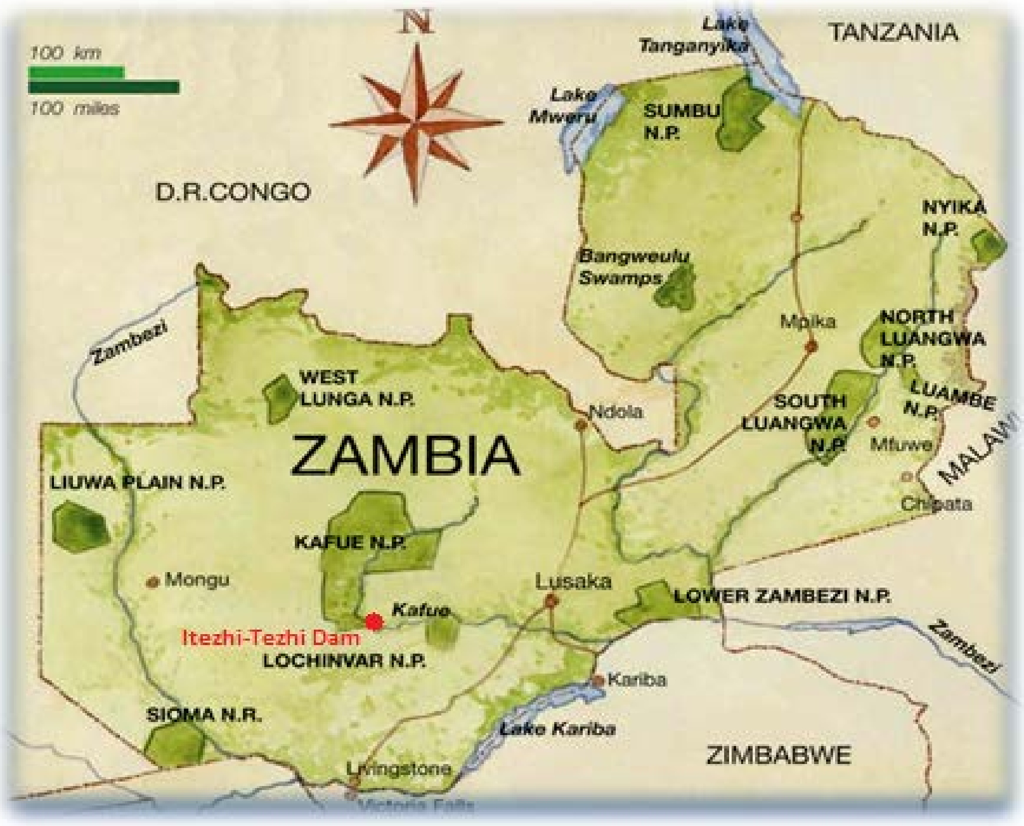
This chapter provides a detailed description of the Project; its components and proposed construction and operational scope of works. The chapter is structured in the following manner:

- Project Location;
- Existing Infrastructure:
  - Itezhi-Tezhi dam;
  - Southern diversion tunnel;
- Project Components:
  - Southern diversion tunnel upgrade;
  - Power house and switchyard;
  - Ancillary facilities – on-site:
    - Construction workshop;
    - Crusher plant;
    - Explosives magazine;
    - Concrete batching plant;
    - Access roads;
  - Ancillary facilities - off-site:
    - Accommodation camp;
    - Potable water intake and treatment plant;
    - Sewage treatment plant;
  - Construction Works;
  - Operational Works;
  - The Need for the Project;
  - Project Alternatives; and
  - Current Status of the Project.

3.2 Project Location

The Project is located in the Itezhi-Tezhi District of the Central Province, Zambia (**Figure 3-1**)

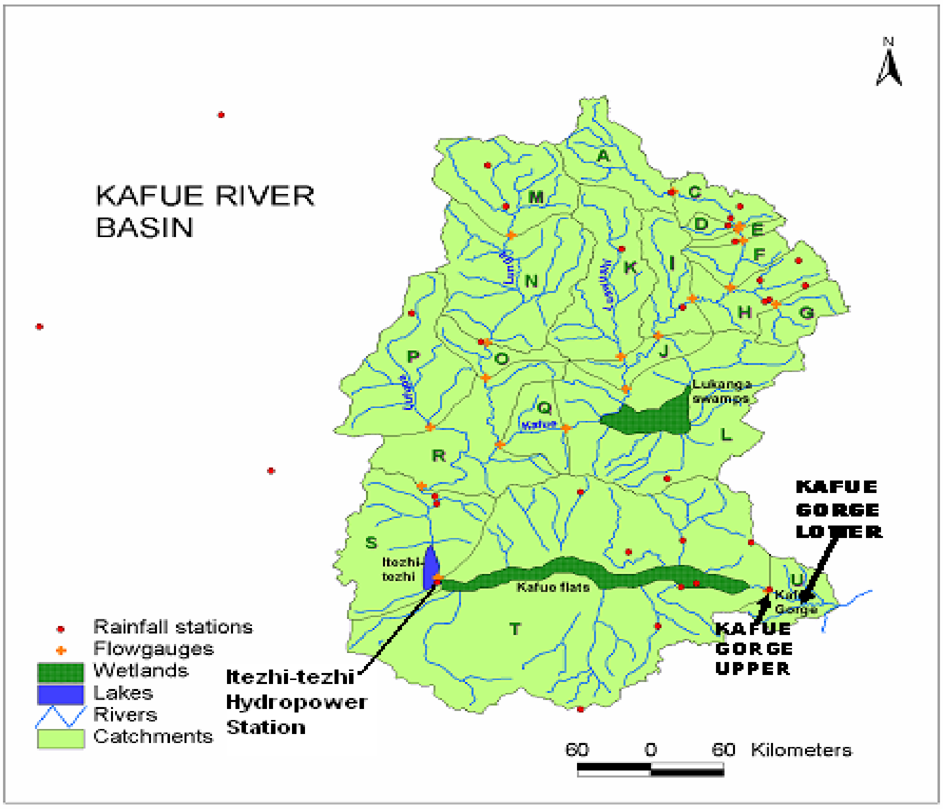
Figure 3-1: Location of Itezhi-Tezhi Hydropower Project[6]



The hydropower house will be constructed at the Itezhi-Tezhi Dam (0395081E; 8256233N) which is located on the Kafue River, 295 km upstream of the confluence of the Kafue River and the Zambezi River and approximately 230 km upstream from the existing Upper Kafue Gorge Hydro Project. **Figure 3-2** shows the location of the proposed Project and its position in the Kafue Basin. Stretching south from latitude 11ºS to 16ºS and east from longitude 26º to 29ºE, the Kafue River basin is located in the middle part of Zambia, bordering upon DRC to the north. After flowing through Kafue Gorge, the lower reach merges with the Zambezi River at Chundu. The total basin area is 153,000 km^2, accounting for 20% of Zambia's land area. The Kafue River has a length of 1550 km and a total head drop of 1000m; the river reach within the Kafue Gorge has a length of 90km and a head drop of 600m. Immediately downstream of the dam the Kafue River meanders through the Kafue Flats, a 5,000 km^2 area of high diversity wetlands. These wetlands form the basis of livelihood for many small permanent and seasonal settlements within the river flood plain.

[6] Image provided by ITPC

Figure 3-2: Kafue River Basin and the Itezhi-Tezhi Dam[7]



Located approximately 250km west of Lusaka, the closest urban area is the town of Itezhi-Tezhi (15°44'18.60"S, 26°00'55.03"E). The town, approximately 2.5km to the north of the hydropower house, is connected to the main project site by the D769 road. **Figure 3-3** demonstrates the location of the hydropower house and other key associated Project facilities in relation to Itezhi-Tezhi town and other local surrounding settlements. In particular, the Kafue River is an important resource to farms, tourist accommodation and private dwellings that are located within 2km of the power house site (**Table 3.1**).

[7] ZESCO, 2006. Environmental Impact Assessment for the Itezhi-Tezhi Hydropower Station

Figure 3-3: Project Site Locations

(Aerial image © 2012 Google; Image © 2012 Cnes/Spot Image;Data SIO, NOAA, U.S. Navy, N.G.A, GBECO)

Table 3-1: Settlements in Proximity to the Power House Site

Settlement	GPS Co-ords (UTM)	Distance from Power House Site	Direction from Power House Site
Melissa Farm	396494E 8257999S	Approximately 1.8 km	Northeast
Choonga Farm	396084E 8257680S	Approximately 1.6 km	Northeast
Khuta Farm	397255E 8256263S	Approximately 2.0 km	East
New Kalala Lodge	393851E 8255724S	Approximately 1.2 km	Southwest
Chibala Camp	393642E 8255444S	Approximately 1.9 km	Southwest
Private Dwellings	393474E 8255379S	Approximately 2.0 km	Southwest

Settlement	GPS Co-ords (UTM)	Distance from Power House Site	Direction from Power House Site
Musungwa Lodge	393466E 8254836S	Approximately 2.2 km	Southwest
Musungwa Compound	394240E 8254852S	Approximately 1.7 km	Southwest

3.3 Project Sites and Land Ownership

The main power house site (which includes the switching yard and associated on-site facilities) will be built within land leased to Itezhi-Tezhi Corporation for a period of 99 years by ZESCO Limited. The Deed of Title extract issued by the Ministry of Lands of the Republic of Zambia in October 2011 shows the demarcated land, Lot No. 24730/M covering 499.67 ha.

Other project ancillary facilities outside of the main powerhouse, such as the construction of permanent camp, sewage and water treatment plants, Rehabilitation of existing infrastructure, will be carried out within other ZESCO owned land parcels within Itezhi-Tezhi township (**Figure 3-3**).

3.3.1 Power House Site

The power house is located downstream of Itezhi-Tezhi dam on the southern bank of Kafue River (**Figure 3-3**). The northern perimeter of the site is approximately 5m from the southern bank of the river. A granite hill borders the southern perimeter of the site. The site slopes on a gentle gradient from the toe of the hill to the Kafue River. Soils at the site are characterised as thin and rocky, and vegetation is comprised of shrubs and scattered trees forming an open canopy.

Headrace, surge shaft and penstock are arranged at the right bank ridge which rises in belts and covered mostly by the quaternary loose debris with bedrock outcrop, at approximately 1070m AMSL[8]. The power house will be constructed at the toe of the right bank ridge. The tailrace and switchyard are located at the flood plain area. With a ground elevation of 980m to 1110m, the project area is higher to the south and lower to the north. The topography along the penstock is gentle, with a natural slope of 10º, although its upstream end becomes steep in proximity to the dam wall, with a natural slope of 27º.

The D769 Road passes east to west through the site and connects the site to Itezhi-Tezhi Town (**Figure 3-3**).

3.3.2 Off-Site Facilities

Accommodation camp

The accommodation camp will be located in the western section of Itezhi-Tezhi town, approximately 2.5 km north of the power house site (**Figure 3-3**). The camp will be constructed on the top of a hill, approximately 1080 m AMSL. The area of the site will be approximately 450 m x 370 m. Soils at the site are characterised as thin and rocky, and vegetation is comprised of shrubs and scattered trees forming an open canopy. The site is connected to the town via an existing local road. Additionally, the local Musa and Shimbizi Guest Houses, and the Kafue Flats and ZESCO mess hall will be refurbished as part of the Project.

[8] AMSL – Above Mean Sea Level (m)

Potable water intake and treatment plant

The potable water intake will be located within the Itezhi-Tezhi reservoir, approximately 1.4 km west of the accommodation camp (**Figure 3-3**). The water treatment plant will be located approximately 200 m west of the accommodation camp. The plant will be constructed on the on the western side of a hill that slopes down to a local road which borders the western perimeter of the site. The area of the site will be approximately 100 m x 100 m. Vegetation at the site is comprised of shrubs and scattered trees forming an open canopy.

Sewage treatment plant

The sewage treatment plant site is located directly adjacent to the emergency spillway of the dam, approximately 2.0 km north of the powerhouse site and 700 m east of the accommodation camp (**Figure 3-3**). The area of the sewage treatment plant is approximately 100 m x 60 m. The topography of the site is flat and grasses are the dominant vegetation type. Access to the site is provided by the D769 Road.

3.4 Existing Infrastructure

3.4.1 Itezhi-Tezhi Dam and Reservoir

The Itezhi-Tezhi Dam and Reservoir was completed in 1978. The dam was built in order to help regulate the flow of the Kafue River through controlled discharge as part of the Upper Kafue Gorge Hydro Project, 230km downstream.

The dam is a conventional rock and earth fill dam with a central impervious core and shell zones designed for seepage control. Rock for the dam was extracted from a quarry to the northwest of the dam (**Figure 3-4**). The main dam has a maximum height of about 65 m and a crest length of 1400 m approximately. The dam crest is at an elevation of 1035 m ASML. There are berms located at the upstream and downstream toes of the structure where the dam foundation consists of mudstone. The berms were originally constructed as cofferdams and were incorporated as part of the main dam fill during construction.

Figure 3-4: Itezhi-Tezhi Dam Main Features

(Aerial image © 2012 Google; Image © 2012 Cnes/Spot Image;Data SIO, NOAA, U.S. Navy, N.G.A, GBECO)

The Itezhi-Tezhi reservoir has a total storage capacity of approximately 5,640 Mm^3. At full capacity, the level of the reservoir is at an elevation of 1030.5 m AMSL. The majority of this storage is available for regulating the flows of the Kafue River. The deepest point of the reservoir is approximately 65 m below the dam crest. The resultant reservoir has a maximum surface area of 364 km^2, and an average depth of 15m.

The main spillway consists of controlled gates and a chute spillway with a flip bucket dissipation structure. The spillway is located between the southern abutment of the main dam and a small saddle dam which forms the emergency spillway. The spillway discharge is directed to the river valley approximately 800 m downstream from the toe of the main dam. The discharge is controlled by three radial-type spillway gates that measure 15 m wide with a sill elevation at 1018.7 m AMSL (**Figure 3-5**) The spillway is capable of discharging at 2,920 m^3/s, when the reservoir is at the full supply level (1029.5 m AMSL) and 4,450 m^3/s at the point of incipient failure of the fuse plug which is at an elevation of 1033 m AMSL.

Figure 3-5: Discharge from the Itezhi-Tezhi Dam Main Spillway Gates

The emergency spillway is a fuse plug embankment, located in an open cut channel through a small topographic saddle, approximately 1,000 m north of the main spillway (**Figure 3-4**). The fuse plug is designed to be operational when the reservoir level is at an elevation of 1033 m AMSL. Upon complete failure the plug would have capacity of 750 m^3/s and discharge is designed to flow along a short excavated channel and then cascade down the river valley slope to re-enter the main river channel. The combined discharge capacity of the main and emergency spillway is 5,200 m^3/s at a reservoir level of 1033 m AMSL.

3.4.2 Northern and Southern Diversion Tunnels

During the construction of the Itezhi-Tezhi Dam, the course of the Kafue River was diverted through two tunnels (i.e. the northern and southern diversion tunnels) until the wall was ready to retain reservoir waters. The overall diversion works comprised an inlet channel, an intake structure, the two parallel tunnels (separated by 41m), and a discharge channel downstream (**Figure 3-4**). The invert of the tunnels is located at 57 m below the dam crest at 978 m AMSL and is the deepest part of the reservoir close to the dam wall. Each tunnel is horseshoe in shape, and has a cross sectional area of approximately 190 m^2, a width of 12.5 m and a height of 15 m. The northern tunnel is 480 m long, and the southern tunnel is 550 m long. Each tunnel had a discharge capacity of 350 m^3/s and discharge occured through a trapezoidal shaped channel downstream from the toe of the dam (**Figure 3-6**).

Figure 3-6 Northern and Southern (Right to Left) Diversion Tunnel Outlets

To control the flow of water through the tunnels during and following construction, the intake structure included two hollow concrete towers (of equivalent height to the dam crest), each housing two sets of bulkhead roller gates. Following completion of construction these gates can be used to isolate the upstream sections of the two diversion tunnels for de-watering, inspection and maintenance. . A set of pre cast concrete wheeled stop logs is also provided that can be introduced into a slot upstream of the bulk head gates to provide a secure arrangement for de-watering each tunnel in turn. Both sets of gates and the stop logs are operated by a gantry crane on the surface of the reservoir (**Figure 3-7**)

Figure 3-7: Diversion Tunnel Intake Towers

Following completion of the dam, the southern diversion tunnel was blocked with a concrete plug (290 m downstream from the intake). The southern tunnel has remained under reservoir pressure upstream from the concrete plug. The downstream section of the southern tunnel has been flooded since the end of the diversion period with the water level determined by the tailwater level in the river channel downstream.

In contrast, the northern diversion tunnel was converted for use as a permanent low level outlet for the dam. The northern tunnel becomes operational when the water level in the reservoir is expected to fall below the sill of the main spillway, which is at an elevation of 1018.7 m AMSL. The radial gate in the northern tunnel is exposed to the full reservoir water pressure.

At present the south diversion tunnel outlet downstream of the plugged part is in a long term state of semi submergence. The north diversion tunnel releases ecological flow[9] towards downstream in the dry season, and is in a semi submerged condition downstream of the radial gate.

Table 3-2 summarises the key engineering characteristics of the existing dam and reservoir infrastructure.

Table 3-2: Engineering Characteristics of the Itezhi-Tezhi Dam and Reservoir

Item		Unit	Quantities
Existing Dam	Elevation of Dam Crest	m	1035.00
	Reservoir Storage	MCM	5,640
Existing South Diversion Tunnel	Section Type	m	D-Shape
	Dimension	m	13.1X15.521
Reservoir Water Level	Max Water Level	m	1033.00
	Full Supply Level (FSL)	m	1030.50
	Min Water Level	m	1006.00
Tailrace Water Level	Highest Flood	m	996.00
	Min T W Level	m	982.00

3.4.3 Dam Operation

The construction of the Itezhi-Tezhi Dam was undertaken to primarily to allow for the provision and regulation of adequate flow to maintain the operation of the Upper Kafue Gorge Hydro Project. In particular, the operation of the dam was designed to stabilise river flows below 250m^3/s to prevent overbank flooding at the hydro power plant (Beilfuss and Dos Santos, 2001). It has been estimated that, by providing a constant and manageable water supply to the Upper Kafue Gorge Hydro Project, the dam is able to provide US $18 million worth of electricity that would have otherwise have been imported (Deines *et al*., 2012).

As part of the approval granting ZESCO the right to operate the Itezhi-Tezhi Dam, a series of conditions relating to the operational flows of the dam were issued by the Zambian Government, including:

- ZESCO shall store and release from the Itezhi-Tezhi Dam a minimum of 300 m^3/s over a period of four weeks in each year (typically March) to preserve the ecological balance of the Kafue Flats.
- ZESCO shall store and release sufficient water to ensure that a minimum of 15 m^3/s is available for other users between Itezhi-Tezhi Dam and Kafue Gorge Dam at all times.

[9] A flow sufficient to maintain downstream ecological conditions

- ZESCO shall ensure that a minimum flow of 25 m^3/s is maintained in the river between the Itezhi-Tezhi dam and Kafue Gorge Dam at all times.

In addition to this, discharge from the dam takes into consideration the hydrological conditions in the year in question as well as the anticipated free surface evaporation (net evaporation from the reservoir is approximately 780 mm per year (Beilfuss and Dos Santos, 2001).

Long-term stream flow monitoring was implemented in association with dam construction. A number of stream gauging stations are or have been operative in the Kafue Basin (**Table 3-3**). Data from the Hook Bridge station (immediately upstream of the reservoir) indicates the mean annual inflow from the Kafue River into the reservoir is approximately 8,000 Mm^3. This indicates that the 5,640 Mm^3 reservoir volume is effectively flushed 1.4 times a year. This inflow, equates to an average flow rate of approximately 250m^3/s. However, it is noted that this rate can vary significantly between the seasons (30 – 1400m^3/s (Beilfuss and Dos Santos, 2001). Prior to the establishment of the dam, this flow volume would have passed directly onto the Kafue Flats.

Table 3-3: Flow Monitoring Stations

STATION	DRAINAGE AREA KM^2	PERIOD OF RECORD
4-670 Kafue R. at Mankoya	94,924	February 1952 - June 1973
4-669 Kafue R. at Hook Bridge	95,053	October 1973 - August 1976
4-710 Kafue R. at Itezhi-Tezhi	105,620	May 1955 - April 1977
Itezhi-Tezhi Res. Outflow		October 1978- January 1994
4-997 Kafue River at Kasaka	150,971	October 1905-December1993

Following construction of the dam and reservoir, operation of the dam has altered the nature of flows passing down to Kafue Flats. The dam has maintained an average discharge rate of 276 m^3/s. This is seen to be comparable to the pre-dam conditions (average discharge 250 m^3/s). However, the need to maintain adequate reservoir levels, while meeting the required operational flow conditions, has altered the monthly distribution patterns of these flows. **Table 3-4** details the average monthly discharges following implementation of the dam in contrast to the observed monthly inflows. (taken from Kunz, 2011) depicts the seasonal impact of this altered discharge patterns, increasing discharge in dry months, while decreasing volumes in wet months.

Table 3-4: Mean Monthly Inflows and Outflows from Itezhi-Tezhi Dam (2001 – 2011)

Mean Flow Rates	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Inflow (m^3/s)	353	682	741	690	387	183	116	87	60	37	36	101
Outflow (m^3/s)	228	454	649	464	303	172	149	149	163	187	197	198

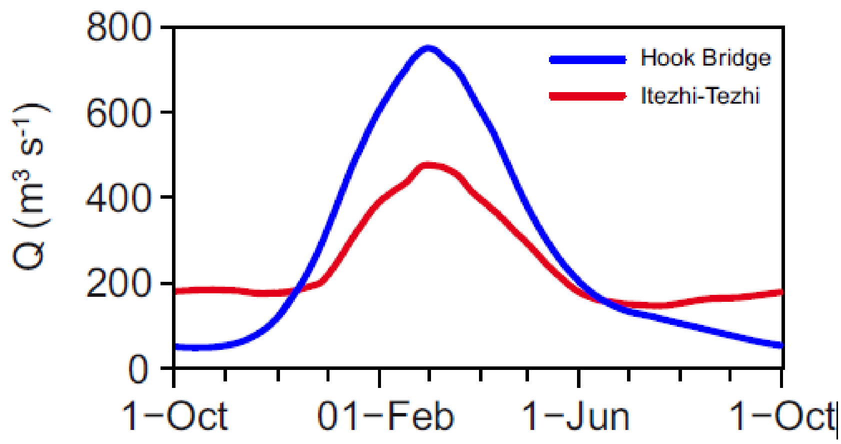
Kunz (2011) undertook a detailed assessment of impacts associated with the creation of the Itezhi-Tezhi reservoir and indicated that in comparison to pre-dam conditions:

- Peak discharge in March has decreased by approximately 30%;
- The minimum discharge rate has increased threefold;

- Flood extents downstream in the wet season have decreased;
- Flood extent in the dry season has increased from 300 to 1500 km^2; and
- Backwater effects associated with the Upper Kafue Gorge Hydro Project downstream have increased the area of permanently inundated land.

As can be seen from **Figure 3-8**, the dam maintains a discharge rate of slightly less than 200 m^3/s for the majority of the year. This is able to be achieved through operation of either the main spillway gates (maximum discharge rate of 2,920 m^3/s at FSL) or through the northern diversion tunnel (maximum discharge rate of 350 m^3/s). When dam water levels drop below the level of the main spillway (1018.7 m AMSL; approximately 8m from normal operating conditions) the northern diversion tunnel is used to generate these flow conditions.

Figure 3-8: Comparison of Inflows from Hook Bridge to Outflows from Itezhi-Tezhi Dam



The annual release of an "ecological freshet" in accordance with the stipulated operating conditions requires the release of 300m^3/s for a four week period (typically March). This annual release has occurred consistently over the past decade. However, it is understood that this release has not been made in all years following construction of the dam.

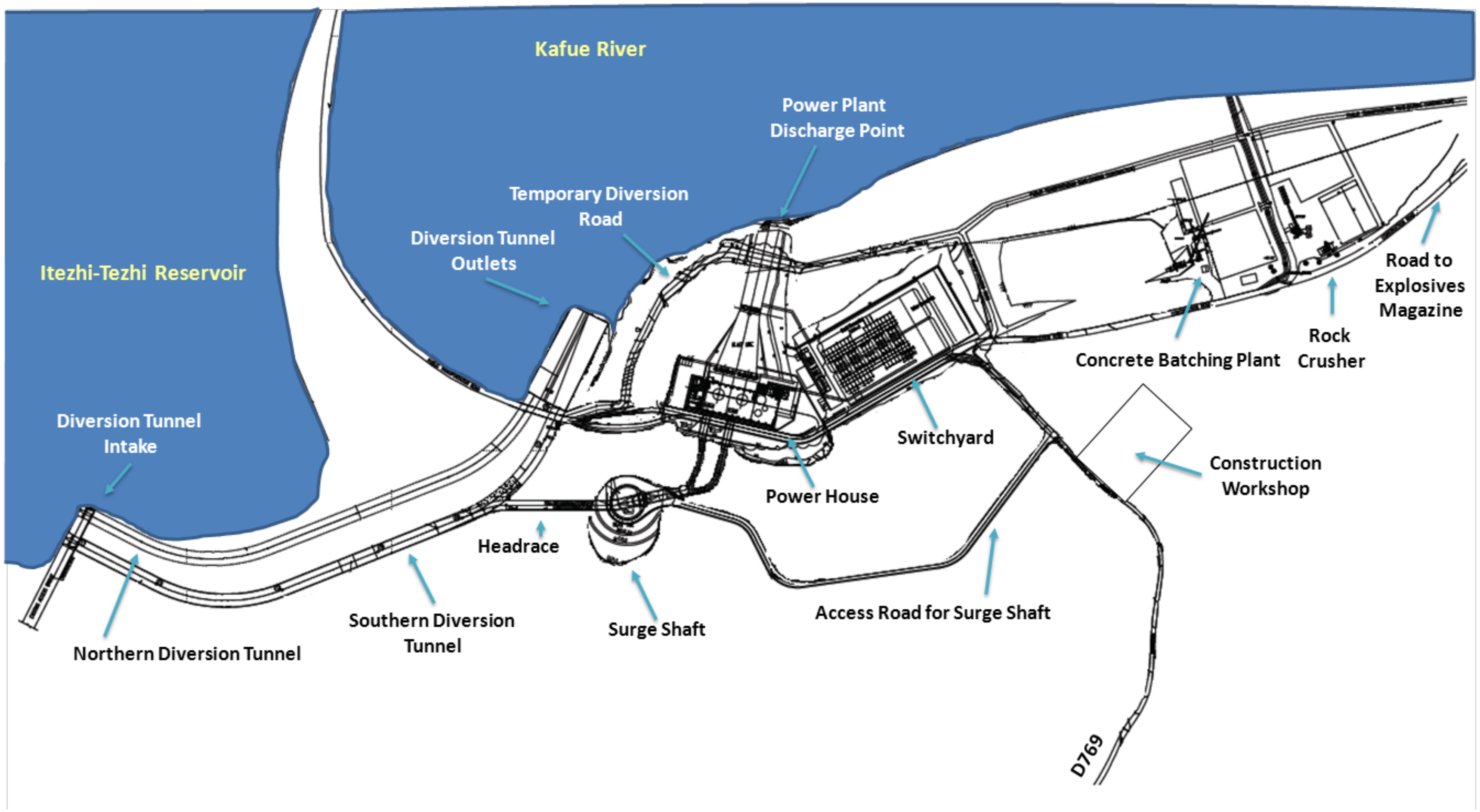
It is noted that this ESIA does not address the environmental and social impacts with the construction and operation of the dam. Rather, the ESIA assesses the potential impacts associated with the construction and operation of the proposed Hydropower Project with respect to the current environmental and social baseline conditions (i.e. assuming normal operation of the dam). Impacts and concerns associated with the development of the dam and reservoir (e.g. impacts on downstream ecosystems through altered flow regimes) will only be discussed in as far as the proposed Project is likely to positively or negatively influence these existing impacts.

3.5 Project Components

3.5.1 Power house and Switchyard

The power house will be located approximately 300 m east of the Dam wall (110 m east of the southern diversion tunnel). In order to accommodate the power house and connect with the southern diversion tunnel, the power house will be cut into the north-eastern face of the hill adjacent to the dam on the southern side of the Kafue River (**Figure 3-3**). The hill is predominantly granite. Water drawn from the reservoir through the southern diversion tunnel will be passed through the turbines within the power house, generating electricity, before being discharged into the Kafue River downstream of the dam (**Figure 3-9**).

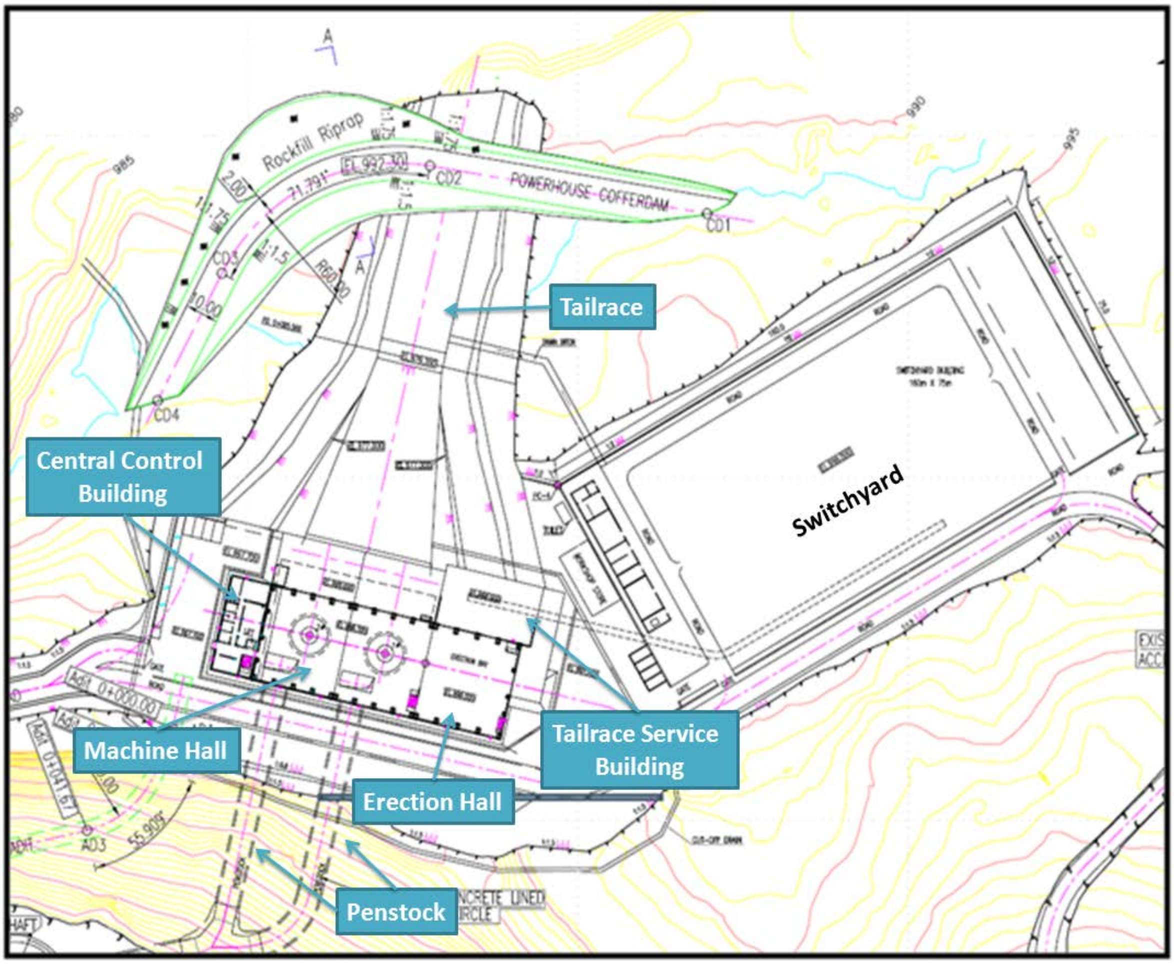
Figure 3-9 Layout of the Proposed Power House Site



The main components of the power house (**Figure 3-10**) will consist of:

- Machine hall;
- Tailrace service building;
- Erection bay;
- Central control building;
- Tailrace; and
- Switchyard.

Figure 3-10: Proposed Layout of the Power House Components



The central control building, machine hall and erection bay will be arranged adjacent to each other from left to right. Structural joints will be provided between each structure. The machine hall will house the two turbines of the power house, which will be placed within individual unit bays. On either side of the machine hall, will be the central control building (from where the plant will be operated) and the erection bay (used for assembly and maintenance of the turbines and generators).

The tailrace service building will be erected on the downstream side of the machine hall (Figure 3-10). The service building will be a five storey building with each floor elevation at 972.9m ASML, 977.7m ASML, 982.0m ASML, 988.3m ASML and 993.0m ASML respectively.

Table 3-5 summarises the key dimensions of these Project buildings. The maximum elevation of all buildings is anticipated to be 1020.23m ASML (i.e. 53m high from the draft tube floor level (967m AMSL)).

Table 3-5: Dimensions of Powerhouse Buildings

Item	Description	Length, (m)	Width, (m)
1	Machine Hall	50.5	29.25
2	Erection bay	21.0	28.75
3	Service Building	7.7	8.95
4	Central Control Building	12.5	28.75

The machine hall will be designed to house two double regulated Kaplan turbines in unit bays. The bays will be 25.0m and 25.5m long respectively, over the 50.5m machine hall. Turbine installation elevation is 977.0m AMSL. The tailrace platform has an elevation of 998.0m, which is 2.0m above maximum tail water level.

The three connected structures of the central control room, machine room and erection bay shall be divided into several floors, including:

- Generator floor (988.3m AMSL);
- Turbine floor (982.0m AMSL);
- Butterfly valve (i.e. main inlet) floor (971.5m AMSL); and
- Draft tube floor (967m AMSL).

Three cranes with a capacity of 250t/50t/10t respectively, covering a span of 25.75m, will be erected in the machine hall to be used for the installation and maintenance of the turbines. The crane will be set upon a steel super structure. Each turbine unit will placed within a metal spiral casing with an inlet diameter of 6.185m.

The turbines will be isolated by inlet butterfly valves with a diameter of 6.185m. The valves will be placed within a butterfly room, immediately adjacent to the turbines with a net width of 8.0m. A dewatering sump will be also provided within the bed rock below butterfly valve floor.

Once water has passed through the turbines it will flow along the draft tubes, composed of a conical section, elbow section and diffused section before entering the tailrace.

3.5.2 Hydro-Mechanical Equipment and Subsystems

Two turbines will be located within the machinery hall of the power house. Both turbines will be conventional vertical–shaft Kaplan units, each rated at 56.3 MW with a maximum capability of 60 MW. They will have a rated speed of 176 rpm and a rated discharge of 156 m^3/s at a net head of 40 m. The centre of the turbine distributor will be at elevation of 976 m AMSL. Discharge of water through the turbines will be through draft tubes which will aid in slowing discharge velocities.

Each turbine will be provided with a digital microprocessor-controlled electric-hydraulic governing system with speed and acceleration sensing, speed regulation, stabilizing, and diagnostic functions. The governing system also will have provisions for remote starting and automatic load control. Each turbine will be protected by a butterfly shutoff valve located in the valve chamber. The valve allow for isolating of the turbines and draft tubes individually as required for maintenance.

A main power house crane will allow for installation and removal of the generating equipment during erection, and for future maintenance of auxiliary equipment in the machine hall. A third crane will be located in the valve chamber for installation and maintenance of the inlet valves.

In addition, other general mechanical equipment will include:

- Turbine flow meters and taps;
- Water level monitoring and sensing systems;
- A cooling and service water system that will be supplied from the draft tubes;
- A treated water system that will include a self-contained water treatment plant;
- A governor and turbine inlet valve compressed air system to provide pressure for the oil pressure tanks;
- A sanitary drainage and sewage treatment system;
- A station service compressed air supply system;
- A unit dewatering and filling system to dewater the area between the draft tube gate and the inlet valve;
- A station drainage system to eliminate water from wash-down areas;
- An oil purification and recovery system;
- A fire protection unit system;
- A forced, re-circulating air conditioning and ventilation system; and
- Emergency generating equipment to supply emergency power to essential station services in the event of station power loss.

3.5.3 Water-Flow Infrastructure

To channel water through the power house turbines, the currently blocked southern diversion tunnel will be re-opened, connected to the power house, and waters discharged approximately 100m downstream of the existing, non-functional, southern diversion tunnel (SDT) discharge location (**Figure 3-9**). This scope of works will include:

- Upgrading of the existing SDT and intake;
- Construction of a new headrace tunnel (approximately 330m long) connecting the SDT to the power house;
- Construction of a surge shaft and penstock; and
- Construction of a tailrace for discharge of waters.

SDT and Intake Upgrading

Currently, the existing southern and northern diversion tunnels utilise tower intakes with an invert level of 978.2m. Each water intake is divided into two openings by an intermediate perpendicular partition wall. Each opening stoplog grooves, bulkhead gate grooves and corresponding hoist equipment. The stoplog opening is 5.5m in width and 21m in height.

To meet the operational requirement of the power station, the stoplog grooves at water intake of the south diversion tunnel will be rebuilt into a trash rack slots. The trash racks will prevent debris and wildlife from entering the diversion tunnel. The trash rack orifice will be 5.521x 21m (width x height). The trash rack will be operated using the existing overhead hoister.

The existing SDT is located under the right abutment of the dam. The axial line of the tunnel consists of three straight lines and two circular arcs with radius of 15.0 m. It is in the form of a

D section with excavation of size 13.1 m x 15.5 m (width x height) and a sectional area of approximately 190 m^2. It is proposed that concrete grouting be used to transform the south diversion tunnel into a headrace tunnel with a diameter of 9.0 m up until the point of diversion towards the proposed headrace tunnel (i.e. 375 m downstream from the SDT intake).

Backfill grouting shall be applied for the area between tunnel crown and surrounding rock. Consolidation grouting shall be applied in accordance with geological conditions revealed after excavation and hydro geological conditions at site. The following principles shall be used for designing backfill and consolidation grouting;

Both the existing concrete plug (290 m downstream from the intake), and temporary concrete plugs used to facilitate construction, shall be dismantled using non-blasting techniques, following completion of construction works.

Headrace Construction

Water flow will enter the new designated headrace tunnel from the existing south diversion tunnel approximately 410 m downstream of the intake. Before changing direction, the headrace will be gradually transformed from D type section in size 12.5 mx14.9 m (width x height) into round section with an internal diameter of 9.0 m. The transition section will occur over a length of 36m.

Following competition of the transition, the tunnel will continue with a 9.0 m diameter for 150 m until it reaches the surge shaft. Downstream of the surge shaft the 9.0 m diameter tunnel will continue for 61 m before bifurcating for the powerhouse penstock. These resulting two penstock tunnels (approximately 77 and 92 m long respectively) will be 6.185 m diameter circular tunnels which will connect up to the butterfly valves of the power house. The majority of the tunnels will be reinforced concrete, although the immediate approach to the valves will be steel and concrete lined.

Surge Shaft

A surge shaft is proposed to be incorporated as part of headrace construction in order to attenuate pressure transients within the tunnel resulting from fluctuations in load demands or machine faults.

A surge shaft, with riser, is will be installed 186 m along the headrace from the diversion point with the SDT (**Figure 3-9**). The shaft will be perpendicularly arranged over the headrace tunnel with and will rise vertically. It will be a simple cylinder type surge shaft comprising upper and lower sections. The lower section will be a linkage pipe between the headrace and the upper section, with a circular radius of 5m at its junction with the headrace (at elevation of 982.908 m AMSL). It will extend vertically for approximately 22 m before expanding out into the wide upper section (at 1004.00 m AMSL). The upper section will be a broader shaft with a circular radius of 15.0 m and 43 m high.

An emergency gate, with an opening size of 9.0 m x9.0 m, and vent holes will be installed on the downstream side of the surge shaft. Three vent holes will be provided with each vent hole measuring 0.8 m x 1.5 m (width x length). The surge shaft will also include a platform with gate hoisting device and a control room. A safety rail with a height of 1.2 m will be provided at the top of, and along the circumference of the surge shaft.

Tailrace

Once waters have passed through the turbines, they will be conducted through the turbine draft tubes, before entering the concreted open-to-air tailrace channel (**Figure 3-10**). Two gates for each draft tube (width 3.9 5m, height 6.181 m) will be provided to permit isolation from the river for maintenance.

The tailrace will be constructed in a straight line with an estimated length of 137 m, and will discharge into the Kafue River. It will be comprised of two main sections: adverse slope and level slope sections.

Following discharge from the draft tubes, water will pass into the upward slope section of the tailrace. This section will be 60 m long with a bottom gradient of 1:4 and end elevation of 979.3 m. The tailrace bottom at adverse section will utilise a 500 mm thick concrete lining structure. It will be 40m wide at inlet and 20 m wide at outlet

Electrical Equipment and Switchyard

The power house will be designed to have two double regulated Kaplan turbines with a single unit of capacity 60MW and a total installed capacity of 120MW. The rated discharge of each unit is 156 m^3/s

Each turbine generator will be designed for an output of 67 MVA at a power factor of 0.9 and maximum 80°C winding temperature rise. The generators will operate at a speed of 176 rpm with a rated voltage of 13.8 kV. Each generator will include its own excitation system and accessories, consisting of a static exciter and voltage regulator.

The turbine generators will be connected to generator transformers via segregated phase bus ducts. The generator transformers will be housed within a generator transformer yard. Three phase transformers will step up the generator voltage from 13.8 kV to the transmission voltage, which is assumed to be 220 kV. Each unit will be connected to an individual unit transformer with a continuous rating of 70 MVA and a rated voltage of 220/13.8 kV. The transformer will be oil-filled and will be cooled by forced oil-to-water heat exchangers. An isolated phase bus with an integrally mounted main disconnecting switch will provide the connection between the generator and transformer. Low voltage switchgear will be incorporated to provide power for the station services, other electrical loads and a site distribution feeder. An emergency standby diesel generator will be provided.

A short transmission line will connect to a 220 kV outdoor switchyard. The switchyard will be located approximately 100 m east of the power house and 400 m downstream of the dam (**Figure 3-9**) The switchyard will house the 220 kV equipment including circuit breakers, isolators and instrument transformers.

The control system will include a hard-wire manual system and a distributed control system to provide control from either a local generator or remote control room.

Other electrical equipment will include:

- A DC system with rectifiers and battery to provide a secure supply of power;
- A fire detection system;
- Communication systems;
- Lightning systems; and
- Grounding.

From the switchyard the generated electrical power is proposed to be transferred, via a 350 km long 220 kV transmission line, to connect with the Zambian grid through Mumbwa to Lusaka West Substation. The impacts associated with the development of this transmission line are assessed within a separate environmental impact assessment (ZESCO, 2008).

3.5.4 Associated Facilities – On-Site

In addition to the power house and the water-flow infrastructure, a number of temporary construction associated facilities are proposed to be developed in proximity to the power house as part of the Project. These include:

- A construction workshop;
- A rock crushing site;
- An explosives magazine; and
- Concrete Batching Plant.

Construction workshop

A temporary construction workshop will be located at the power house site, approximately 400 m east of the power house (**Figure 3-9**). The workshop will be approximately 190 m x 110 m and will house workshop buildings, a mess hall, shipping containers and a laydown for construction equipment. Following the completion of the construction phase of the project, the construction workshop will be removed and the site will be rehabilitated.

Concrete Batching Plant

A temporary concrete batching plant will be installed approximately 500 m east of the powerhouse (**Figure 3-9**). The plant will be used to supply the concrete needs of the project. The concrete batching plant will include the following equipment:

- Loaders and forklifts;
- Cement sand and aggregate silos;
- Debagging machines and blowers;
- Concrete batching plant and agitator truck loading facilities;
- Storage facilities for concrete additives;
- Water tank and water pumps; and
- A site office.

Following the completion of the construction phase of the project, the concrete batching plant will be removed and the site will be rehabilitated.

Rock Crusher

A rock crusher will be located approximately 650 m east of the powerhouse site (**Figure 3-9**). The site will be approximately 100 m x 120 m and will house a rock crusher, and rock stockpiles. The site will require vegetative clearance prior to use. The crushed rock will provide rock required for cement works. Excess rock will be sold users within Itezhi-Tezhi town or depositied at an appropriate borrow pit.

Explosives Magazine

An explosives magazine (a building designed specifically for the safe storage of explosives) will be constructed approximately 1 km east of the power house. The magazine will be constructed using ventilated steel containers kept at least 60m apart. One container will be used for storing detonators, and the other will be used for storing explosives. In accordance with the Explosives Act, the containers will have an internal lining of wooden board all round.

Sand heaps will also be provided around each container. An appropriate fence will thereafter be constructed around the magazine to restrict entry only to authorized staff.

All explosives will be kept securely within this facility when not being used as part of rock blasting activities. Following the completion of the construction phase of the project, the explosives magazine will be removed and the site will be restored in accordance with the environmental action plan.

3.5.5 Access Roads

To permit safe construction of the power house and rock blasting activities, temporary closure of the D769 will be required between New Kalala Lodge and Itezhi-Tezhi town. As a result, it is proposed that a temporary bypass road will be established to maintain access. The diversion road will be approximately 450m in length and will wrap around the power house works site to the north, following the Kafue River to the east, before rejoining the D769 immediately before its junction with the road to Shantanda (**Figure 3-3**). The road will be designed to accommodate the load for normal traffic as well as heavy construction equipment. The previous route of the existing road will be re-instated following construction. Land disturbed for the installation of the temporary road will be rehabilitated.

In addition, a new 350 m road will be constructed at the powerhouse site to facilitate access to the surge shaft. The road will extend from the D769, approximately 50m south of its diversion with the road to Shantanda, to the top of the hill that ties in with the southern abutment of the dam (**Figure 3-9**). The road will be sealed, with a width of 7.5m. Given the steepness of terrain, the road will be designed with maximum gradients of 8%. The road surface will be designed to be repaired at ten-year intervals.

3.5.6 Associated Facilities – Off-Site

In addition to the facilities surrounding the power house, a number of ancillary facilities required for the completion of the Project will be established off-site, in the surrounding vicinity of the plant (**Figure 3-3**). These will include:

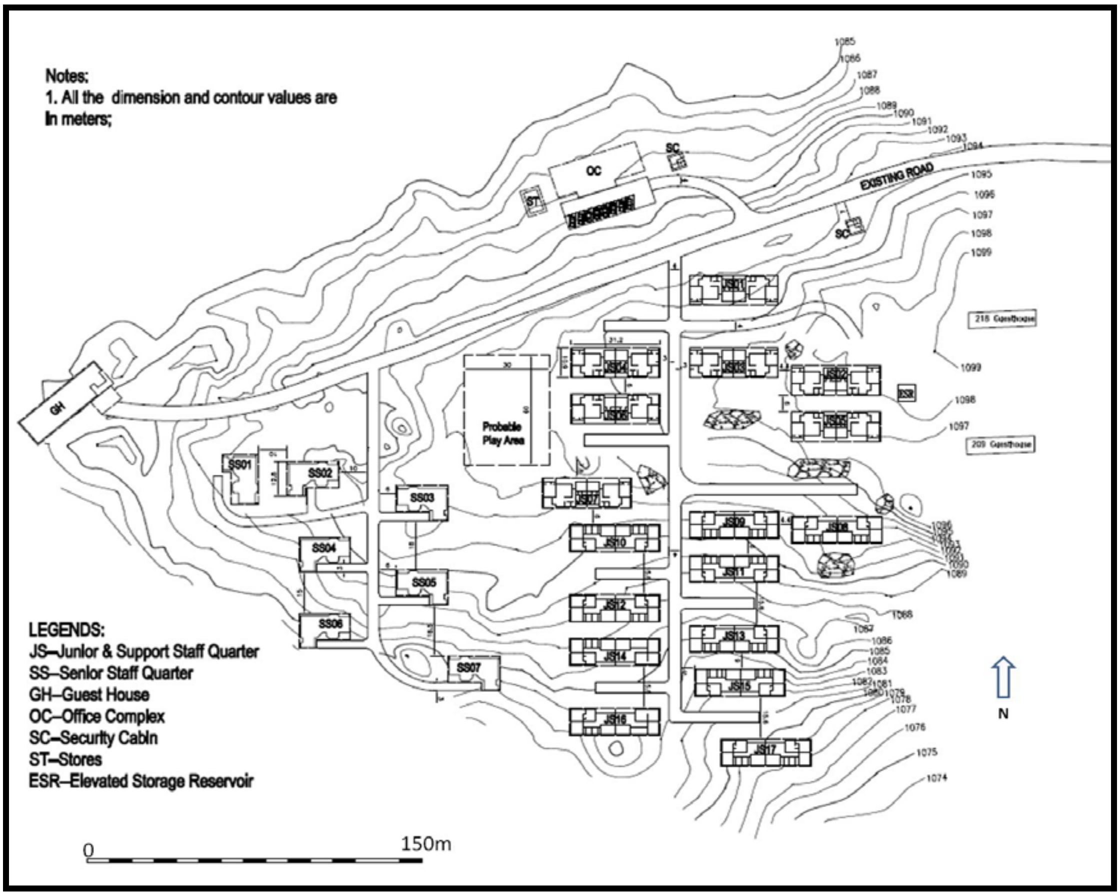
- A worker accommodation camp;
- A potable water intake and treatment plant;
- A sewage treatment plant;
- Rehabilitation of existing housing facilities; and
- Modification of 33/11kV substation.

Accommodation Camp

A permanent accommodation camp will be located within the western section of Itezhi-Tezhi town (**Figure 3-11**). The camp will have the capacity to house approximately 47 staff, comprising managerial and technical personnel, and semi-skilled labourers. Staff will be housed at the accommodation camp during construction (once housing is complete) and operations. The area of the camp will be approximately 450 m x 320 m, and will contain:

- 46 single storied buildings;
- Aix units and one main bungalow for senior staff;
- 17 semi-detached blocks (giving a total of 34 units) for junior and supporting staff;
- One equipment store;
- Three security cabins;
- A guesthouse; and
- An office complex.

Figure 3-10: Proposed Layout of Accommodation Camp



Lighting will be provided by fixed lighting which will be powered by the Itezhi-Tezhi town electricity supply. Water supply will be provided by the newly built water treatment plant and wastewater treatment will occur at the newly built sewage treatment plant. Following construction, remaining cleared areas will be landscaped.

Sealed road access to all the units and buildings inside the accommodation camp will be provided (with a minimum width of 4.0 m). Street lighting will be provided along all the roads as will a storm water drainage system to prevent the area from water logging. The drains will be connected towards a suitable disposal point.

In addition, the Musa and Shimbizhi guest houses, and the Kafue Flats and ZESCO canteen shall be redesigned by utilizing the existing floor layout to increase and optimize floor space usage. These facilities shall be rehabilitated and upgraded with new finishes and refurbishments.

Potable Water Intake and Treatment Plant

ZESCO currently owns and manages the existing Itezhi-Tezhi water treatment and distribution system. It has two intakes, a raw water distribution tank, conventional treatment plant, distribution pipelines and three ground distribution/storage tanks located within the township.

The raw water is pumped from the raw water intakes located within the Itezhi-Tezhi reservoir to the water treatment plant from where it is treated and directly pumped into the distribution system, as well as stored in terminal storage reservoirs. The existing water intake has a

capacity of 15l/s and this feeds into an existing water treatment plant with a capacity of 1.3Ml/d.

Major rehabilitations will be carried out on Intake 1 and Intake 2 of the existing infrastructure. The refurbished intakes will be used to supply raw water to both the existing and new water treatment plants.

The rehabilitated new water intake system will be housed within a floating barge, at Intake 1. The barge will be anchored approximately 200 m from the bank. Two pumps, one operational and one standby, will be mounted on the barge and then connected to the existing power supply using underwater cables to be laid between the bank and the barge location. The pumping capacity of the intake will be 122 m^3/hr. The discharge pipeline will also be laid at the reservoir bed. Water discharge will be piped to the water treatment plant via an approximately 400 m underground pipeline passing through vegetated areas.

In addition to the improved intake, a new water treatment plant will be built adjacent to the existing treatment plant, within an area of 150 m x 150 m. The treatment plant will be designed to treat 2.4 Ml/d of raw water and will have a treated water output of 2.3 Ml/d. Losses from the plant are not anticipated to exceed 4% of the raw water inflow.

The treatment plant will be designed to achieve, under all raw water conditions, the design delivery flow of 2.3 Ml/d of water to Zambian drinking water quality standards, with filter run times of 24 hours.

The water treatment plant will comprise the following units, treatment processes and services:

- Inlet chamber;
- Flash mixing;
- Flocculation;
- Rapid gravity filtration;
- Disinfection;
- Clear water reservoir and pump house;
- Backwash water reservoir; and
- Waste water disposal.

The new water intake and treatment plant will provide potable water additional to the amount required for the accommodation camp, therefore excess water will feed into the town's water supply chain and will be sold to Itezhi-Tezhi users. It is estimated that this will increase the town water supply by a third.

Sewage Treatment Plant

Itezhi-Tezhi currently has a small operational sewage treatment plant in operation, comprising of three ponds, with an inlet, overflow, by-pass and disposal arrangement. This plant will be rehabilitated as part of the Project.

In addition, a new sewage treatment plant (STP) will be installed to treat sewage arising from the new accommodation camp. The plant will be located adjacent to the Itezhi-Tezhi dam secondary spillway and existing local STP. Sewage to be accepted in the new plant includes waste from toilets, sinks and showers. Sewage from the accommodation camp will be piped to the plant via an approximately 700 m long underground pipeline. The sewage treatment plants shall have the following characteristics;

Capacity of new Sewage Treatment Plant:

- Average 300 m^3/day;
- Peak 900 m^3/day; and
- Minimum 150 m^3/day.

Capacity of existing (Rehabilitated) Sewage Treatment Plant:

- Average 150 m^3/day;
- Peak 450 m^3/day; and
- Minimum 75 m^3/day.

The STP shall include the following components:

- Inlet chamber with coarse screen;
- Screen chamber with fine bar screen;
- Inlet and outlet pipes for anaerobic and facultative ponds;
- Distribution chamber;
- Anaerobic pond;
- Facultative oxidation ponds;
- By-pass pipe line and chambers;
- Street lighting along the road between existing and proposed STP;
- Common Effluent disposal system between existing and proposed STP;
- Roads and Drainage;
- Landscaping;
- Fencing and gates (common for existing and proposed STP); and
- Connection to water supply system

Modification of 33/11kV Substation

The existing substation shall be modified by supplying, installing, testing and commissioning of indoor 11 kV switchgear, two pole mounted lightning arrestors, complete 11 kV cable and conductor terminations, two 1.5 MVA transformers, 1 MVA DG set, 48v 50ah Ni-Cd batteries, construction of a new switchgear room, and all accessories to complete the construction of a new substation.

3.6 Construction

Earthworks carried out during the construction of the headrace tunnel, surge shaft and power house will involve controlled blasting to assist with the excavation of rock material. The construction of the headrace tunnel will involve excavations to a diameter of 9 m and a length of 330 m. The construction of the surge shaft will involve excavations to a diameter of 30 m and depth of 65 m.

The construction of the power house will involve the excavation of an area 90 m long and 30 m wide, and to a depth of 50 m. Approximately 140,000 m^2 of rock will be removed, of which approximately 30% will be crushed and used for concrete aggregate during construction and 70% will be disposed of as waste rock at the de-commissioned quarry (**Figure 3-4**), or will be offered as construction aggregate to the users in the vicinity of the site.

A blasting management system that encompasses all blasting activities for the project has been prepared by ITPC. Blasting will be carried out following the Blast Management System,

in compliance with the Republic of Zambia Explosives Act (2003), Mining Regulations Act (1995), and Zambia Environmental Management Act No. 12 of 2011.

Excavation activity will initially occur between daylight hours of approximately 8am to 6pm, and will involve both rock blasting and bulk earthworks. As construction progresses earthworks will be carried out on a 24 hour basis, including blasting during daylight hours and clearance overnight. Rock material unearthed during blasting will be transported to the rock crushing area for processing, storage and ultimately transported off site.

Blasting at other project sites is not anticipated. Bulk earthworks at these sites shall be limited to vegetative clearance and site levelling.

Table 3-6 details the estimated quantities of concrete and explosives required for the construction phase for the various facilities.

Table 3-6: Project Estimated Material Usage During Construction

Material	Location Used				Total
	Power House (including head and tailrace and surge shaft)	Accommodation Camp	Sewage Treatment Plant	Water Intake and Treatment Plant	
Concrete (m^3)	128 820	1100	400	450	130 720
Explosives (kg)	375 000	1000	-	100	376 100

3.6.1 Workforce

At the peak of construction there will be approximately 500 workers on site. Of these, approximately 20 to 25 will be management and technical personnel, and 50 to 60 will be semiskilled workers, including but not limited to equipment operators, welders, carpenters, glazers, and electricians. The remaining workforce personnel will be unskilled and will be recruited from the local villages.

Managerial, technical and unskilled labour personnel will be housed in existing ZESCO-owned properties located within Itezhi-Tezhi town. Following the completion of the Project's accommodation camp, some of these personnel will be re-located to the camp. Unskilled labourers will continue to reside within their villages and will be transported to the Project site via bus.

3.7 Operation

3.7.1 Workforce

During the operations phase of the Project approximately 47 workers will be employed. The operations workforce will be housed at the Project's accommodation camp.

3.7.2 Power House

In operation the power house will be run as a base load power station. Its operation will be designed to produce energy at an approximately constant rate throughout each day. Seasonal energy generation will vary. It is anticipated that peaks or spikes in demand will be met by other peaking power plants within Zambia. However, over the immediate future, it is anticipated that the operation of the power house as a base load station will not only contribute to offsetting the existing power deficit within Zambia at peak times (ZESCO's peak demand

currently stands at about 1580MW while available generation capacity stands at about 1401MW), but also allow for export of surplus energy as other power projects come on-line (e.g. the Lower Kafue Gorge Project).

As a baseload plant, the required generation flow from the reservoir will be relatively constant and the power house will operate 24 hours a day. As the project will produce base load power, there will be no peak times of operation throughout the day, therefore the flow of water through the power house and associated discharge will remain relatively constant throughout the operating time.

The power station will be operated in accordance with the existing water management regime at the dam (Itezhi-Tezhi Dam Operating Rule), therefore adjustments in flow will occur based on hydrological conditions upstream and ITPC's obligations to make downstream water releases.

The tailrace has been designed such that discharge waters will enter the Kafue River at a maximum 312 m^3/s under full operation (**Section 3.4.3**).

3.8 Need for the Proposed Development

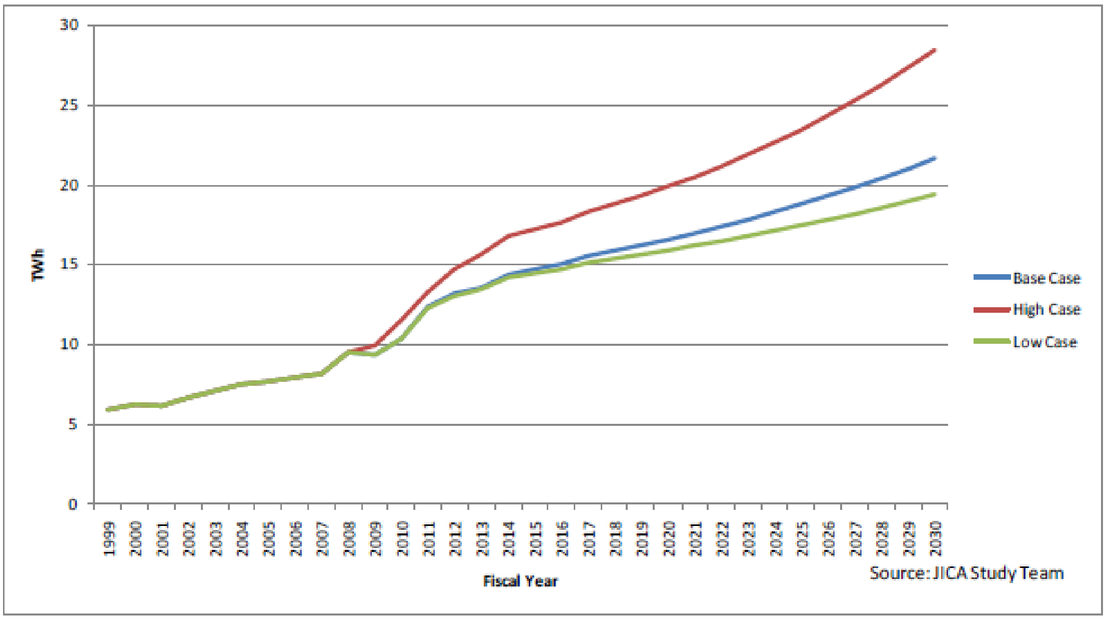
Zambia is one of Sub Saharan Africa's most urbanised countries and has experienced strong growth in recent years, with real GDP growth of more than 6% per year between 2005 and 2011. The consistent economic growth has fuelled increased demand for electricity, driven by its growing mining, industrial and commercial sector as well as agricultural growth.

The main objective of the project is the provision of additional energy to meet the growing demand of the Zambian economy. Electricity is the principal form of energy in Zambia, sourced primarily from hydropower projects with some coal-based production. The project will produce clean energy with a significantly lesser carbon foot print than a coal powered or wood powered station. By contributing to the South African Power Pool it will also reduce the production load of the coal-based power plants in Botswana and South Africa.

Several other hydroelectric projects within Zambia are currently being constructed or under consideration. Those under study include Batoka Project (1,600 MW), on the Zambezi River and the Kafue Lower Gorge Project (750MW), on the Kafue River further downstream from Itezhi-Tezhi. These are large and expensive projects which may take some time to materialise. However, as the Itezhi-Tezhi dam is already in existence, it is considered that the installation of a hydropower facility on this dam would provide a relatively low impact and long term contribution to the rapidly increasing energy demand within Zambia.

ZESCO developed a Power System Development Master Plan (JICA, 2010) to manage energy infrastructure and energy supply from 2010 to 2030. The master plan modelled anticipated energy demand within Zambia and then identified the potential preferred options by which this demand could be met taking into consideration associated costs and the potential to import energy from neighbouring countries. The identified Optimal Power Development Plan highlighted the need for the Itezhi-Tezhi Hydropower Project and recognised it as pivotal in acting as the point for supply for power to the western region into the future. **Figure 3-11** indicates the predicted rapid growth in demand for energy within Zambia over the next two decades. Growth in energy demand of at least 4% per annum can be expected over the next 20 years. An inability to meet this demand level will have negative socio-economic consequences for the growing Zambian population.

Figure 3-11: Forecasted Energy Demand Scenarios[10]



3.9 Alternatives

3.9.1 Location of power house

Given the nature of the development utilising water from the Itezhi-Tezhi dam, the Project must be developed at the dam site and utilisation of the existing southern diversion tunnel and intake structure provides an obvious advantage. A number of alternative hydropower projects are currently being considered and constructed within Zambia. The unique advantage of the Itezhi-Tezhi Hydropower Project is that the reservoir and dam infrastructure are already in place.

Potential options, regarding the precise arrangement of the project infrastructure have been evaluated in previous studies. Alternative arrangements featuring two-units, with either surface or underground powerhouses, were compared for various installed capacities. The surface powerhouse alternative has been described in **Section 3.5** of this report. The underground powerhouse alternative would be located about adjacent to the crest of the dam in a cavern formed from an enlarged section of the existing southern diversion tunnel. The arrangement would make use of the existing intake and upstream portion of the outside diversion tunnel as does the surface alternative and discharge from the powerhouse would be directed back into the diversion tunnel to be discharged at the existing outfall.

An evaluation of the costs and benefits associated with these two options was undertaken by ITPC in determining the final design. **Table 3-7** summarises the key decision making factors differentiating between the two options. The surface power house option was identified as the preferred option.

[10] JICA, 2012. The Study for Power System Development Master Plan in Zambia. Prepared for the Ministry of Energy and Water Development. Zambia.

Table 3-7: Comparison of Underground and Surface Power House Options

No	Underground Power House System	Surface Power House System
1	During cavern excavation should heavy ingress of ground water or other geological surprises be encountered, these could result in time and cost over runs	Under similar conditions engineering solutions are less expensive
2	Underground excavation works require higher expertise in deployment of equipment and personnel within a limited space to work simultaneously	Severity of these requirements is relatively less.
3	Underground excavations require adequate ventilation facility to safeguard health of workmen and minimize hazards due to dust and noise	Requirement is less stringent
4	Requirement of auxiliary power will be higher	Relatively lower
5	In the present case, surge shaft is not required	Surge shaft is required
6	Total project cost excluding transmission line works is about 173 million USD	Total project cost excluding transmission line works is about 165 million USD
7	Project execution time – 52 months after award of contract	Project execution time – 42 months after award of contract
8	Enhanced risks due to flooding and fire hazards	Risks are relatively less severe. Emergency evacuation could be done in a shorter time
9	Less vulnerable to seismic induced damage	Relatively more vulnerable
10	Less vulnerable to risks of war damage, terrorists attacks, vandalism, etc	Risks are there

3.9.2 Do nothing option

The project objective is the provision of additional electrical energy to meet the growing demand of the Zambian economy. Although electricity is the principal energy source within Zambia, a large proportion of energy demand is currently met through the domestic burning of fuel (both firewood and charcoal). As such, there is a high social demand for the provision of formal energy infrastructure. Of the energy that is supplied approximately 95 percent of electrical energy is obtained from hydroelectric plants (the majority of which comes from the Kariba North (600MW) and Kafue Upper Gorge (900MW) hydropower projects).

The gradually increasing demand for electricity could be met by alternative hydroelectric projects or by additional use of diesel and gas turbine units. The use of coal is also possible, particularly via importing energy from neighbouring countries. Environmental and economic considerations normally dictate the use of hydroelectric power where a suitable resource is available. Although the hydroelectric plants usually exert higher initial impacts, through the inundation of land and habitat and the displacement of people, coal and diesel alternatives impact air quality, contribute significantly to climate change, cause substantial environmental impact at the point of fuel production, have shorter operational lifetimes and may require substantial consumption of water for cooling. By utilizing the dam at the present height, inundation of arable land, habitat, displacement of people and considerable aquatic disturbance will be avoided in comparison to other hydropower projects.

If the project is not constructed there will be continued shortfall in meeting energy needs requiring load shedding affecting residents and industry until newer power projects are made operational. The development of alternative energy sources is also likely to be associated with significant environmental and social impacts. As the Itezhi-Tezhi dam is currently in existence environmental and social impacts are relatively minimised through the reduced required development footprint.

3.10 Current Status of the Project

Environmental approval for the Project was issued by the Zambian Environmental Management Agency (ZEMA) (formerly the Environmental Council of Zambia) on January 26, 2009. Construction works of the ancillary facilities commenced in April 2011 and are estimated to be completed in the fourth quarter of 2012. Construction works at the power house site commenced in November 2011 and are estimated to be completed in May 2015. This ESIA has subsequently been prepared to meet assessment standards in line with international lending requirements. Construction is being undertaken by the Chinese-owned Sinohydro. Works undertaken to date include:

- Construction and operation of the sewerage treatment plant;
- Construction of the accommodation camp;
- Construction of the water treatment plant and pipeline (nearing completion);
- Construction of a construction workshop;
- Construction of the explosives magazine;
- Construction of the rock crushing site; and
- Site clearance, blasting for the surge shaft, and bulk-earthworks associated with the development of the power house site.

As far as possible, this ESIA has been prepared retrospectively, assessing the baseline conditions as they were prior to the start of construction works.

4 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT METHODOLOGY

The environmental and social impact assessment methodology adopted for this report reflects both the requirements of Zambian environmental legislation as well as international best-practice.

4.1 Methodology Outline

This ESIA identifies both the environmental and social impacts associated with the construction and operation of the proposed surface power generation plant. In addition, the ESIA provides project specific mitigation measures to ameliorate, as far as practicable the identified impacts. Further, in considering the application of these mitigation measures, the ESIA assesses the residual risks posed to the existing social and environmental systems and how these can best be managed.

The process by which this was achieved can be summarised as:

- Review of Existing Environmental and Social Information;
- Key stakeholder consultation;
- Undertaking specialist studies and field survey;
- Identification and Assessment of Impacts; and
- Identification of Mitigation Measures and Residual Risks.

4.1.1 Review of Existing Environmental and Social Information

The proposed project consists of constructing a surface power generation plant to harness the hydropower potential of the Itezhi-Tezhi dam. The dam was constructed in 1978. Thereafter a proposal to construct an underground hydropower plant was approved by the Environmental Council of Zambia in 2006. However subsequently it was decided to construct a surface power plant based on a cost benefit analysis. The present study investigates the environmental and social impacts of this proposed development.

At the outset of the study, a desktop review of all available information pertaining to the proposed project and the earlier impact assessments undertaken were reviewed, including:

- Summary of the Environmental and Social Impact Assessment, April 2011, prepared by the Environmental and Social Affairs unit of ZESCO Ltd. A state owned utility company.
- ITT Hydropower Project Environmental Impact Assessment, 2006, prepared by the Environmental and Social Affairs unit of ZESCO Ltd.
- Environmental Impact Assessment Addendum for Itezhi-Tezhi Hydroelectric Project (Surface Power House), November 2008, prepared by the Environmental and Social Affairs unit of ZESCO Ltd
- ITT Power Station Environmental Management Plan, March 2009, prepared by the Environmental and Social Affairs unit of ZESCO Ltd.
- Abbreviated Resettlement Action Plan for the proposed Itezhi-Tezhi – Mumbwa – Lusaka West Transmission Line Project, November 2010, prepared by the Environmental and Social Affairs unit of ZESCO Ltd.
- Environmental Management Plan for the Itezhi-Tezhi Transmission Line Project, June 2011, prepared by the Environmental and Social Affairs unit of ZESCO Ltd.
- Integrated Kafue Basin Environmental Impact Assessment Study: Diurnal Water Level Variations of the Kafue River, October 2009, prepared by Scott Wilson.

4.1.2 Stakeholder Consultation

Some level of consultation had been undertaken as part of the EIA previously approved for the Project. In order to obtain broad community support for the project and fully understand the potential impacts and concerns associated with the project, a new range of stakeholder engagement activities were undertaken with local community residents, traditional leaders, local businesses, NGOs and governmental authorities.

These engagement activities were guided by a Stakeholder Engagement Plan (**Appendix B**) prepared for the Project.

Section 9 details the findings of the stakeholder consultation undertaken to date.

4.1.3 Specialist studies and field surveys

A number of field inspections and specialist surveys were undertaken as part of the ESIA assessment. General field inspections were undertaken on 14-18 June 2012, by URS, in order to establish the context. In addition to this field survey, site specific inspections were undertaken in June-July 2012 as part of the following specialist studies

- Ecology Impact Assessment (**Appendix C**)**;**
- Noise Impact Assessment (**Section 6.2**);
- Water and Sediment Quality Baseline Assessment (**Appendix D**);
- Cultural Heritage Impact Assessment (**Appendix E**).
- Socio-Economic Impact Assessment (**Appendix F**); and

The details of field surveys (e.g. dates and times of field surveys, methodologies) are provided within the relevant sections of this ESIA and appendices.

4.1.4 Identification and Assessment of Impacts

The assessment of social and environmental impacts, including a description of baseline conditions, identified impacts, and proposed mitigation measures, are presented in **Sections 6, 7 and 8** and of this report. All environmental and social aspects identified are considered in turn through these sections.

The identification and determination of assessment requirements for relevant environmental and social aspects was undertaken based upon the findings of the previous Environmental Impact Assessment under by ZESCO (2009), the outcomes of a Gap Analysis (URS, 2011; **Appendix A**), and a high level Risk Analysis (**Section 4.2**). The Risk Assessment categorised all the relevant environmental and social aspects identified in the previous studies as posing either 'major' or 'minor' risks to the environment and society (not considering potentially applicable mitigation measures).

Those environmental aspects considered to be potential 'major' risks to be assessed in detail as part of the ESIA included:

- Terrestrial and aquatic Ecology;
- Noise and Vibration;
- Water Quality;
- Flooding and Hydrology; and
- Socio-Economic Impacts.

The remaining environmental and social risk aspects were considered likely to be of relatively low significance and classified as ‘minor’ risks. These include:

- Air Quality;
- Climate and Climate Change;
- Cultural heritage;
- Ground water;
- Land Contamination;
- Landscape and Visual Impacts;
- Lighting;
- Project Hazards and Risks;
- Solar Access;
- Traffic and Transport;
- Trans-boundary Watershed Issues;
- Topography, Geology and Soils; and
- Waste and Waste Management.

The extent of individual impacts arising within these impacts will vary significantly over the differing Project stages (e.g. construction and operation). For each of these major and minor topics, a range of specific environmental and social impacts were identified based on the:

- plans and descriptions of the work provided to URS by ITPC;
- existing relevant impact assessments undertaken within the region;
- expected construction methodologies and site operations; and
- URS’ professional judgement.

The classification of aspects as being either major or minor risks allowed for appropriate application of assessment effort in identifying and detailing potential impacts and subsequent mitigation measures.

4.1.5 Identification of Mitigation Measures and Residual Risk

Following identification of environmental and social risk topics and their potential specific environmental and social impacts, a series of mitigation measures were developed. For each individual impact identified, one or more mitigation measures were developed, where possible, in order to ameliorate and minimise the specific impacts. The mitigation measures were developed based on URS’s experience in the industry, specialist sub-consultant advice, international best practice and applicable guidelines and requirements. Where specific guidelines were used these are detailed within the relevant impact assessment chapters and sections.

Following the identification of mitigation measures, a second evaluation of the residual significance of impacts associated with each environmental topic was undertaken (i.e. an assessment of how significant potential impacts will be taking into consideration the beneficial effects of the recommended mitigation measures).

To aid in the application of the recommended mitigation measures, a framework Environmental and Social Management Plan (**Section 11**) was developed, outlining responsibilities, actions, and monitoring requirements to ensure adverse impacts associated with the Project are minimised.

Section 12 provides a summary of these evaluations as well as drawing conclusions as to the overall significance of environmental and social impacts as a result of the proposed Hydro-power plant construction and operation.

4.2 Risk Analysis

The concept of risk refers to the uncertainty of outcome resulting from a specified action. As such, risks are an inherent part of any project. The uncertain outcomes may be either favourable (e.g. achieving project objectives) or unfavourable (e.g. unwanted secondary impacts associated with the project). Although identifying both favourable/positive outcomes and unfavourable/negative outcomes, this ESIA focuses on the potentially negative risks faced as a result of the proposed Itezhi-Tezhi Hydropower Project in construction and operation. These risks were identified as the potential impacts associated with the environmental and social aspects of the Project.

The purpose of the risk assessment was to aid in identifying the project risks and estimating the likelihood and consequence (i.e. significance) of these potential outcomes/impacts. Ultimately, understanding the Project's environmental and social risks allows for the application of effective and appropriate assessment and management. In particular, evaluation of risk significance, allows for the adoption of mitigation measures aimed at reducing the risk of adverse outcomes associated with the project. The residual risk (i.e. the remaining risk to the environment and social systems following application of mitigation measures) represents the 'unavoidable' risks that adopting the project entails. The significance of these residual risks is a key factor in determining whether the construction and operation of the Project is justifiable from an environmental and social standpoint.

The significance of a particular risk is a function of both its *likelihood* (**Section 4.2.1**) and *consequence* (**Section 4.2.2**).

4.2.1 Risk Likelihood

The likelihood of a risk is best described as the associated probability of the risk's impact occurring. Typically, these probabilities are determined through qualitative assessment of the scenario by experienced practitioners. As such assessments are qualitative in nature, rather than quantitative, there remains a further uncertainty through human biases (e.g. availability of knowledge, human error). Consequently, best practice includes adoption of conservative estimates (i.e. assessments that over-estimate the probability of impact occurrence) to account for the underlying uncertainty.

For the purpose of this ESIA, five 'Occurrence Probability Categories' were demarcated over the probability continuum to capture the likelihood of specific impacts occurring. All identified impacts were assigned to a perceived occurrence probability category by URS' experienced practitioners. The five categories developed are summarised in **Table 4-1**.

Table 4-1 Risk Likelihood Criteria

Occurrence Probability Category	Description	Indicative Probability Percentiles
Improbable	The outcome is not expect to occur	0-5%
Unlikely	The outcome is only expected to occur in a few circumstances	6-35%
Possible	The outcome may occur	36-65%

Likely	The outcome is expected to occur in most circumstances	66-95%
Probable	The outcome is expected to occur	95-100%

4.2.2 Consequence

The consequence of a risk is best described as the foreseeable magnitude of the risk's impact on relevant 'sensitive' receivers (i.e. individuals, communities and environmental systems capable of being affected by the impact). As with risk likelihood, this is best described through qualitative assessment considering the scale of impact and the nature affected environment In particular, it is noted that in order for a risk/impact to have any sort of consequence it must, by definition, occur in the presence of a sensitive receiver. The range of sensitive receivers considered for the purposes of this ESIA include:

- Natural Systems – the existing natural environment;
- Social Systems – the human and built environment; and
- Economic Systems – the financial environment.

Any one risk may impact on one or more of these receivers. It is important to note that individual receptors within each of these systems are likely to vary in regards to their sensitivity towards an impact. For example, a pristine environmental community may be considered to be more sensitive to disturbance/degradation than an environment which has already been heavily disturbed (i.e. the impact of further disturbance on a degraded environment would be considered to be of relatively less consequence than the same impact on a pristine environment).

A further complication to the idea of risk consequence is that the magnitude of consequence of an impact is also likely to vary in terms of its:

- Spatial influence – whether it affects a large or small area;
- The intensity of impact – whether it mildly hampers the functioning of the receiver or prevents its overall operation;
- Duration of impact – whether it is a short tem event or a permanent impact; and
- Timing of impact – whether the event occurs at non-sensitive periods or during critical moments.

Further elements which influence the perceived risk consequence will reflect the specific nature of the risk and affected receivers (e.g. if the risk affects social systems the number of people affected (population sphere of influence) would be a relevant consideration in determining risk magnitude).

Collectively, all these various elements can be qualitatively assessed to ascribe a 'Consequence Magnitude Categorisation' for all potential outcomes resulting from a specific action. The five categories adopted, example relevant triggers within the range of sensitive receivers are shown in **Table 4-2**.

As with Risk Likelihood, it is noted that qualitative assessments carry with them a further level of systemic uncertainty. In recognition of this, a conservative approach (i.e. over-estimating the magnitude of consequence) was adopted where possible. The final categorisation of any one particular risk was determined by the average categorisation of the impact across the relevant consequence elements.

Table 4-2 Risk Consequence Criteria with Example Scenarios

Consequence Element		Consequence Magnitude Categories				
		Minimal	**Minor**	**Moderate**	**Major**	**Catastrophic**
Magnitude	**Spatial**	A single pool	A stretch of river	A whole River	A whole catchment	A whole basin
	Intensity	Low level behavioral impacts	Acute impact on some species	Moderate impact on growth and recruitment or survival rates	Lethal impacts on some species	Lethal for individuals or communities
Temporal	**Duration**	One off event	Short term impact affecting the existing generation	Medium term	Affects extending over multiple generations	Permanent impacts
	Timing	Occurs outside breeding season	Occasional disturbance during breeding season	Interruption to one breeding season	Multiple consecutive breeding seasons lost	Permanent disruption to life cycles
Ecological	**Values**	Heavily Disturbed environment	Agricultural and park lands	Native forest	Conservation areas	Nationally threatened communities
	Sensitivity	Resilient species	Will recover over time	Some change to ecosystem functioning	Significant change to ecosystem functioning	Ecosystem functioning disabled
Social	**Population**	Few people indirectly affected	Some people directly affected	Several people directly affected or many people indirectly affected	Large number of people directly affected	Loss of Life
	Heritage	Impact on item of minimal significance	Impact on multiple items of low significance	Impact on a significant item	Impact on multiple significant items	Major impact on nationally sensitive items
	Political	Social concern	Negative press articles	Significant public outcry	A national enquiry	Change of government
Economic	**Financial**	Minimal losses	Thousands of dollars of loss or remediation expense	Hundreds of thousands of dollars of losses	One million dollar loss or remediation expense	Multi-million expenditure on remediation and compensation

4.2.3 Risk Rating

As risk is both a function of likelihood and consequence a corresponding risk matrix can be developed, reflecting the various potential combinations of likelihood and consequence. The outcome of the risk matrix is the assigning of a unique 'risk rating' (**Table 4-3**). Under this matrix, risks with both high likelihood (e.g. Probable) and high consequence (e.g. Catastrophic) are considered to have a higher risk rating (i.e. to be of greater risk to the project), than those risks that are unlikely to occur and would be of only minor consequence if they did so. For the purposed of this ESIA, seven risk rating categories were developed to capture the overall risk posed by a particular project outcome, these included:

- **Negligible** – Risks are considered to be immaterial to the project and do not require response;

- **Very Low** – Risks are not considered to be significant and will not affect project outcomes;
- **Low** – Risks are not considered to be of concern but may require a project response;
- **Medium** – Risks are of concern and should be actively responded to and managed;
- **High** – Risks are significant and may affect project outcomes unless mitigated;
- **Very High** – Risk are significant and will affect project outcomes unless mitigated; and
- **Extreme** – Risks are likely to prevent the project from proceeding.

Table 4-3 Risk Rating Criteria

Likelihood	Consequence				
	Minimal	**Minor**	**Moderate**	**Major**	**Catastrophic**
Improbable	Negligible	Negligible	Very Low	Low	Medium
Unlikely	Negligible	Very Low	Low	Medium	High
Possible	Very Low	Low	Medium	High	Very High
Likely	Low	Medium	High	Very High	Extreme
Probable	Medium	High	Very High	Extreme	Extreme

4.2.4 Risk Identification and Evaluation

A three stage risk identification and evaluation process was adopted as part of the ESIA to ensure all project environmental and social risks were adequately captured and assessed. The three stages included:

- Risk Evaluation of Environmental Aspects;
- Risk Evaluation of Environmental Impacts; and
- Risk Evaluation of Residual Risks.

The Risk Evaluation of Environmental Aspects comprised a high level assessment of the range of environmental aspects that are considered to be potential affected by the proposed development (**Table 4-4**).This assessment drew heavily upon the findings of the ZESCO EIA which provided an assessment of the key issues associated with the project and requiring consideration within the ESIA. Environmental aspects that were seen to have a risk rating of 'Medium' or higher were deemed to be of concern and requiring detailed assessment within the ESIA (**Section 6**). The remaining environmental aspects with risk ratings below 'Medium' were considered to be comparatively minor concerns (**Section 7**). The detail and level of assessment undertaken for these risks reflects their respective risk ratings.

Table 4-4: Risk Ratings of Environmental Aspects

Environmental Aspect	Risk Assessment			EIS Section	Adequacy of Data
	Likelihood	Consequence	Risk Rating		
Ecology	Possible	Catastrophic	**Very High**	**Section 6.1**	Field survey investigations required.
Noise and Vibration	Possible	Moderate	**Medium**	**Section 6.2**	Field survey investigations required.
Surface Water Quantity and Quality	Possible	Catastrophic	**Very High**	**Section 6.3**	Field survey investigations required.
Flooding and Hydrology	Unlikely	Catastrophic	**High**	**Section 6.4**	Field survey investigations required.
Socio-Economic Impacts	Unlikely	Major	**Medium**	**Section 8**	Field survey investigations required.
Cultural Heritage.	Unlikely	Moderate	**Low**	**Section 7.12**	Database and literature searches recommended
Air Quality	Possible	Minor	**Low**	**Section 7.1**	Database and literature searches recommended
Climate and Climate Change	Unlikely	Minor	**Very Low**	**Section 7.2**	Database and literature searches recommended
Groundwater	Possible	Minor	**Low**	**Section 7.3**	Database and literature searches recommended
Land Contamination	Unlikely	Minor	**Very Low**	**Section 7.4**	Database and literature searches recommended
Landscape and Visual Impacts	Improbable	Minimal	**Negligible**	**Section 7.5**	Database and literature searches recommended
Lighting	Unlikely	Minor	**Very Low**	**Section 7.6**	Database and literature searches recommended
Project Hazards and Risks	Possible	Minor	**Low**	**Section 7.7**	Database and literature searches recommended

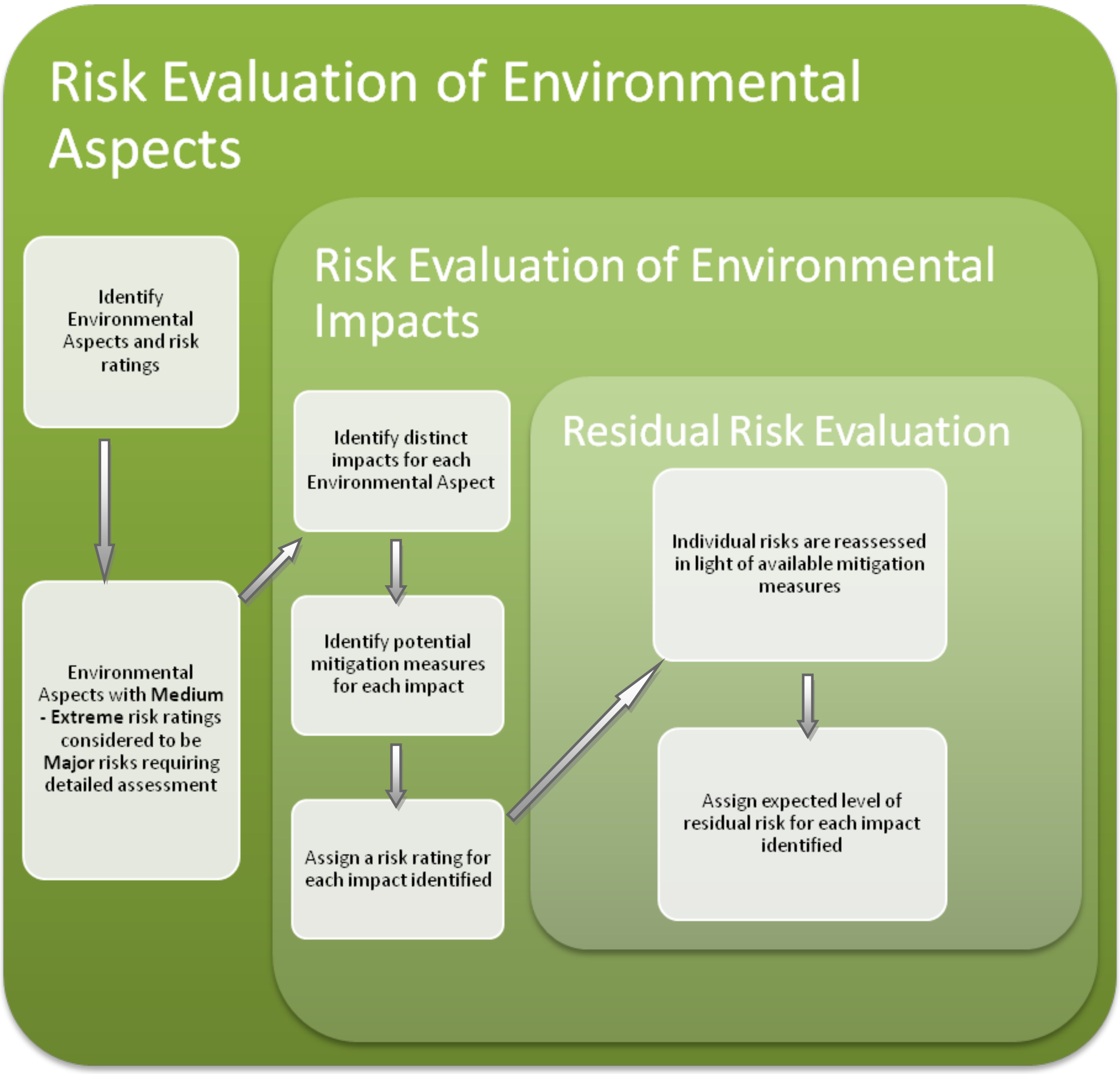
Environmental Aspect	Risk Assessment			EIS Section	Adequacy of Data
	Likelihood	Consequence	Risk Rating		
Solar Access	Improbable	Minimal	**Negligible**	**Section 7.8**	Database and literature searches recommended
Traffic and Transport	Unlikely	Moderate	**Low**	**Section 7.9**	Database and literature searches recommended
Trans-boundary Issues	Unlikely	Minimal	**Negligible**	**Section 7.10**	Database and literature searches recommended
Topography, Geology and Soils	Unlikely	Minimal	**Negligible**	**Section 7.11**	Database and literature searches recommended
Waste and Waste Management	Possible	Minor	**Low**	**Section 7.13**	Database and literature searches recommended

Following the Risk Evaluation of Environmental Aspects, specific potential project impacts were identified within each environmental topic based on the known baseline information, proposed construction methodologies and operating conditions. These impacts are discussed in detail within the relevant impact assessment sections of this ESIA. For each impact a Risk Evaluation of Environmental Impacts was undertaken and an individual impact risk rating was determined (**Appendix G**). The resultant risk levels assigned are in accordance with the adopted risk matrix (**Table 4-3**).

In line with the findings of the Risk Evaluation of Environmental Impacts, a range of mitigation measures were developed, where appropriate, to minimise as far as practicable the individual risks identified. The application of mitigation measures is designed to reduce the risk rating of individual impacts and the overall project risks. Subsequently, a Risk Evaluation of Residual Risk was undertaken to reassess all individual impacts assuming the correct application of the identified mitigation measures. The resultant residual risk rating is displayed within the relevant 'Impact and Mitigation' tables presented within the relevant environmental aspect sections of this ESIA.

This three stage risk assessment procedure is summarised in **Figure 4-1**.

Figure 4-1: Risk Analysis Procedure



5 STAKEHOLDER ENGAGEMENT

Stakeholder Engagement is fundamental to the ESIA process in that it:

- Ensures the scope of the ESIA captures all potential impacts and concerns held by the public;
- Provides understanding for the decision making authorities as to the social issues surrounding a project;
- Provides an opportunity for stakeholders to have their interests considered in regards to developments that may affect them; and
- Helps establish a relationship between the Project and stakeholders, ultimately facilitating establishing broad community support for the Project.

In order to effectively engage with Project stakeholders a Stakeholder Engagement Plan (SEP) was developed (URS, 2012) to manage the stakeholder engagement process and ensure that all engagement undertaken was in-line with principles of Free, Prior and Informed engagement.

As a national EIA has already been prepared, disclosed and approved, and construction works have already commenced, it is acknowledged that further stakeholder engagement will not influence governmental decision-making.. As such the SEP, and all engagement undertaken during the development of the ESIA, did not attempt to fill gaps associated with the EIA process. Rather, the engagement activities were undertaken in order to establish an IFC PS compliant engagement programme for the project moving forwards from ESIA and into its construction and operation phase.

5.1 Consultation Requirements

The IFC PS and African Development Bank (AfDB) Integrated Environmental and Social Impact Assessments are relevant and outline key requirements for consultation.

The IFC Performance Standard 1, the IFC Policy on Social and Environmental Sustainability, and Access to Information Policy is of particular relevance to this SEP.

Performance Standard 1: Social and Environmental Assessment and Management System

This standard outlines the following requirements specifically in relation to stakeholder engagement:

- *Stakeholder Analysis and Engagement Planning*: i) developers should identify a range of stakeholders, ii) develop and implement a Stakeholder Engagement Plan.
- *Disclosure of Information*: the developer will provide stakeholders with access to information on: i) purpose, nature and scale of the project, ii) duration of proposed project activities, iii) any risks, potential impacts and mitigation measures, iv) proposed stakeholder engagement process, v) grievance mechanism.
- *Consultation*: consultation will be in line with the degree of impact of the Project and should: i) begin early and continue through project, ii) be based on prior disclosure of relevant and easily accessible information on the project, iii) focus engagement on those who are directly affected, iv) be free of outside interference and external manipulation, v) enable meaningful participation, vi) be documented.
- *Informed Consultation and Participation*: for projects with potentially adverse impacts, conduct an Informed Consultation and Participation (ICP) process. ICP is a more in-depth exchange of views and information and developer incorporates views into

decision making process. It should be ensured that the ICP process: i) captures both men and women's views, ii) reflects men and women's different concerns and priorities on impacts, benefits and mitigation measures. This should be documented and feedback given to those affected.

As the Project will not involve land acquisition or involuntary resettlement actions, the requirements of Performance Standard 5 (Land Acquisition and Involuntary Resettlement) are not directly applicable. However, elements of PS 5 have been considered within the SEP prepared as and when appropriate. For example, PS 5 stipulates that the developer should implement a grievance mechanism as early as possible during project development and disputes resolved in an impartial manner.

African Development Bank Integrated Environmental and Social Impact Assessment Guidelines

The AfDB Integrated Environmental and Social Impact Assessment Guidelines (2003) place particular emphasis on cross-cutting issues, for example gender and poverty. The AfDB Handbook on Stakeholder Consultation and Participation (2001) outlines the following requirements for successful engagement:

- Communicate with people on all levels;
- Involve stakeholders in all stages of the project cycle;
- Ensure a voice for women and other groups that have traditionally been excluded;
- Promote the role of civil society in the development process;
- Use participatory methods and techniques;
- Establish mechanisms for decentralised decision-making; and
- Support the capacity-building of local institutions.

Other international standards and best practice relevant for this SEP include The Equator Principles, and World Bank Operational Policies (OP) 4.01 Environment Assessment and OP 4.2 Gender and Development.

The SEP prepared for the Project provides a detailed description of how these guidelines were met in the engagement undertaken, indicating:

- How stakeholders were identified;
- How stakeholders were mapped;
- Which stakeholders were contacted during ESIA preparation and how they were contacted;
- A forward plan for further on-going engagement into Project construction and operation; and
- Provision of a grievance mechanism and feedback systems to ensure the Project's environmental and social practices are continuously improving.

5.2 Engagement Undertaken

5.2.1 Previous Consultation

Consultations were undertaken by ZESCO for the ITT Hydropower Project EIA between April and August 2008. Local communities, local businesses and households residing along the proposed transmission pipeline route also participated. The EIA report states that all major institutions were represented and that meetings were held with the relevant stakeholders at the downstream villages of Musangwa and Laingo. Documentation of the content and extent

of these consultations is limited (e.g. the EIA does not state which institutions were consulted or how).

It is also noted that although the EIA consulted with some villages, there are a range of additional villages downstream of the dam which would be considered to require consultation under IFC PS 1. **Table 5-1** summarises the known consultations undertaken and key findings.

Table 5-1 Previous Stakeholder Engagement Consultations

MEETING	STAKEHOLDER TYPE	LOCATION	STAKEHOLDER	KEY CONCERNS
Description of the Project and potential impacts	Traditional leader	Musungwa village	Chief Musungwa Headman Shamwene Headman Mwiila	Compensation for potentially affected people and the need to involve local Chiefs in the recruitment of local construction workers Since the dam was constructed in 1978, there has been less flooding downstream and the ponds have no water ZESCO should inform the Chiefs downstream of the dam before opening the water gates
Description of the Project and potential impacts	Traditional leader	Kaingo village	Chief Kaingo and his Indunas	
Description of the Project and potential impacts	District and National Authorities	Itezhi-Tezhi	District Council offices Zambia Wildlife Authority	The effect that potential raising of the dam would cause to the immediate surroundings and fishing industry The effect of continuous flooding on fishing downstream of the river People need to be informed before releases are changed Fluctuation of water releases would affect fish breeding The intake should be designed to avoid use of deoxygenated water. Use of this water would kill the fish Relocation should take into consideration the differences in ethnic composition of people along the reservoir and that of the upper land

It is also noted that since these consultations were undertaken, the Project scope of works has considerably changed.

5.2.2 ESIA Consultations

In accordance with Project SEP, a range of stakeholder engagement activities were undertaken in June and July 2012 to aid in the preparation of the ESIA. **Table 5-2** details consultations that have taken place, with which stakeholders and key comments, issues and feedback raised.

Table 5-3: ESIA Consultations in June and July 2012

TYPE	STAKEHOLDER	STAKEHOLDER NAME	DATE	TYPE OF MEETING	KEY ISSUSES AND CONCERNS
National government	Ngoma Zambia Wildlife Authority	Mr. Kennedy Mweetwa –Park	21 June	One-to-one meeting	The Kafue National Park (KNP) operates in Nkala Game

TYPE	STAKEHOLDER	STAKEHOLDER NAME	DATE	TYPE OF MEETING	KEY ISSUSES AND CONCERNS
	Headquarters Office	Ranger	2012		Management Area, part of Namwala Game Management Area. The Zambia Wildlife Act No.12 of 1998 allows greater participation of local communities, establishing their rights to use and manage natural resources in GMAs. Key concerns: potential impact on flora and fauna.
NGO	Wildlife and Environmental Conservation Society of Zambia	Patrick Shawa National Coordinator	30 July 2012	One-to-one meeting	It currently has no office in Itezhi-Tezhi but operates the Chibila Wildlife Camp. It has plans to open a resource centre in Itezhi-Tezhi. As part of its outreach programme WECSZ is willing to engage with the community on environmental and social sector issues in relation to the Project. Key concern: potential impact on flora and fauna, and wildlife conservation.
NGO	Shelter Zambia Trust Fund	Alfred Kalipa Project Liaison Officer Mukela Simunji – Community Liaison Officer	27 July 2012	One-to-one meeting	It believes that the Project will positively affect the provision of shelter in the district as more people are employed by the Project, and it will result in increased demand for more housing. Key concern: potential impact on existing infrastructure.
Local business	New Kalala Lodge	Mr. Michael Mpundu – Manager – New Kalala Lodge	21 June 2012	One-to-one meeting	Electricity load shedding is a problem which may be solved by completion of the ITPC Project. During the construction phase clients are affected by noise from blasting from the Project site. Key concern: potential impact on existing infrastructure and livelihoods.
Local business	Musungwa Safari Lodge	Mr. Luke Chirwa – Manager	21 June 2012	One-to-one meeting	ITPC Project is a welcome development in the area. It will improve electricity and reduce power outages. The Project has also employed young people from area, which has reduced petty crime, which was being experienced at the Lodge. Although the blasting noise can be heard from the Project site, there have been no effects from blasting. Key concerns: potential impact on existing infrastructure and livelihoods.
Local business	Musungwa Lodge Compound	Frevios Mphanza – Chairman Mr. Charles Mabuwa –	21 June 2012 & 27 July	Focus group discussion	The settlement has no running water. Potable water is obtained from Musungwa Lodge about 500 metres away.

TYPE	STAKEHOLDER	STAKEHOLDER NAME	DATE	TYPE OF MEETING	KEY ISSUSES AND CONCERNS
		Musungwa Lodge Chairman Ms. Beatrice Pumulo – Class Teacher Mrs. Mercy Muyumba – Nursery Class Teacher Mrs. Precious Mabuwa	2012		Residents use pit latrines for sanitation. Many of the housing structures are in a dilapidated state. Key concerns: potential impact of noise/vibration and construction in progress and employment opportunities.
Local business	Melissa Farm	Mr. Victor Lungu – Manager Melissa Farm	21 June 2012	One-to-one meeting	Most of the farm produce is sold in Lusaka. Some vegetables are supplied to Melissa Supermarket in Itezhi-Tezhi and the New Kalala Lodge. The water used at the farm is abstracted from the Kafue River using two 7.5Hp pumps. Key concerns: potential impacts of noise/vibration, the construction in progress and on livelihoods.
Local government	Department of Fisheries Offices, Itezhi-Tezhi	Mr. Remmy LIshebo Mr. Victor Bwalinde	18 June 2012	One-to-one meeting	The Fisheries Officers outlined the social dynamics of fishing camps, which are influenced by ethnic composition. Fishing camps are often predominantly Lozi or Luvale, or a mixture of both. The Fisheries Officers identified the following as major fishing camps downstream: 1. Mulando 2. Kalala 3. Kabishabisha 4. Batunga 5. Shampumbe 6. Mang’ongo 7. Kasamu 8. Namacheka 9. Zambwa Key concerns: potential impact on livelihoods and fishing.
Local government	Itezhi-Tezhi District Commissioners Office	Mr. Roy Nang’a’elwa	27 July 2012	One-to-one meeting	Fishing and agricultural sectors are important economic activities in the district. The ITPC project is a welcome development in the district. It is anticipated that the project will: a) Create employment b) Provide increased capacity for power generation and reduce electricity power outages through load

TYPE	STAKEHOLDER	STAKEHOLDER NAME	DATE	TYPE OF MEETING	KEY ISSUSES AND CONCERNS
					shedding in the town c) Attract local tourism and contribute to improvement in the tourism sector in the district d) The project will lead to improved infrastructure due to increased demand on existing services However, there are anticipated negative effects of Project induced migration to the town. This will increase demands on existing infrastructure. Key concerns: potential impacts on water users, employment opportunities, livelihoods, and infrastructure.
Local government	Itezhi-Tezhi Council Offices	Hastings Chinyundu – District AIDS Coordination Advisor	27 July 2012	One-to-one meeting	Works in 13 Wards of the Itezhi-Tezhi District. It considers high poverty levels and unemployment as the most important problems facing the district. The influx of in-migrants to the district in search of employment is likely to increase HIV/AIDS and crime. The organisation is willing to engage with the community in HIV/AIDS issue in relation to the Project. Key concern: potential impact on rate of infection of HIV/AIDs.
Local government	Itezhi-Tezhi Council Offices	Mr. Gaphine Walubita – District Planning Officer	20 June 2012	One-to-one meeting	The town is connected to the national power grid through Choma and Namwala towns. Key concerns: potential impact on employment, infrastructure, livelihoods, health, and waste management.
Local government	Itezhi-Tezhi, Department of Livestock Services	Shepard Phiri – Veterinary Assistant	21 June 2012	One-to-one meeting	Livestock husbandry is an important livelihood activity in the district for a large proportion of the population. Key concern: potential impacts on livelihoods, such as animal husbandry.
Local government	Department of Agriculture Offices	Ms. Petronella Lubasi – Senior Agricultural Officer	21 June 2012	One-to-one meeting	In recent years there has been an influx of migrants to the district from southern province towns of Kalomo and Monze in search of productive agricultural land. These are food shortage areas due to adverse weather conditions in the past three years.

TYPE	STAKEHOLDER	STAKEHOLDER NAME	DATE	TYPE OF MEETING	KEY ISSUSES AND CONCERNS
					Key concern: potential impact on livelihoods and agriculture.
Local government	District Education Board Secretary's office	Mr. John Moose, District Education Board Secretary	21 June 2012	One-to-one meeting	There are challenges in the provision of education to girls, especially in the rural parts of the district. Girls are more likely to drop out of school at Grade 7 or Grade 9 because of forced early marriages. However, in some livestock communities boys drop out of school at similar levels of education attainment to herd cattle. Key concern is education.
Local government	Council Secretary	Mr. Cheembo Mang'watu	25 July 2012	One-to-one meeting	In past 5 years there has been increased in-migration of the Tonga from Southern Province towns of Kalomo, Kazungula, Choma and Monze in search of farming land. This caused consternation among the host population such that in 2010 there were conflicts as the in-migrants settled in Game Management Areas. Some were resettled in Chief Kaingu's and Shimbhizi's areas and others were sent back. It is expected that the ITPC project will increase demands for water supply and sewerage facilities. Currently only about 30% of houses have electricity. The ITPC is a positive development in the district. It is expected to create employment which will contribute to increased personal levy payable to the council; the project will increase prospects of more houses being built which will increase rateable property; the development will also enhance Itezhi-Tezhi's status. The increased power generated is also expected to reduce the load shedding and will attract more industries to come to Itezhi-Tezhi. Key concern: employment, land, infrastructure, livelihoods, health, water and waste.
Local leader	Chief Musunga	Chief Musungwa	24 July 2012	One-to-one meeting	Over 90% of the people in Itezhi-Tezhi are indigenous Ila. The migrant settlers from Luapula, Northern, Central, Western and Northwestern provinces have settled in fishing lagoons/camps along the Kafue River. This includes ethnic groups such as Bemba, Luvale, Mbunda, Lozi and Tonga. Recent Tonga

TYPE	STAKEHOLDER	STAKEHOLDER NAME	DATE	TYPE OF MEETING	KEY ISSUSES AND CONCERNS
					migrants from Southern province have come to the area in search of farming land. The main livelihood activity of the Ila people is livestock rearing. Chief Musungwa noted that the ITPC Project is expected to create local employment and solve the problem of power outages in the district. He also expected the Project to give back to the community through its corporate social responsibility programme. Key concern: employment, land, livelihoods, and cultural heritage.
Local government	Itezhi-Tezhi Ward Area Development Committee (ADC)	Ms Getrude Sosopi	27 July 2012	One-to-one meeting	Although Ms Sosopi was not aware of all the details of the ITPC Project she expects the Project will benefit the community by providing electricity to their houses. She also expects more local people in the community to be employed, especially in unskilled jobs. Key concern: employment, land, infrastructure, livelihoods, water and health and safety.
Fishermen	Nuungu Fishing Camp		20 June 2012	Focus group discussion	Blasting from the ITPC Project site can be heard in the fishing camp. There have been low catches because of high waters, which drives the fish into the reeds. Key concern: livelihoods, health, noise/vibration and water.
Fishermen	Namacheka Fishing Camp		20 June 2012	Focus group discussion	Namacheka fishing camp is a temporary fishing camp, which is abandoned when the Kafue River overflows its banks. The camp is abandoned between November and March when the water level is high and the camp is submerged. This period also coincides with the Fishery Department's fish ban. Key concern: water, livelihood, fishing.
Fishermen	Mang'ongo Fishing Camp		20 June 2012	Focus group discussion	Mang'ongo fishing camp is temporary camp occupied by fishermen and their families during the fishing season which runs from April to November. There are 25 households found at the fishing camp. Key concern: water, livelihood, fishing.

5.2.3 Stakeholder Engagement Conclusions

It is seen that the engagement activities identified both positive and negative concerns in regards to the project. In regards to positive outcomes, it was seen that the Project is considered to be beneficial due to:

- The provision of employment opportunities;
- The provision of improved electricity supply; and
- Stimulating the development of the region.

However, it is also apparent that there are concerns held by stakeholders in regards to the Project. Stakeholders with greatest concerns are seen to be those located downstream of the dam and dependent upon the regulated supply and quality of water in the Kafue River. It is also considered that these stakeholders are likely to have been impacted by the initial development of the dam, and as such may view any associated developments (such as the Project) with concern. In particular, concerns were expressed regarding:

- Potential changes to water quality / volumes affecting the abundance of fish stocks and livelihoods
- Potential impacts associated with construction noise;
- The potential for in-migration and associated impacts; and
- Potential changes to water quality / volumes affecting a valuable ecological system.

6 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT – MAJOR RISKS

Sections 6 and **7** of the ESIA provide a detailed description of the existing environmental baseline conditions for the Project, the potential impacts of the Project upon this baseline, and recommended mitigation measures to help minimise these impacts. **Section 8** repeats this process within the social context of the Project. Based upon the findings of the previous ZESCO EIA and the adopted ESIA risk assessment (**Section 4.2**), the potentially Project-affected environmental aspects identified were categorised as major and minor aspects of concern (**Table 4-4**).

The potential 'major' risk aspects are considered in **Section 6** and include:

- Terrestrial and Aquatic Ecology;
- Noise and Vibration;
- Water and Sediment Quality; and
- Flooding and Hydrology.

The minor risk aspects considered in **Section 7** and include:

- Air Quality;
- Climate and Climate Change;
- Cultural Heritage;
- Groundwater;
- Land Contamination;
- Landscape and Visual Impacts;
- Lighting;
- Project Hazards and Risks;
- Solar Access;
- Traffic and Transport;
- Transboundary Watershed Issues;
- Topography, Geology and Soils; and
- Waste and Waste Management.

Socio-economic aspects are discussed in **Section 8**.

6.1 Terrestrial and Aquatic Ecology

6.1.1 Methodology

Baseline conditions were characterised using a combination of the following methods:

- Desktop study
- Field survey by local specialists; and
- Interviews with stakeholders

Desktop Study

The desktop study involved a review of existing ITPC reports, publicly available literature, and documents and data sourced from government and non-government stakeholders.

Field Survey

A terrestrial, aquatic and riparian flora and fauna survey was carried out by a qualified national Ecologist in June 2012, and involved a prior site reconnaissance visit and subsequent field measurements.

Vegetation at the power house site was surveyed using radius plots. Vegetation clearance had commenced within the power house site prior to the survey, therefore the surveys were carried out in intact vegetation adjacent to the power house site as the adjacent sites retained similar vegetation to what was understood to be on the project site. Riparian vegetation was surveyed by transecting downstream along the river bank and establishing plots whenever a change in vegetation composition was observed. In each plot, species, number of individuals per species, and stem/trunk diameters (in case of tree/shrub species) were recorded. Additionally, data on non-woody plants was also collected. A boat survey was carried on the Kafue River, from the Powerhouse site to Namwala Pontoon (approximately 65 km downstream of the power house site) to make visual observations of riparian flora species further downstream of the Powerhouse site.

Transect walks were undertaken adjacent to the powerhouse site and within riparian vegetation along the Kafue River to identify and quantify fauna species. A boat survey was carried on the Kafue River to Namwala Pontoon, up to approximately 65km downstream of the Powerhouse site to make visual observations of aquatic and riparian fauna and flora species, and significant habitat such that used for fish spawning.

To understand the aquatic ecology aspects of the Kafue River and its fisheries, data was obtained for the years 2007 to 2012 from an ongoing monitoring program of fish species within the Kafue River. The study is being carried out by the Department of Fisheries and has been ongoing for 10 years. The monitoring program occurs at locations downstream of the power house site and includes sites at Choongo, Moongoshiya, Lwabeza, Munyanja and Musungwa. Within each month of the year (excluding October and November), nets are laid at dawn and hauled in the following morning. This is repeated for three days at each sampling location. Individuals caught are identified by species, weight and length, maturity and sex.

Further details of the terrestrial, aquatic and riparian flora and fauna survey methodology are provided in **Appendix C**.

Interviews with Stakeholders

Discussions were held with organisations including the Zambia Wildlife Authority, Forest Department, Department of Fisheries, World Wide Fund for Nature, and local communities to supplement the desktop study and field surveys.

The International Union for the Conservation of Nature (IUCN) Red List was employed to determine the conservation status of species identified during the desktop study, field survey and interviews with stakeholders. There is no similar list of the conservation status of Zambian flora and fauna.

6.1.2 Baseline Conditions

Zambia is a sub tropical country in Southern Africa and is one of the most highly forested countries with about 60% of its total land area under forest or 64 million hectares most of which is administered traditionally under customary law (Keddy, 2003). Of this forested area about 9.6 percent is gazetted forests. As per the world database on Protected Areas (Arce, 2008), there are 626 nationally recognised protected areas in Zambia.

Zambia has 19 National Parks. The Kafue National Park is particularly important on account of being home to 55 different species of animals spread over an area of 22,400 sq km (Thapa et al., 2011). It is administered by the Zambian Wildlife Authority.

The Kafue River runs centrally through the National Park and is dammed by the Itezhi-Tezhi Dam just outside the park precincts. The Itezhi-Tezhi reservoir formed by the dam lies within the park limits. The Itezhi-Tezhi dam is located on the south-east boundary of the national park.

The Kafue River originates at an elevation of 1350 m on the relatively flat plateau just south of the border of Zambia and the Democratic Republic of the Congo. The river passes through the Copperbelt District (a region where several copper, cobalt mines are located) before entering the Kafue National Park.

Downstream of the Itezhi-Tezhi dam the river meanders slowly through an expanse of oxbow lakes and lagoons known as the Kafue Flats. Further downstream the Kafue River is again obstructed in its flow by the Kafue Upper Gorge Dam (**Figure 1-1**).

Ramsar and IBA Sites

At present there are eight listed Ramsar Wetlands in Zambia. **Table 6-1** gives a list of Ramsar sites and their area.

Table 6-1 Wetlands recognised under the Ramsar Convention in Zambia[11]

Name	Area (hectares)[12]
Bangweulu Swamps	1,100,000
Busanga Swamp	200,000
Kafue Flats: Lochinvar National Park & Blue Lagoon National Park	600,500

[11] http://www.eoearth.org/article/Protected_areas_of_Zambia, accessed on July 5, 2012
[12] http://en.wikipedia.org/wiki/List_of_Ramsar_wetlands_of_international_importance, accessed on July 5, 2012

Lake Tanganyika (portion in Zambia)	230,000
Luangwa floodplains	250,000
Lukanga Swamp	260,000
Mweru wa Ntipa	490,000
Zambezi Floodplain (Barotse Floodplain)	900,000
Total Area	4,030,500

The Kafue Flats are the only Ramsar wetland within 50 km of the proposed development, located immediately downstream of the Itezhi-Tezhi Dam, and the only wetland downstream of the dam. The Kafue wetlands and floodplains cover an area of around 6,500 sq. km. The wetland is characterised by extremely flat topography and is considered a crucial home for rare and endemic species such as Kafue Lechwe, (*Kobus leche kafuensis*), and Wattled Crane (*Bugeranus carunculatus*). These flats are important in socio-economic terms, supporting local industries such as cattle grazing, floodplain agriculture and traditional fisheries (as discussed in **Section 8**). Despite the ecological importance, rich natural resource base, and economic significance of these resources, the Kafue Flats ecosystem, is reported to be the most ecologically disturbed wetland in Zambia (Chabwela, 1994; Chabwela 1986; Kalunga, 1996).

Terrestrial Flora

Woodlands and grasslands are the dominant vegetation types within the Itezhi-Tezhi District. Specifically, the prevailing vegetation types include dry deciduous forest, riparian woodland, open-forest, termitaria (i.e. grasslands characterised by the presence of termite-mounds) and open-grassland. Within these vegetation types the following major ecosystem communities occur:

- *Baikiaea* forest;
- Pteleopsis forest;
- Riparian woodland;
- Miombo woodland;
- Kalahari woodland;
- Mopane woodland;
- Munga woodland;
- *Suffrutex* savanna;
- Miombo Termitaria;
- Munga Termitaria;
- Dambo grassland;
- Riverine grassland; and
- Flood plain grasslands.

Each of these ecosystems has distinctive dominant species, species diversity and species abundances within them. **Table 6-1** identifies the major vegetative communities within a 10km radius of the Project area and the dominant species present.

Table 6-1: Major Vegetative Communities Surrounding the Project Area

Major Ecosystem	Ecosystem Diversity Components	Dominant species
Dry Deciduous Forest	*Baikiaea* Forest (mature)	*Baikiaea plurijuga, Pterocarpus angolensis, Vachelia giraffe, Vachelia nigrescens*
	Secondary *Baikiaea* Forest	*Baikiaea plurijuga,*
	Pteleopsis Forest	*Pteleopsis spp.*
Riparian Woodland	Riparian Woodland	*Syzygium cordatum, Combretum imberbe, Rhus quartiniana, Parinari excelsa*
Open Forest	Miombo woodland	*Julbernadia paniculata, Brachystegia* species
	Kalahari woodland	*Vachelia giraffe, Amblygonocarpus andonoensis, Baikiaea plurijuga, Brachystegia species, Erythrophleum africanum, Parinari curatellifolia*
	Mopane woodland	*Colophospermum mopane, Adansonia digitata, Kirkia acuminata, Vachelia* species
	Munga woodland	*Vachelia* species
	Suffrutex woodland	
Termitaria	Miombo Termitaria	*Julbernadia paniculata, Brachystegia species, Boscia angustifolia, Diospyros mespiliformis*
	Munga Termitaria	*Vachelia* species, *Boscia angustifolia*
Grassland	Dambo grassland	*Loudetia* species, *Andropogon* species.
	Riverine grassland	
	Flood plain grassland	

Miombo woodland is considered to be the most extensive warm dry forest type in Southern Africa (Frost, 1996). The woodlands, as described by Campbell (1996) typically comprises:

- an upper canopy of umbrella shaped tree;
- a scattered layer that is often absent of sub-canopy trees;
- a discontinuous under-storey of shrubs and saplings; and
- a patchy layer of grasses.

The woodland is characterised as deciduous woodland of broad-leaved vegetation, dominated by species of *Brachystegia*, *Julbernadia* and *Isoberlinia* genus. Miombo Woodland extends from the Atlantic coast of Angola, across Zambia, the southern Democratic Republic of Congo, Malawi and much of Zimbabwe, almost to the eastern African coast of Tanzania and Mozambique (Timberlake *et al*. 2010; White, 1983). The resources of Miombo woodlands are central to the livelihood systems of millions of rural and urban dwellers. The woodlands have for a long time been useful sources of forest products and services for the subsistence needs of both rural and urban dwellers.

Powerhouse Site

Although there is significant regional diversity, vegetation is relatively homogenous surrounding the Project area. Vegetation within the immediate vicinity of the power house site is dominated by shrubs and scattered trees forming an open canopy (**Figure 6-1**). Due to the rocky nature of the region and stony soils, there is a lack of an extensive root system and the site is considered incapable of supporting dense forest vegetation.

Figure 6-1: Vegetation at the Power House Site

The flora survey of the Powerhouse site identified a total of 13 tree species and 14 shrub species. The Relative Importance Value of these species is provided in **Table 6-2**. The predominant tree species include *Combretum zeyheri*, *Sclerocarya caffra* and *Dalbergia nitidula*. The Prominent shrubs include *Diplorhynchus condylocarpon*, *Sapium bussei* and *Combretum molle.* None of these tree and shrub species are considered to be threatened as they are abundant throughout the Miombo region.

Table 6-2: Characteristic Species Recorded at the Power House Site

Tree Species	Importance value[1] (%)	Shrub Species	Importance value[1] (%)
Sclerocarya caffra	8.14	*Diplorhynchus condylocarpon*	12.34
Combretum zeyheri	7.30	*Sapium bussei*	6.02
Dalbergia nitidula	5.03	*Combretum molle*	5.34
Lannea stulhmannii	4.87	*Strychnos spinosa*	4.73
Byrsocarpus orientalis	3.71	*Dalbergiella nyasae*	4.33
Schrebera alata	3.58	*Strychnos potatorum*	3.36
Afzelia quanzensis	2.49	*Flacourtia indica*	3.04
Brachystegia utilis	2.27	*Pseudolachnostylis maprouneifolia*	2.56
Albizia antunesiana	2.17	*Lonchocarpus spp*	2.45
Kirkia acuminata	1.88	*Dichrostachys cinerea*	2.33
Schrebera trichoclada	1.86	*Burkea africana*	1.53
Strychnos innocua	1.82	*Swartzia madagascariensis*	2.19

Tree Species	Importance value[1] (%)	Shrub Species	Importance value[1] (%)
Hymenocardia acida	1.44	*Monotes africanus*	1.76
		Canthium spp	1.44

[1] the sum of relative density, relative dominance and relative frequency of a species

Riparian Zone

Downstream of the Powerhouse site, riparian vegetation is more varied... Riparian woody vegetation consists of evergreen vegetation along the river bank and semi-deciduous vegetation further back from the river bank (**Figure 6-2**). Semi-deciduous vegetation such as *Albizia versicolor*, *Combretum imberbe*, *Lannea stulhmannii* and *Bauhinia thonningii* do not occur close to the river banks and form a canopy of 21 m in some cases.

Figure 6-2: Characteristic Woody Riparian Vegetation Downstream of the Power House Site

A total of 12 tree species and nine shrub species were identified downstream of the project site. The Relative Importance Value of these species is provided in **Table 6-3**. Dominant species include *Ficus sycomorus*, *Syzygium cordatum*, Rhus quartiniana, *Albizia versicolor*, Diospyros mespiliformis, *Lannea stulhmannii, Bauhinia thonningii* and *Combretum imberbe.* The invasive species *Lantana camara* was also present in small numbers. *Lantana Camara* is considered to be a significant weed and it widespread around the world, including many countries in Africa (ISSG, 2012). The weed commonly invades areas of forest clearance and is known to lead to decreases in biodiversity (ISSG, 2012).

Table 6-3: Characteristic Species Downstream of the Power House Site

Tree Species	Importance value[1] (%)	Shrub Species	Importance value[1] (%)
Ficus sycomorus	38.80	*Rhus quartiniana*	9.15
Syzygium cordatum	10.83	*Bauhinia thonningii*	3.84

Tree Species	Importance value[1] (%)	Shrub Species	Importance value[1] (%)
Combretum imberbe	4.92	*Balanite spp*	2.41
Diospyros mespiliformis	4.53	*Magnistipula butayei*	1.75
Albizia versicolor	4.53	*Flacourtia indica*	1.42
Lannea stulhmannii	3.51	*Vachelia sieberana*	1.41
Marquesia macroura	1.74	*Lantana camara*	1.41
Ziziphus mauritiania	1.43	*Azanza garckeana*	1.41
Hyphaene ventricosa	1.43	*Rhus longipes*	1.41
Vachelia polyacantha	1.42		
Faiderbia albida	1.41		
Albizia amara	1.24		

[1] Sum of relative density, relative dominance and relative frequency of a species.

Non woody vegetation is dominated by Sedges and *Phragmites* (**Figure 6-3**). Dominant sedge varieties identified include *Cyperus esculentus*, *C.compressus*, *C. rotundus*, *C.obtusifolia*, *C.fulgens*, *C.laevigatus* and *C.haspan*. Grass species present include *Loudetia simplex*, *Andropogon schirensis*, *Hyparrhenia spp*., and *Monocymbium ceresiiforme*. Additionally, species such as *Miscanthus teretiforlius*, *Themedia triandra* and *Trachypogon spicatus* also occur in the area. They are common species and occur in abundance across the Miombo ecoregion (White, 1983). The percentage presence for most of these species ranges from 81 to 100%.

None of the plant species recorded during the survey are protected, threatened or considered endemic to the Project site.

Figure 6-3: Characteristic non-woody vegetation downstream of the Power House Site

Terrestrial Fauna

The project site is located adjacent to the Kafue National Park and falls within the Nkala Game Management Area (GMA). The Nkala GMA is an area of 192 km^2 that was established to provide a buffer around the Kafue National Park and for sustainable wildlife management

through joint wildlife management strategies between local communities and the Zambian Wildlife Authority. **Figure 6-4** demonstrates the project site in relation to the Kafue National Park and the Nkala GMA.

Figure 6-4: Location of Project Site in Relation to the Kafue National Park and the Nkala GMA[13]

<u>Mammals</u>

The Powerhouse site is classified as Prime Hunting Area as it is located within the Nkala GMA and within close proximity to the Kafue National Park (i.e., the Powerhouse site is approximately 4 km from the Kafue National Park). A total of 12 mammal species are commonly observed in close proximity to the powerhouse site, and include species of trophy value such as Lion (*Panthera leo*) and Leopard (*Panthera pardus*). Other animals commonly observed close to the project site include, Elephant (*Loxodonta Africana*), Buffalo (*Syncerus caffer*), Waterbuck-Defassa (*Kobus ellipsiprymnus*), Impala (*Aespyceros melampus*), Wild dog (*Lycadon pictus*), Rock Hyrax (*Procavia spp*.; Figure 5-5), Zebra-Burchell's (*Equus burchelli*), Reedbuck (*Redunca arundinum*), Eland (*Taurotragus oryx*) and Blue wildebeest (*Connochaetes taurinus*). The conservation status of these species is provided in **Table 6-4**. Protected species identified include the Leopard (IUCN-Near Threatened), Lion (IUCN-Vulnerable) and Elephant (IUCN-Vulnerable). No other species were identified as conservation significant.

An established Elephant corridor occurs in close proximity to the power house site and is used by the animals to pass between the Kafue River and the Nkala GMA and Kafue National Park. This corridor is used at both dawn and dusk and runs from southwest of the Powerhouse

[13] http://www.african-elephant.org/aed/pdfs/aesr2007s.pdf and http://www.african-elephant.org/aed/aedquest/pdfs/AED02Rngszm.pdf

site (i.e., Kafue National Park), to the north east where it runs in close proximity to the construction workshop and the explosives magazine. The precise alignment of the corridor is not known, however it is unlikely to occur less than 200m from the sites of any Project facilities.

The rocky outcrop hill located at the northwest corner of the powerhouse site provides prime habitat for the Rock Hyrax (**Figure 6-5**). Habitat for the Rock Hyrax is includes the hills with rocky outcrops between the project site and Musungwa Lodge. Little is known about the population status of the Rock Hyrax on this site.

Figure 6-5: Rock Hyrax (*Procavia spp.*)

Table 6-4: Mammals Commonly Observed Within and in Close Proximity to the Power House Site

Common name	Scientific name	IUCN Conservation status
Leopard	*Panthera pardus*	Near Threatened
Lion	*Panthera leo*	Vulnerable
Elephant	*Loxodonta africana*	Vulnerable
Buffalo	*Syncerus caffer*	Least concern
Waterbuck	*Kobus ellipsiprymnus*	Least concern
Reedbuck	*Redunca arundinum*	Least concern
Blue wildebeest	*Connochaetes taurinus*	Least concern
Impala	*Aepyceros melampu*	Unknown
Wild dog	*Lycadon pictus*	Unknown
Rock Hyrax	*Procavia spp*	Unknown

Zebra	*Equus burchelli*	Unknown
Eland	*Taurotragus oryx*	Unknown

A total of 15 mammals are occasionally observed within or in close proximity to the powerhouse site. They include Bush pig (*Potamochoerus larvatus*), Kudu (*Tragelephus strepsiceros*), Hyena (*Crocuta crocuta*), Sable (*Hippotragus niger*), Roan (*Hippotragus equinus*), Yellow Baboon (*Papio cynocephalus*), Vervet Monkey (*Chlorocebus pygerythrus*), Warthog (*Phacochoerus aethipicus*), Bushbuck (*Tragelaphus scriptus*), Hippopotamus (*Hippopotamus amphibious*), Grysbok (*Raphicerus sharpie*), Common Duiker (*Sylvicapra grimmia*), Hartbeest (*Alcelaphus lichtensteini*), Greater Cane Rat (*Thryonomys swinderianus*), and Otter (*Aonyx capensis*). The conservation status of these species is provided in **Table 6-5**. Protected species identified include the Hippopotamus (IUCN-Vulnerable). No other species were identified as conservation significant.

Table 6-5: Mammals Occasionally observed Within or in Close Proximity to the Power House Site

Common name	Scientific name	IUCN Conservation status
Hippopotamus	*Hippopotamus amphibious*	Vulnerable
Sable	*Hippotragus niger*	Least Concern
Kudu	*Tragelephus strepsiceros*	Least concern
Hyena	*Crocuta crocuta*	Least concern
Bush Pig	*Potamochoerus larvatus*	Least concern
Roan	*Hippotragus equinus*	Least concern
Yellow Baboon	*Papio cynocephalus*	Least concern
Vervet Monkey	*Chlorocebus pygerythrus*	Least concern
Warthog	*Phacochoerus aethipicus*	Least concern
Bushbuck	*Tragelaphus scriptus*	Least concern
Grysbok	*Raphicerus sharpie*	Least concern
Common Duiker	*Sylvicapra grimmia*	Least concern
Hartebeest	*Alcelaphus lichtensteini*	Least concern
Greater Cane Rat	*Thryonomys swinderianus*	Least concern
Otter	*Aonyx capensis*	Least concern

Reptiles and Amphibians

The Kafue River provides habitat for a variety of reptiles and amphibians (**Table 6-6**). A total of seven reptiles and five amphibians are commonly observed within and in close proximity to the power house site. Crocodiles are commonly observed downstream by the banks of the river as the presence of rocky banks and vegetation provides ideal habitation for these reptiles.

Protected species identified include the African Rock Python (*Python sebae*; IUCN-Endangered) and the Leopard tortoise (*Geochelone pardalis*). No other species were identified as conservation significant.

Table 6-6: Reptiles and Amphibians Commonly Observed in the Kafue River and in close proximity to the Power House Site.

Common name	Scientific name	IUCN Conservation status
Reptiles		
African Rock Python	*Python sebae*	Endangered
Flap-necked chameleon	*Chameoleo dilepis*	Least concern
Nile monitor lizard	*Varanus niloticus*	Least concern
Crocodile	*Crocodylus niloticus*	Least concern
Cobra	*Naja mossambica*	Least concern
Leopard tortoise	*Geochelone pardalis*	Unknown
Puff adder	*Bitis orientans*	Unknown
Amphibians		
Giant bullfrog	*Pyxicephalus adspersus*	Least concern
Mottled-shovel nosed frog	*Hemisus marmoratus*	Unknown
Grass frog	*Ptychadena spp*	Unknown
Foam nest frog	*Chiromantis xerampelina*	Unknown

Avifauna

The Project site is located close to a number of important wildlife conservation zones. The Kafue Flats, is classified as an Important Bird Area[14]. Additionally, the Lochinvar and Blue Lagoon National Parks, which occur within the Kafue flats approximately 120 km and 150 km east of the powerhouse site, comprise Ramsar sites[15]. Together, these sites have approximately 400 species of birds. The majority of these species are present throughout the year, however some migrate from Eurasia, Northern and Southern Africa such as European Hobby (*Falco subbuteo*.) and Peregrine Falcon (*Falco peregrinus*).

Table 6-7 provides a list and the conservation status of bird species that occur within the Nkala GMA and in close proximity to the powerhouse site. The Whitebacked Vulture (*Gyps africanus*) is listed as IUCN-Endangered. No other species were identified as conservation significant.

Table 6-7: Birds of the Nkala GMA and in Close Proximity to the Power House Site

[14] Important Bird Areas (IBAs) are considered by BirdLife International to be key sites for conservation. In order to be identified as an IBA, a site must have one (or more) of the following functions, hold significant numbers of one or more globally threatened species; are one of a set of sites that together hold a suite of restricted-range species or biomerestricted species; and/or have exceptionally large numbers of migratory or congregatory species.

[15] Ramsar sites are considered by the Ramsar Convention to be wetlands of international significance.

Common name	Scientific name	IUCN Conservation status
Whitebacked Vulture	*Gyps africanus*	Endangered
Cattle Egret	*Bubulcus ibis*	Least concern
Pied Kingfisher	*Ceryle rudis*	Least concern
Grey Heron	*Ardea cinerea*	Least concern
African Darter	*Anhinga rufa*	Least concern
Hamercop	*Scopus umbretta*	Least concern
Grey Hornbill	*Tockus nasutus*	Least concern
Yellow billed stork	*Mycteria ibis*	Least concern
Crowned Hornbill	*Tockus alboterminatus*	Least concern
Trumpeter Hornbill	*Bycanistes bucinator*	Least concern
Red billed quelea	*Quelea quelea*	Least concern
Greenshank	*Tringa nebularia*	Least concern
European Swallow	*Hirundo rustica*	Least concern
Woogland Kingfisher	*Haleyon senegalensis*	Least concern
Euorpean Bee-eater	*Merops apiaster*	Least concern
Openbilled stork	*Anastomus lamelligerus*	Least concern
Knobbilled Duck	*Sarkidiornis melanotos*	Least concern
Black kite	*Milvus migrans*	Least concern
Honey buzzard	*Pernis apivorus*	Least concern
Blackwinged Stilt	*Himantopus himantopus*	Least concern
Rock Pratincole	*Glareola nuchalis*	Least concern
Blue-cheeked bee-eater	*Merops nubicoides*	Least concern
Broadbilled Roller	*Eurystomus glaucurus*	Least concern
European Sedge Warbler	*Acrocephalus schoenobaenus*	Least concern
Greatspotted Cuckcoo	*Clamator glandarius*	Least concern
Black cuckcoo	*Cuculus clamosus*	Least concern
Peregrine Falcon	*Falco peregrinus*	Least concern
European Hobby	*Falco subbuteo*	Least concern
Spurwinged Goose	*Pletctropreus gambensis*	Unknown

Common name	Scientific name	IUCN Conservation status
Egyptian Goose	*Alpochen aegyptiacus*	Unknown
Giant Kingfisher	*Ceryle maxima*	Unknown
Barteleur Eagle	*Terathiopius ecaudatus*	Unknown
Lilac breasted Roller	*Coracias caudate*	Unknown
Water Dikkop	*Burhinnus vermiculatus*	Unknown
Blacksmith Plover	*Vanellas armatus*	Unknown
Redbilled Teal	*Anas erythrohyncha*	Unknown
Cape Turtle Dove	*Streptpelia capicola*	Unknown
African Skimmer	*Rhynchops flavirostris*	Unknown
Lappet-faced vulture	*Torgos tracheliotus*	Unknown
Ground hornbill	*Burcorvus leadbeateri*	Unknown
Marsh Sandpiper	*Tringa stagnattilis*	Unknown
Common sandpiper	*Actitis hypoleucoc*	Unknown
Yellowbilled kite	*Milvus aegyptius*	Unknown

Prior to the construction of the Itezhi-Tezhi Dam, the Kafue Flats was an important nesting site for water birds. Following the dams construction, significant changes have been observed in water bird populations. It is suggested that these changes are attributed to altered flood regimes and the expansion of invasive plant species such as Giant Sensitive Tree (*Mimosa pigra*). The Giant Sensitive Tree is an invasive shrub that can spread through natural grassland floodplain ecosystems and pastures and convert them into unproductive scrubland which sustain lower levels of biodiversity (ISSG, 2012). While some smaller bird species that are typical of lagoon, swamp and brushland habitats have benefited from the presence of the invasive plant, larger species (primarily fish eating species) that are typical of open, muddy shorelines, have declined. Changes in the population of the Watttled Crane (*Grus carunculatus*) have been widely studied and have demonstrated a decrease in the population of this species since the construction of the dam. In the period 1972 to 2001, the mean population count was 2,718 which is a 60% decrease compared with 1,104 for the period 1993-2001 (SWP, 2003). Wattled Crane are heavily reliant on flood regimes of the Kafue Flats. They nest on flood plains as the water level subside, and their nesting sites are surrounded by deep water which acts as protection from predators. When flooding patterns are erratic and not timed appropriately, cranes may not breed. Additionally an unseasonal rise in water levels may result in breeding and nesting sites being submerged (SWP, 2003).

Fisheries

The Kafue River is rich in fish species and fisheries have been an important livelihood for people residing near the Kafue Flats (as described in **Section 8.4**). Data collected from 2007 to 2012 identified 23 fish species within the Kafue River (**Table 6-8**). The data demonstrates that there are variations in the in ‘catch per unit of effort’ and ‘index of relative importance’ amongst the species. The most common fish species present include Silver Butter Catfish (*Schilbe intermidius*), Lake Tanganyika Sardine (*Limnothrissa miodon*), and Striped Robber

(*Brycinus lateralis*). Commercially viable species such as Silver Butter Catfish, Striped Robber, Threespot Tilapia (*Oreochromis andersonii*), Greenhead Tilapia (*Oreochromis macrochir*) and Purpleface largemouth (*Serranochromis macrocephalus*) recorded lower numbers in recent years compared with long-term values which may indicate over fishing of these species, this is also reflected in the Catch per Unit Effort values as there are very high fluctuations of these species. The Kafue Killifish (*Nothobranchius kafuensis*), an endemic fish to the Kafue Flats region, is also known to occur in the Kafue River. The Threespot Tilapia and Greenhead Tilapia are both considereds IUCN-Vulnerable. No other conservation significant species were recorded.

Table 6-8: Experimental Catch Statistics and Index of Relative Importance of Fish Species in close proximity to the Power House Site

Common Name	Species	Range (Catch Per Unit Effort)	Index of Relative Importance	IUCN Conservation Status
Threespot Tilapia	*Oreochromis andersonii*	0-1600	1.45±2.52	Vulnerable
Greenhead Tilapia	*Oreochromis macrochir*	0-1600	1.52±2	Vulnerable
Silver Butter Catfish	*Shilbe intermedius*	67-15300	33.07±22.72	Unknown
Purpleface largemouth	*Serranochromis macrocephalus*	2-700	0.72±0.98	Least concern
African Blunt-toothed Catfish	*Clarius ngamensis*	0-400	0.78±0.87	Unknown
African Sharp-tooth catfish	*Clarius gariepinus*	4-700	3.47±4.57	Unknown
Yellowbelly Bream	*Serranocromis robustus*	0-1000	0.48±1.13	Unknown
Redeyed labeo	*Labeo cylindricus*	20-2900	2.73±2.52	Least concern
Speckleface bream	*Serranochromis angusticeps*	2-600	0.48±0.39	Least concern
Redbreast Talapia	*Tilapia rendalli*	7-1600	0.82±1.44	Least concern
Western Bottlenose	*Mormyrus larcerda*	0-700	0.17±0.44	Unknown
Striped Robber	*Brycinus lateralis*	0-12500	10.58±8.07	Least concern
Straightfin Barb	*Barbus paludinosus*	0-15100	2.13±3.03	Least concern
Southern Mouth-Brooder	*Pseudocrenilabrus philander*	0-3100	0.45±1.11	Unknown
Banded tilapia	*Tilapia sparrmanii*	0-1500	1.32±1.49	Unknown
Kafue Catfish	*Synodontis kafuensis*	0-7500	2.87±2.57	Unknown
Smooth spine spot Barb	*Barbus poechi*	0-8700	1.48±1.85	Unknown
Lake Tanganyika Sardine	*Limnothrissa miodon*	169-62700	16.47±17.09	Least concern
Serranochromis	*Serranochromis*	0-400	0.05±0.08	Unknown

Common Name	Species	Range (Catch Per Unit Effort)	Index of Relative Importance	IUCN Conservation Status
	thumbergii			
Kafue Pike	*Hepsetus odoe*	2-1200	0.33±0.51	Least concern
Bulldog-fish	*Marcusenius macrolepidotus*	16-1800	1.02±1.13	Least concern
Barilius	*Barilius spp*	0-100	0.00	Unknown
Churchill	*Petrocephalus catastoma*	0-400	0.15±0.39	Unknown

Seasonal flooding in the Kafue Flats is considered to be the most important ecological process maintaining biodiversity. During flooding, fish migrate into the floodplain to spawn, hatching is then delayed until the following year, when flooding occurs. Changes in fish species have been reported following the construction of the Kafue Gorge and the Itezhi-Tezhi Dams Declines in species diversity and species composition have occurred and are due to disturbance from fluctuating water levels. Changes in fish community structure can be attributed to water level fluctuations, increased population on the floodplains and increased fishing pressure[16].

The Kafue River supports many areas of Reed (*Phragmites*) vegetation downstream of the Powerhouse site. Reeds provide habitat and food rich environments for fish, including supporting fish spawning. During the boat survey, stands of reeds established on sediment pans were observed at various locations within the Kafue River, and along banks of the river, downstream of the Project Site (**Figure 6-6**).

Figure 6-6: *Phragmites* (Reeds) Provide Fish Habitat Along the Banks of the Kafue River.

[16] Scott Wilson Piesold (2003). Integrated Kafue River Basin Environmental Impact Study: State of the Environment Report, Pg 4-32 to 33

The Kafue River supports populations of the Redclaw Crayfish (*Cherax quadricarinatus*; **Figure 6-7**). This fast growing omnivorous species is reported, by local fishermen, to have negative effect on fish catch due to the crayfish feeding on fish that have been caught in nets. The impact on the fish catch in terms of market value is not yet understood as is its distribution, abundance and density in the middle Kafue River. The invasive fish species, Nile Tilapia (*Oreochromis niloticus*), is also known to occur in the Kafue River.

Figure 6-7: The *Cherax quadricarinatus* (Redclaw Crayfish)

Value of Habitat

The IFC Performance Standard 6 divides habitat into the following three characterisations:

- <u>Modified habitats</u> 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.
- <u>Natural habitats</u> 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.
- <u>Critical habitats</u> as those 'areas with high biodiversity value', including:

  (i) habitat of significant importance to Critically Endangered and / or Endangered species;

  (ii) habitat of significant importance to endemic and / or range-restricted 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.

Based on the above definitions, the powerhouse site is considered to contain Natural Habitat. The site is located within the Nkala GMA which (194 km^2), of which approximately 0.5 km^2 of land will be cleared to provide for the construction of the Powerhouse and the associated on-

site facilities. Vegetation within much of the site is largely intact and is characteristic of the wider Miombo Woodland, however some level of disturbance occurs due to the existing D769 Road and the road to Shantanda (see Figure 3-3). Two IUCN-endangered species, the African Rock Python and the White backed Vulture, are commonly observed within or in close proximity to the Powerhouse site. The Powerhouse site is not considered to provide 'habitat of significant importance' for these species, due to the level of disturbance discussed above. Additionally, with reference to the Rock Python the presence of rocks and rocky vegetation surrounding the Powerhouse site make ideal habitat for most reptiles, rather than habitat within the powerhouse site. Therefore the Powerhouse site is not considered to provide Critical Habitat.

The baseline demonstrates that the operation of Itezhi-Tezhi Dam has changed the flow regime of the Kafue River and the flooding regime of the Kafue Flats, which has decreased the area of the Kafue Flats that experiences periodic flooding and increased the area of land that is permanently flooded. This has altered habitats of a range of flora and fauna and resulted in the following changes:

- increase in some fauna species, such as small bird species;
- decline in the abundance of avian fauna (including large bird species such as the Wattled Crane);
- decline in fish species diversity, species composition, and community structure; and
- proliferation of invasive flora, such as the Giant Sensitive Tree.

The operation of the Project will be carried out to align with the existing discharge regime of the Itezhi-Tezhi dam, therefore is not envisaged to result in any changes to the downstream hydrology of the Kafue River. However, the operation of the hydropower station has the potential to alter the water hydrology of the Kafue River and the Kafue Flats. **Table 6-9** summarises valuable habitat in proximity to the Project Site.

Table 6-9: IFC Habitat Assessment

Area	Habitat Values	IFC Habitat assessment
Powerhouse site (Nkala GMA)	Within the protected Nkala Game Management Area. (IUCN VI 'Protected area with sustainable use of natural resources). Provides habitat to endangered species.	Supports 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. Therefore considered to provide 'Natural Habitat'.
Kafue Flats	Important Bird Area Provides habitat to endangered species. Lochinvar National Park (Ramsar Site) Blue Lagoon National Park (Ramsar Site)	Habitat of significant importance to endemic and / or range-restricted species. habitat supporting globally significant concentrations of migratory species and / or congregatory species; highly threatened and / or unique ecosystems. Therefore considered to provide Critical Habitat'.

6.1.3 Potential Impacts

The following ecological impacts have been identified as a likely result of the project activities. A worst-case scenario has been adopted to ensure the most significant impacts have been identified.

Construction

- Clearance of vegetation and loss of habitat;
- Noise and vibrational disturbance to wildlife;
- Disturbance to fauna from increased people and vehicle movements;
- Promote Invasive flora and Fauna; and
- Dust impacts on vegetation.

Operations

- Disturbance due to changes in water quality;
- Disturbance due to changes in hydrology;
- Risk of wildlife death as a result of impacts on water quality; and
- Promote invasive flora and Fauna.

Construction

Clearance of vegetation and loss of habitat

Construction works at the powerhouse site will involve the clearance and excavation of approximately 50 ha of land to provide for the construction of the power house, switchyard, construction workshop, roads and associated on-site ancillary facilities (refer to **Section 3.5**). Additionally, 7.6 Ha will be cleared for off-site ancillary facilities. **Table 6-10** details the extent of vegetation to be cleared as part of the Project. Of the total 57.6 ha to be cleared, approximately 15 ha will be rehabilitated following the completion of construction and is therefore considered to be habitat that is temporarily lost. The other 42.6 ha provide for Project infrastructure and therefore habitat loss will be permanent. Vegetation loss as a result of construction is anticipated to have a minor ecological impact on flora species present within the Project site as tree and shrub species are abundant throughout the Miombo region. None of the vegetation communities or flora species that will be impacted are threatened or of limited extent, or are otherwise critical habitat (as defined in IFC Performance Standard 6) for rare or threatened flora and fauna.

Table 6-10: Vegetation Clearance Areas

Project Component	Area of Occupation (ha)
Power house site	50
Sewerage treatment plant	0.6
Accommodation camp	6
Water treatment plant	1

The clearance and excavation of land as described above will result in both the temporary and permanent loss of habitat for some fauna species. The displacement of Fauna will be limited to the footprint of project infrastructure (0.5 km^2) which represents approximately 0.25% of the overall 194 km^2 area of the Nkala GMA. The remaining area of the Nkala GMA provides appropriate suitable habitat.

Clearance works and blasting that will be carried out to provide for the powerhouse and surge shaft will result in the destruction of habitat of the Rock Hyrax. The rocky outcrop hill that borders the northwest corner of the Powerhouse site provides significant habitat for this

species. The impact is considered to be relatively low due to the availability of an approximately 1 km^2 area of suitable habitat immediately adjacent to the excavation site (**Figure 3-3**). The local population status of the hyrax is not well understood, therefore monitoring of this species is considered to be important to determine its population status and continue to monitor the population throughout the construction of the Project.

Overall the clearance of vegetation and loss of habitat is considered to be ‘medium’.

Noise and vibration disturbance to wildlife

Fauna species reported to occur within and surrounding the project area are likely to be affected by construction noise and blasting works carried out during construction. Key fauna species that have been identified as likely to be disturbed include Elephant, Rock Hyrax, Buffalo, Waterbuck, Puku and Impala. These species are sensitive to noise as they use noise for communication for both navigation and reproduction. Of primary concern are the Elephant and Impala as these species are known to be highly sensitive to noise.

Disturbance to Elephants from blasting is considered to be a high level impact, given that it has the potential to impact on individual species, reproduction, and the well established migration route that traverses within close proximity to the site. Additionally, Elephants are known to react violently to noise and the species is considered iconic. Impacts to Elephants during construction will be temporary and localised to the site and are not likely to impact on water supply due to the abundance of habitat outside of the Project area and water supply provided by both the Itezhi-Tezhi dam and the Kafue River.

Noise and blasting are likely to impact upon bird species, however this is envisaged to be low considering that impacts will be temporary and the area that noise will impact upon is minor compared with the availability of habitat both upstream and downstream of the power house site.

Impacts from blasting are also discussed in **Section 6.2**.

Disturbance to fauna from increased people and vehicle movements

Species of high trophy value have been identified within or in close proximity to the project site, therefore hunting pressures may occur from an increased workforce in the area.

It is unlikely that accidents between fauna and vehicles and machinery will be more than a rare occurrence. Construction materials and workforce will be transported to site from the northeast (via the D769 Road), therefore the majority of activity will occur within 1.2 km from the northwest boundary of the Nkala GMA and within an area that is less than 1 km^2, which is approximately 0.5% of the overall area of the Nkala GMA. Additionally, ongoing disturbance due to construction and blasting is likely to displace fauna from traversing near the Project site, which will limit the presence of fauna within the site.

The potential for conservation significant and highly iconic species such as the Leopard (IUCN-Near threatened), Lion (IUCN-Vulnerable), and Elephant (IUCN-Vulnerable), may occur within or in close proximity to the site results in the disturbance to fauna to be considered a ‘medium’ level impact.

Dust impacts on vegetation

Physical site disturbance during dry weather may generate dust and dust deposition on vegetation. Given the baseline conditions of soils and the lack of existing sealed roads that run through the site, dust generation is likely to be comparable with existing baseline conditions. Therefore this impact is considered to be low.

Dust impacts are also discussed in **Section 7.1**.

Disturbance to conservation significant habitats

Potential impacts to Natural Habitat from the construction of the Project are limited to land clearance of the Powerhouse site. The clearance of the Powerhouse site represents approximately 0.25% area of the Nkala GMA, therefore the overall impact is considered to be low. This impact is consistent with the impact 'Clearance of vegetation and loss of habitat' described above.

No impacts to critical habitats (Kafue River and Kafue Flats) are expected from the construction of the Project.

Operation

Disturbance due to changes in water quality

Potential changes to water quality are discussed in **Section 6.3**. The release of low level water within the Itezhi-Tezhi Reservoir to the Kafue River may result in the release of water that is anoxic, cold, and has high levels of nutrients and dissolved H_2S. This is likely to impact on water quality downstream of the Project site. Water that is anoxic and has high levels of dissolved H_2S, is highly toxic to fish. The release of anoxic water may lead to direct impacts such as fish kills as has previously been associated with the site. The potential for this to occur is discussed in detail in **Section 6.3**.

However, the largest ecological impacts with respect to water quality impacts are likely to be associated with potential increased nutrient loads within the Kafue River. Suspended sediments and dissolved nutrients and ions trapped within the bottom waters of the dam may be released through the power plant (in particular organic carbon, nitrogen, phosphorous and iron). This may act to stimulate production of aquatic species within the river and potentially more broadly across the flood plain. However, there is also the potential for eutrophication events to arise, leading to algal blooms and weed infestations by both flora and fauna species (e.g. nile tilapia, red claw crayfish, water hyacinth) (Alsterhag and Patersson, 2004). It is noted though that regular long term discharges (ie. several months) do occur from the NDT as part of current dam operations and these have not been associated with significant downstream elevations in nutrients load or eutrophication events.

The operation of the power plant may lead to a release of water with higher concentrations of suspended sediments that potentially contains elevated concentrations of metal contaminants. High concentrations of iron and manganese may be toxic to aquatic life and may result in the heavy metals entering the food chain leading to bio-accumulation of heavy metals into tissues, therefore this impact is considered to be potentially significant. Increased suspended sediment may also result in the smothering of vegetation which is considered to be a potentially significant impact.

Overall, the potential disturbance due to changes in water quality are considered to be high in terms of its ecological impact.

Disturbance due to changes in hydrology

The Itezhi-Tezhi hydropower plant and Itezhi-Tezhi dam will operated in co-ordination to ensure that the discharge from the dam will replicate the existing discharge regime from the dam. Under this scenario there will be a negligible change in the volume and timing of water flows compared with the existing regime (discussed in **Section 6.4**), therefore it is unlikely that impacts associated with altered hydrology of the Kafue River and the Kafue Flats will occur.

However, it is stressed that if the power plant is unable to follow the existing discharge pattern (**Section 3**), then it is likely that there will be impacts upon the downstream flooding regime which may significantly alter the Kafue Flat wetlands. Seasonal flooding in the Kafue Flats is considered to be the most important ecological process that maintains biodiversity within the

flats. The baseline demonstrates that the discharge from the Itezhi-Tezhi dam has previously influenced the ecology of the downstream Kafue River and Kafue Flats. The operation of the Itezhi-Tezhi dam is understood to have increased the area of permanently inundated land within the Kafue Flats, while reducing the surface area within the flats that is influenced by periodic inundation. The resulting impacts include disturbances to aquatic and terrestrial flora and fauna, and altered habitats for a range of species.

However, it should be noted that although the net volume of discharges to the Kafue Flats will not vary under operation, there will be local changes to hydrology as a result of the majority of discharge will occur through the power plant tailrace instead of the main spillway or the NDT. These impacts (see **Section 6.3**) will lead to alterations in local water levels and flow rates / flushing within:

- the 300m channel from the spillway to the main river channel;
- the approximately 200m backwater area between the NDT discharge location and the tailrace; and
- the vegetated sandbank directly located immediately downstream of the tailrace discharge.

Reductions in flushing rates and volumes in both the spillway channel and NDT backwater may result in minor changes in riparian vegetation upon the banks of the river in these sections. However, the discharge of the tailrace directly onto the vegetated sandbank immediately downstream may lead to gradual erosion of this sandbank and associated vegetation (approximately 3 ha). This patch of vegetation is not known to represent primary habitat for any threatened species or communities. Most species likely to inhabit the bank are tolerant of inundation.

<u>Disturbance due to release of odorous gases.</u>

The release of H_2S gas will occur during the project operation associated with release of anoxic waters drawn from the bottom of the dam. This is likely to be a short term but potentially recurrent impact. In sufficient quantities H2S can be toxic to animal species. It is unlikely H2S densities will reach such levels, with odour acting more as an annoyance to local species. Nuisance odours are likely to be limited to the powerhouse site and will not significantly differ to existing odour issues associated with the discharges of the NDT.

<u>Disturbance to critical habitats</u>

As the current operation of the NDT as part of dam operation generates similar impacts to those proposed under the power plant, it is difficult to evaluate the degree to which the scale of impacts may vary. **Section 6.3** provides a detailed description of the likely water quality impacts and potential mitigation measures associated with the project. Provided these measures are applied, it is considered that there will be no significant disturbance to critical habitat. None of the other impacts identified above are seen to impact upon critical habitat or significantly impact endangered species. As such a Biodiversity Action Plan under IFC PS 6 has not been prepared. Should the results of water quality monitoring as specified in **Section 6.3** indicate there are significant risks for such impacts to arise, the need for a Biodiversity Action Plan should be revisited.

6.1.4 Mitigation Measures

Impacts experienced during construction are predominantly related to terrestrial fauna and flora, and operational impacts are largely related to aquatic flora and fauna. Mitigation measures to address each of the identified impacts to Ecology are provided in **Table 6-11**.

Table 6-11: Mitigation Measures for Ecological Impacts

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
1	Clearance of vegetation and loss of habitat	Construction	Medium	Clearance of vegetation and habitat will be minimised, where practicable, and limited to the construction footprint. Bare earth surfaces to be re-vegetated or sealed as soon as possible following completion of immediate construction works (i.e. site re-vegetation and rehabilitation shall occur progressively throughout construction in accordance with an Ecology Management Plan). Refer to **Section 7.11.** Large trees (>1 DBH) will be retained where practicable. A Rock Hyrax monitoring program will be carried out to determine the current population status of this species within habitat adjacent to the Powerhouse site and monitor this population throughout construction. Data gathered to be reviewed periodically to identify whether mitigation can be implemented to reduce any impacts that the project may be having on the local population. Provide suitable electricity or alternative fuel at accommodation and construction workshop facilities. Employees and contractors no permitted from destroying trees at Project sites, beyond that required as part of clearance for project facilities.	Negligible
2	Noise and vibration as a result of construction activities and equipment leading to disturbance of wildlife	Construction	Medium	Blasting to be carried out in accordance with the Blast Management System (refer to **Section 6.2**). Blasting to cease if fauna are observed within the powerhouse site. Blasting to cease if Elephants are observed within or in close proximity to the Powerhouse site.	Very Low

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
				Blasting to re-commence once Elephants have left the area.	
3	Disturbance to fauna from increased people and vehicle movements	Construction Operation	Medium	Monitoring to identify the presence of harm to wildlife. Remediation measures implemented where harmful effects identified.	Very Low
4	Death of terrestrial fauna as a result of construction equipment and vehicles or Project workers	Construction Operation	Medium	Vehicle movements to be subjected to specified site speed limits to negate any risks of accidents with wildlife. A 40 km speed limit at the Powerhouse site is suggested. A no hunting policy to be employed for all employees and contractors. Records to be kept of all wildlife or livestock mortalities (e.g. road kill) that is directly attributable to the construction and operation of the Project. The data gathered will be reviewed periodically to identify whether mitigation can be implemented to reduce incidental mortality.	Very Low
5	Site disturbance leading to growth of invasive flora and fauna. Changes in water quality may also generate conditions favourable for the growth of noxious weeds and pests.	Construction (Terrestrial) Operation (Aquatic)	High	Annual inspections to be undertaken to identify presence of invasive flora and fauna. Suitable eradication measures can be instigated promptly following confirmation of invasive species. Carry out an ongoing monitoring study of the Red Claw Lobster to monitor the abundance and distribution of the species. Carry out hydrology mitigation measures outlined in **Section 6.4**, to prevent changes in flooding regime/areas of inundation of the Kafue Flats.	Low
6	Construction dust smothering local vegetation	Construction	Low	Carry out dust suppression measures such as water spraying on exposed soils and unsealed roads, to minimise dust generation.	Negligible
7	Disturbance in downstream	Construction	Extreme	Carry out water quality mitigation measures outlined	High

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
	ecosystems as a result of changes in water quality.	Operation		in **Section 6.3**) Carry out yearly consultation with Department of Fisheries and obtain data on Kafue River fisheries. Determine whether any correlation occurs between the operation of the power plant and change in fisheries composition.	
8	Fish kills and aquatic flora and fauna death due to changes in water and sediment quality (e.g. temperature shocks, eutrophication events, anoxic water discharge)	Operation	High	Carry out water quality mitigation measures outlined in **Section 6.3**. Carry out yearly consultation with Department of Fisheries and obtain data on Kafue River fisheries. Determine whether any correlation occurs between the operation of the power plant and change in fisheries composition. Regular visual inspection of downstream habitat areas to observe any changes in condition and extent potentially arising from changes in water quality Regular visual inspection for the occurrence of algal blooms	Medium
9	Ecological disturbance due to changes in hydrology.	Operation	Low	Carry out hydrology mitigation measures outlined in **Section 6.4**). Operation of the hydropower station to be consistent with the dams existing operating rule curve. Regular visual inspection of local and downstream habitat areas to observe any changes in condition and extent potentially arising from changes in hydrological condition.	Negligible

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
10	Disturbance to local fauna due to release of odiferous gases.	Operation	Low	Carry out air quality mitigation measures outlined in **Section 7.1**).	Negligible

6.1.5 Residual Risks

Following the application of the specified mitigation measures listed in **Table 6-11** the residual impact risk in terms of ecological impacts is considered to be generally low. However, the potential ecological impacts downstream associated with discharge of waters drawn from the base of the dam are recognised as residual risks of significance due to the wide ecological area over which these impacts may be felt. A full discussion of the potential to mitigate these impacts is provided in **Section 6.3**.

6.2 Noise and Vibration

6.2.1 Methodology

The assessment of noise impacts on sensitive receivers from the construction and operation of the Project adopted operational noise limits provided by the IFC Environmental, Health, and Safety (EHS) Guidelines, General EHS Guidelines: Environmental Noise Management[17] (IFC, 2007). Acceptable noise levels provided in the guideline are presented in **Table 6-12**. According to the guidelines, noise levels should not exceed the levels present, or result in a maximum increase in background levels of 3 dB at the nearest receptor location off-site.

Table 6-12: IFC Noise Level Guidelines.

Receptor	One Hour L_{Aeq} (dBA) Daytime 07:00 - 22:00	One Hour L_{Aeq} (dBA) Night time 22:00 - 07:00
Residential; institutional; educational	55 (free field)	45 (façade)
Industrial; commercial	70 (free field)	70 (free field)

A façade noise level of 45 dB L_{Aeq} is equivalent to an internal noise level of approximately 30 dB L_{Aeq} assuming that the buildings windows are partly open (WHO, 1999). An internal noise level of 30 dB is not considered to cause sleep disturbance, therefore this criterion has been used for this assessment (WHO, 1999).

The acoustic specifications of equipment to be used during construction of the Project were not available, therefore non-basting noise levels generated during construction have been predicted using sound power levels provided in the British Standard BS 5228: 2009 ‘Control of noise and vibration from construction and open sites’ (BSI, 2009).

Predicted construction noise levels at defined sensitive receivers have been assessed against the IFC noise level criteria detailed in **Table 6-12**. The significance of construction noise impacts are based on the level above a calculated maximum noise level that can be generated at the power house site that is considered not to exceed the IFC criteria at the closest sensitive receiver.

The assessment of noise from the construction and operation of the Project is particularly relevant to the power house site, rather than the off-site ancillary facilities as the latter are in at the final stages of construction (**Section 3.10**).

[17] Based on WHO (1999) Guidelines for Community Noise

Human Sensitive Receivers

The majority of noise sensitive receivers occur within a radius of between 1.2 to 2.2 km from the power house site (**Figure3-3**). **Table 6-13** provides a description of the sensitive receivers including their distance and direction from the power house site. Additionally, the western and eastern areas of Itezhi-Tezhi town are located approximately 2.5 km northwest and 3.0 km northeast of the power house site respectively. There are no sensitive receivers less that 1 km from the site.

Table 6-13: The Nearest Sensitive Receivers to the Power House Site.

Sensitive receiver	Distance from Powerhouse site.	Direction from Powerhouse site	Description
New Kalala Lodge	1.2 km	Southwest	Tourist safari lodge.
Cho'onga Farm	1.6 km	Northeast	Privately owned farm that is currently uninhabited.
Musungwa Compound	1.7 km	Southwest	Private dwellings, worker accommodation and school.
Melissa Farm	1.8 km	Northeast	Privately owned vegetable and livestock farm that provides accommodation for employees
Chibala Camp	1.9 km	Southwest	Lodge owned and operated by the Wildlife and Environmental Conservation Society of Zambia. There are also three private dwellings adjacent to this site.
Private dwellings and worker accommodation	2.0 km	Southwest	Three private dwellings and one building providing worker accommodation.
Musungwa Lodge	2.2 km	Southwest	Tourist safari lodge.

Ecological Sensitive Receivers

Noise sensitive fauna species including Elephant, Rock Hyrax, Buffalo, Waterbuck, Puku and Impala are commonly observed in close proximity to the power house site. These species use noise based communication for both navigation and reproduction and therefore are sensitive to noise disturbance. An established Elephant corridor occurs south of the power house site. This corridor is used by Elephants daily at dawn and dusk.

The sensitivity of ecological sensitive receptors to noise is discussed further in **Section 6.1**.

6.2.2 Baseline

To determine existing noise levels at the powerhouse site and sensitive receivers, baseline noise measurements were carried during over 3 days in June 2012[18]. The aim of these measurements was to record 'point source' noise levels to provide an indication of the existing noise levels. Measurements were carried out at 10 to15 minute intervals using a mobile noise measuring device. Day-time measurements were carried out between 9:00am and 5:00pm and a night-time measurements were carried out between 8:00pm and 10:00pm. The maximum and minimum results of noise measurements are presented in **Table 6-14**

Table 6-14: Existing Noise Measurements at Sensitive Receivers

	Day time noise levels 10-15 min measurements		Night time noise levels – 10-15 min measurements	
Sensitive receiver	Minimum L_{Aeq}, dBA	Maximum L_{Aeq}, dBA	Minimum L_{Aeq}, dBA	Maximum L_{Aeq}, dBA
New Kalala Lodge	34.0	64.4	29.3	41.9
Musungwa Lodge	36.2	62.6	-	-
Chibala Camp	30.5	51.4	-	-
Cho'nga Farm	31.4	34.9	-	-
Melissa Farm	35.6	67.2	-	-

The results of the noise measurements demonstrate that baseline noise levels at New Kalala Lodge, Musungwa lodge and Melissa Farm were all above the IFC day time criteria. The Chibala Camp and Choonga farm were below the IFC day time criteria. Night time noise levels recorded at the closest sensitive receiver were below the IFC night time criteria.

Additional to measuring the baseline noise levels, observations were made of possible sources that are likely to contribute existing ambient noise at the powerhouse site and off-site facilities. At the power house site, vehicles that use the D769 Road and the road to Shantanda provide the main source of existing noise (**Figure 3-3**). The dam spillway was also observed to contribute to night time ambient noise. At the locations of sensitive receivers, vehicle movements and general maintenance works are likely to be the primary source of noise, however the use of farming machinery was observed at Melissa Farm which is likely to have contributed to the relatively high readings recorded at this receiver (**Table 6-14**).

6.2.3 Impacts

Construction

<u>Noise</u>

The following non-blasting activities are considered to generate noise during construction:

- Site Clearance;

[18]Site clearance works were taking place at the power house site during this period. To prevent construction noise contributing to baseline levels, any measurements that were recorded while construction noise was observed were omitted from the baseline assessment.

- Earthworks;
- Excavations and foundations;
- Slab construction;
- Steelwork construction;
- Installation of equipment;
- Road construction;
- Aggregate crushing; and
- Concrete batching plant.

Construction activities will vary in their location and in the nature of equipment utilised across the power house site and throughout the 3.5 year construction period. Estimated noise levels (at 10 m from their source) associated with equipment used during the construction activities are provided in **Table 6-15**. In the absence of equipment specifications, the precautionary principle was applied, therefore the majority of estimates are considered 'worst case scenarios'.

Table 6-15: Estimated Construction Noise Levels[19]

Construction Equipment / Activity	L_{Aeq} (dB) at 10 m
Backhoe	68
Chainsaw	86
Dozer	81
Drilling rig (tracked) – drilling blast holes	92
Concrete batching plant	80
Cement mixer truck	75
Concrete mixer	76
Concrete mixer truck	80
Concrete pump	78
Concrete saw	91
Dump truck – empty load	87
Excavator (tracked)	79
Excavator / wheeled loader – loading dump truck	91
Grader	86
Hydraulic hammer rig – piling	87
Loader	80
Loader - loading dump truck	91
Lorry	80
Rock breaker (excavator mounted)	95
Rock crusher (semi mobile)	96

[19] Source: British Standard BS 5228: 2009 'Control of noise and vibration from construction and open sites'

To breach the IFC night time noise limits of 45dB (façade) at the nearest (1.2 km) residential site, noise generated during construction would need to exceed L_{Aeq} 91dB at 10m from the source. According to the predicted noise levels in **Table 6-15**, construction equipment and activities that may exceed 91dB at 10m from the source include the drilling of blast holes using a tracked drilling rig, the operation of an excavator mounted rock breaker and the operation of a semi-mobile rock crusher. It is considered unlikely that construction noise will not exceed IFC daytime criterion of 55dB (free field). Taking into consideration the large distance of noise sensitive receivers from the site and the short term nature of construction noise impacts, non-blasting construction noise impacts are assessed to be a medium risk.

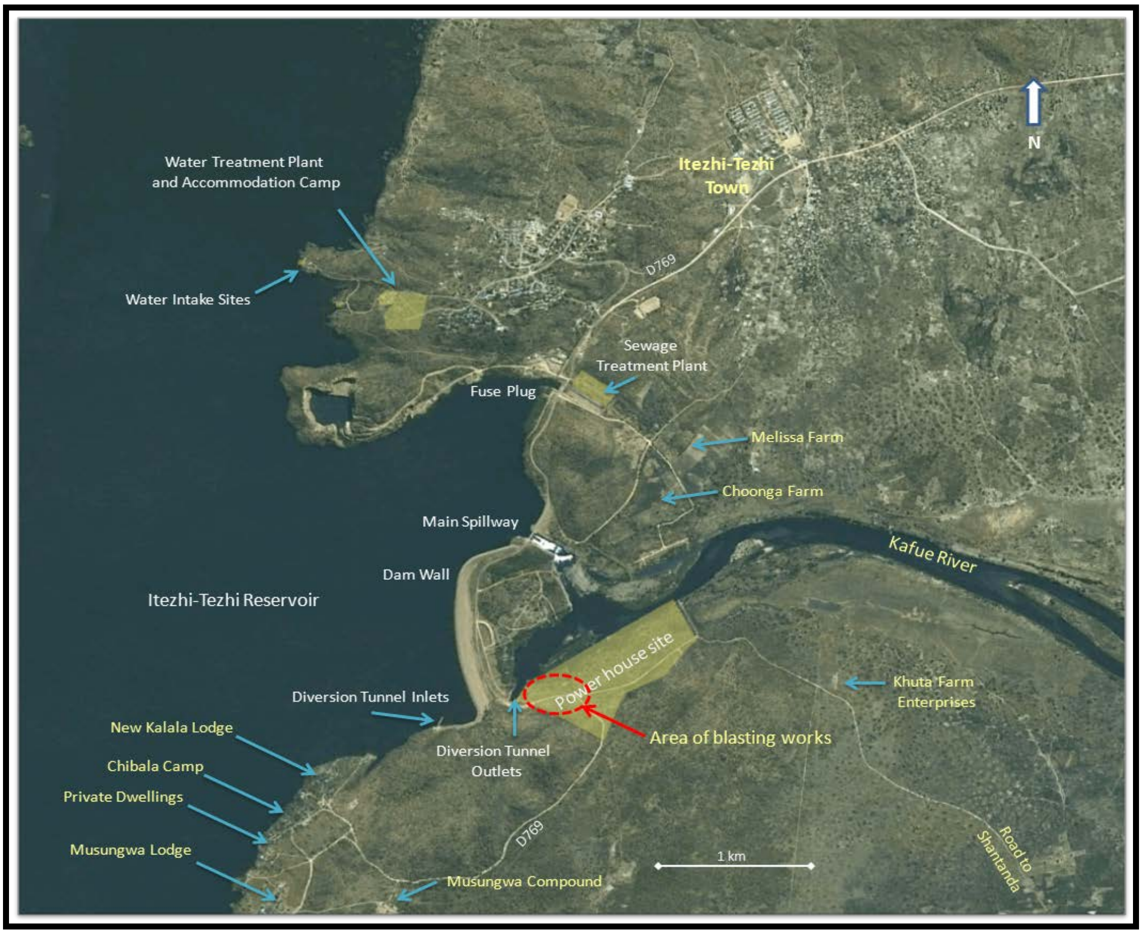
Fauna that may be impacted by construction noise (including Elephants that use the corridor) are likely to be impacted by loud impulsive events (such as rock breaking) rather than a continued elevated noise level from general construction activities. Construction at the power house site will involve extensive rock excavations, therefore it is expected that rock breaking will comprise a regular source of impulsive noise. As such, this impact is considered to be high.

Due to the distances between sources of vibration and sensitive receptors (minimum of 1.2 km), no prediction of vibration from non-blasting construction activities has been carried out.

<u>Blasting</u>

Blasting will be carried out during the construction of the headrace, surge shaft, penstock and the power house to assist with both surface and underground rock excavations. The majority of blasting will take place approximately 200 m west of the Itezhi-Tezhi Dam wall (**Figure 6-7**).

Figure 6-8: The Project Area of Blasting Works.



Specific noise levels generated by blasting were not available. It is expected that blasting noise will exceed the L_{Aeq} 91dB at 10m from the source and will therefore be perceived by the nearest sensitive receptors to the power house site. As such, this risk is considered to be 'Medium'. Noise from blasting will be characterised as loud impulsive events. It is this characteristic that is considered to present a risk to noise sensitive fauna (including Elephants that use the corridor). Therefore this risk is considered to be medium. It is considered that general construction noise (i.e., continued elevated noise level rather than loud impulsive events) is likely to repel noise sensitive fauna from occurring at the site, and therefore may reduce the risk of blasting noise impacts to ecological sensitive receivers.

The prediction of ground borne vibration from blasting without site specific measurement data is not considered to be an accurate exercise. As such, no predictions of vibration levels at sensitive receivers has been carried out for blasting. If not appropriately managed, ground vibration and air blast overpressure resulting from blasting may result in damage to the dam and nearby properties, and disturb human and ecological sensitive receivers. As such, this impact is considered to be high.

Operation

Sources of noise during the operation of the project are likely to be the following:

- Tail race discharge;
- Vehicle movements; and

- Maintenance of infrastructure.

Limited information is available to predict the noise generated by the water flow through the tailrace and into the Kafue River. The overall noise level generated by the tailrace will be dependent upon a number of design factors such as flow rate and the precise specification of the tailrace. As such, it is not possible to accurately predict the noise output during the operation of the tailrace. To breach the IFC night time noise criteria at the closest noise sensitive receivers, the noise generated during the operation of the tailrace would need to exceed L_{Aeq} 91dB at 10 m from the tailrace. This level is considered unlikely to occur.

The operation of the tailrace may result in elevated noise levels at the elephant migration ‘corridor’, however this will be a broad band of continuous noise to which the animals are likely to become acclimatised. Therefore this risk is considered to be very low.

Given that the closest sensitive receiver to the powerhouse site is greater than 1 km, it is unlikely that noise generated from vehicle movements and the maintenance of infrastructure during operation will exceed day-time IFC noise level criteria. However, it is considered that the maintenance of infrastructure may exceed IFC night-time criterion.

None of the activities proposed to be undertaken during the operation of the Project are anticipated to produce significant levels of ground vibration. In the instance that any vibrations do arise (e.g. accidental dropping of heavy objects) the distance from the nearest sensitive receptors is such that vibration levels are likely to attenuate to negligible levels prior to reaching the receptor.

Overall, the risk of impacts to human and ecological receptors from the operation of the project is considered to be low.

6.2.4 Mitigation measures

Construction of the Project provides the main source of noise related impacts to both human and ecological receptors.

To address the risk of potential impacts from blasting, ITPC prepared a Blast Management System prior to the commencement of blasting at the site (ITPC, 2012). URS understands that this plan is currently operational. To manage blasting impacts, the following mitigations are currently being carried out in accordance with the Blast Management System:

- Controlled blasting will be employed to maintain ground vibrations and air blast overpressures to acceptable levels;
- Blasting will not occur in weather conditions that may enhance vibration or air blast overpressures;
- Inspections will be carried out prior to blasting to ensure that no geological weaknesses are present that may contaminate the explosive energy;
- The peak particle velocity will not exceed 2.5 mm/s for the Dam structure;
- Crack monitoring will occur on/in the dam before blasting commences;
- Blasting will be suspended if unusual behaviour is observed on the dam;
- ITPC and the construction contractor will each manage vibration recorders and results will be compared for consistency; and
- Building dilapidation surveys, with consent of building owner within the blast perimeter of 2.5km, will be undertaken on a biannual basis during the life of the mine.

Geotechnical and structural monitoring of the dam is currently being carried out and will continue throughout construction. In the event that the unusual behaviour is observed, blasting

will be suspended to assess any potential issues and determine new measures to be adopted prior to blasting resuming (ITPC, 2012).

Based on the measures that are currently being applied as part of the Blast Management System, the risk of vibration, noise and air blast overpressures are considered to be low.

At the detailed design of the tail race, a full investigation into the likely noise generation by the operation of the tail race should be undertaken with mitigation measures recommended where levels may exceed a level of L_{Aeq} 91dB at 10 m from the tail race.

Mitigation measures to address each of the identified noise impacts are provided in **Table 6-16**

Table 6-16: Mitigation Measures to Reduce Impacts Relating to Noise

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
11	Intermittent non-blasting noise and vibration emitted during construction	Construction	Medium	A Construction Noise Management Plan will be developed outlining the mitigation measures to be adopted during construction. As part of this a complaints register should be developed to record resident and commercial operator complaints in regards to noise and vibration. High noise emitting construction activities such as blast hole drilling, rock breaking and rock crushing to be limited to daylight hours (0700h to 1900h). Plant and equipment such as flat bed lorries, skips and chutes to be lined with noise attenuating materials, where practicable. Materials should be handled with care and be placed, not dropped. All vehicles and mechanical plant used for the purpose of the works to be fitted with exhaust silencers and should be maintained in good efficient working order. All generators, compressors and pumps to be ‘sound reduced’ models where possible fitted with properly lined and sealed acoustic covers which should be kept closed whenever the machines are in use. Additionally, they should be positioned so as to cause minimum noise disturbance, i.e. behind noise barriers.	Low

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
				Machines in intermittent use to be shut down in the intervening periods between works or throttled down to a minimum. Noisy areas to be well defined with sign boards recommending the use of hearing protection. Where appropriate, site staff should be issued with, trained in the proper use of, and use suitable hearing protection equipment. Construction to cease if Elephants are observed within the power house site. Blasting to re-commence once Elephants have left the area (**Section 6.1**). High noise emitting activities such as rock breaking to cease if Elephants or other noise sensitive fauna are observed in close proximity to the power house site. Blasting to re-commence once Elephants have left the area (**Section 6.1**).	
12	Noise, vibration and air blast overpressures emitted during blasting	Construction	High	Blasting to be carried out in accordance with the Blast Management System. Blasting times and locations to be publicly advertised. Blasting to only occur during daylight hours. Strict boundaries to be enforced around blasting sites during blasting procedures.	Low

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
				Blasting to be postponed during high wind periods at the discretion of the site manager. Blasting to cease if fauna are observed within the powerhouse site. Blasting to re-commence once fauna have left the area (**Section 6.1**). Blasting to cease if Elephants or other noise sensitive fauna are observed within or in close proximity to the Powerhouse site. Blasting to re-commence once fauna have left the area (**Section 6.1**).	
13	Noise and vibration emitted during construction activities and equipment, leading to disturbance of wildlife	Construction	Medium	Blasting to be carried out in accordance with the Blast Management System.	Very Low
14	Noise and vibration emitted during the operation of the Project.	Operation	Very Low	Maintenance of Project infrastructure to be restricted to day time hours (e.g. 0700h to 1900h). At the detailed design of the tail race, a full investigation into the likely noise generation by the operation of the tail race should be undertaken with mitigation measures recommended where levels may exceed a level of LAeq 91dB at 10 m from the tail race.	Negligible

6.2.5 Residual Risks

Following the application of the specified mitigation measures listed in **Table 6-16**, the residual impact risk in terms of ecological impacts is considered to be low.

The development of a Construction Noise Management Plan is recommended. This plan should outline the mitigation measures to be adopted during construction and include the development of a grievance procedure to record resident and commercial operator complaints in regards to noise and vibration. It is recognised that noise impacts from blasting may be an unavoidable impact to human sensitive receivers, therefore the Construction Noise Management Plan should also include a grievance procedure to record resident and commercial operator complaints in regards to blasting noise and vibration.

6.3 Water and Sediment Quality

6.3.1 Assessment Criteria

In order to assess the baseline water and sediment quality conditions in the Project area, one-off "snap-shot" water and sediment quality sampling was undertaken within Itezhi-Tezhi reservoir and immediately downstream, in order to characterise the current conditions and allow comparison with historic water quality data collated in the region (**Appendix H**). Generally, consideration of sediment and water quality needs to take into account two main categories of substance:

- Contaminants – contamination, particular in the form of metals (originating from upstream metalliferous mining) can have impacts on the ecologically sensitive receptors, and may also impact upon human health either by direct consumption (in the case of water used for drinking and cooking) or indirect consumption (by concentration and uptake along the food chain, e.g. in fish which are then eaten by humans); and
- Nutrients – major nutrients such as nitrogen and phosphorus are present in water and sediment in varying quantities. The nutrient status of water and sediment has a major impact on the productivity and hence ecology of a river and its floodplain, and variations in nutrient concentrations can have profound impacts on the functioning of a riverine system.

Zambian environmental regulations do not include environmental quality standards for either water or sediment, but do include drinking water quality standards and standards for effluent discharged into the aquatic environment. Water quality standards for drinking water have been issued by the Zambia Bureau of Standards (ZS 190:1990 Zambian Standard – Drinking Water Quality) although such standards are not strictly applicable for governing the quality of water in rivers and water bodies except where water is extracted for potable supply. They nevertheless provide a reasonable screening level to determine the quality of river and lake water. In additional, further comparison with standards was provided with use of Australian and New Zealand Water Quality Standards (ANZECC, 2010) and Zambian Effluent Discharge into Aquatic Environment Guidelines.

In the absence of sediment quality guidelines, the Canadian Sediment Quality Guidelines (CSQC) for the Protection of Aquatic Life have been adopted as criteria for assessing sediment quality. These guidelines have been chosen since they are readily available, based on ecological risk assessment, and have been developed for use in a country where there is significant metalliferous mining activity.

It is noted that the sampling regime undertaken was limited in extent, designed to identify likely potential water and sediment quality issues. It was not intended to be a detailed ecological and toxicological assessment capable of determining whether concentrations of contaminants in

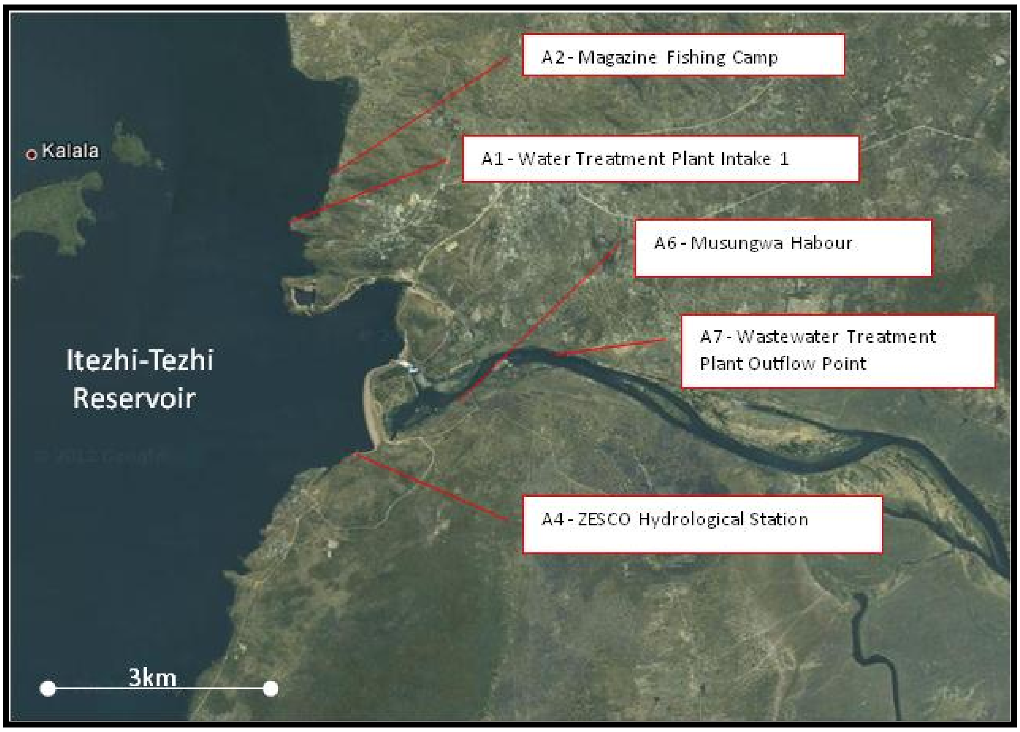
sediments pose a significant risk to ecological or human receptors. The potential need for such further detailed studies is discussed in **Section 6.3.4**.

Sampling was undertaken at a number of locations upstream of and close to ITT dam, including:

- A1 - Water Treatment Plant Intake 1;
- A2 - Magazine Fishing Camp;
- A3 - Kafue Hook Bridge;
- A4 - ZESCO Hydrological Station (SDT inlet);
- A5 - Namwala Hydrological Station;
- A6 - Musungwa Habour; and
- A7 - Wastewater Treatment Plant Outflow Point.

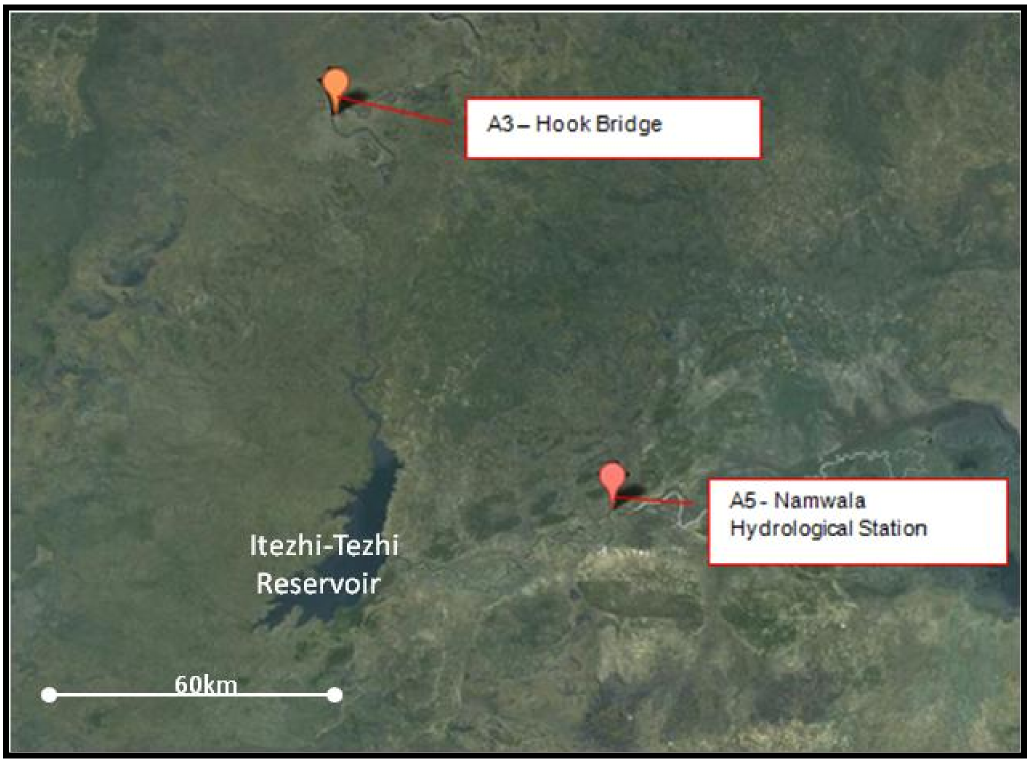
Figure 6.9 and **Figure 6.10** indicate the location of these sites in relation to the Itezhi-Tezhi reservoir. Water samples were analysed at two laboratories: the internationally accredited laboratory Alfred H Knight, Kitwe, as well as the laboratory within the University of Zambia. Two laboratories were used to ensure that international standards were applied where possible, as well as analysis of regional specific (i.e. potential copper mining pollutants).

Figure 6-9: Water and sediment sampling locations in proximity to the Project site



(Aerial image © 2012 Google; Image © 2012 Cnes/Spot Image;Data SIO, NOAA, U.S. Navy, N.G.A, GBECO)

Figure 6-10: Regional Water and sediment sampling locations



(Aerial image © 2012 Google; Image © 2012 Cnes/Spot Image;Data SIO, NOAA, U.S. Navy, N.G.A, GBECO)

6.3.2 Baseline Conditions

Sediment Quality

The Kafue River rises in Copperbelt Province of Zambia, from where it flows southwards to the Itezhi-Tezhi district. Sediment and water quality in the river basin is believed to be affected by the significant amount of mining activity occurring within the Copperbelt Province within the upper catchment of the Kafue River (Sracek, 2012; Nakayama *et al*., 2010).

A study of sediment quality in the Upper Kafue River (Sracek, 2012) noted copper concentrations of over 3,000 mg/kg in some locations, and associated these elevated concentrations with inflows from tributaries carrying eroded material from mine tailings dams and other sources. This study extended only as far as Kitwe (in Copperbelt), however, it does suggest that copper and other heavy metals disturbed within Copperbelt, may be pass down the Kafue River system and accumulate within Itezhi-Tezhi reservoir.

All reservoirs act as settling basins for sediment loads. In particular, artificial reservoirs such as Itezhi-Tezhi significantly alter the existing sedimentation patterns within a hydrological system. Vorosmarty *et al*. (2003) suggest that sediment flow reduction levels could be greater than 80%. As such, it is considered that the previous construction of the Itezhi-Tezhi dam has significantly reduced the flow of sediments and nutrients downstream to the Kafue Flats. This is considered to be both a positive (e.g. preventing migration of heavy metal contaminants downstream) and negative (preventing the transport of ecologically important nutrients, such as Nitrogen and Phosphorous, downstream) impact. Due to the size of the reservoir, the majority of sedimentation settlement out of the water column occurs near the upstream mouth of the reservoir, at the Hook Bridge end of the reservoir (**Figure 6-10**). Sediment settlement rates then decrease exponentially along the length of the reservoir towards the dam wall (Kunz, 2011). Waters containing high sediment loads typically only reach the dam wall under flood conditions. Kunz *et al.* (2011) indicates that external nutrient loadings into the reservoir from the Kafue River are typically low (i.e. there is relatively low inflow concentrations of Carbon, Nitrogen and Phosphorous under normal operation river conditions). However, they also note that settlement of the small volume of received material within the reservoir is relatively high (i.e. only about 20% of the volume of organic matter received is discharged downstream).

Current operational discharge patterns of the dam are such that high sediment loads are typically only passed on downstream during operation of the main spillway during flood events, or operation of the Northern Diversion Tunnel (NDT). Operation of the diversion tunnel discharges up to 312m^3/s, pending on prevailing hydrological conditions and dam levels. In particular, as the intake for the intake towers and NDT inlet (**Section 3**) are located on the floor of the reservoir, it is considered that this rate of flow is capable of entraining significant sediment loads. Since commencing dam operations, no studies have been undertaken detailing downstream sediment loads during discharge from the NDT. The longest recent period over which the NDT has been in continuous operation is 154 days in 2005.

The study undertaken by Nakayama *et al.* (2010) identified a mean concentration of copper within the reservoir of 82 mg/kg (c.f. 3,000 mg/kg). This value exceeds the Canadian Interim Sediment Quality Guideline (ISQG - threshold level effects below which adverse biological effects are not expected) of 35.7 mg/kg but not the listed Probable Effects Level (PEL – the threshold level above which adverse impacts are expected to occur frequently) of 197 mg/kg. This value is significantly lower than the concentrations reported by Sracek (2012) upstream in the Copperbelt. This suggests that the hydrological processes upstream of the reservoir do filter out sediment loads from Copperbelt, reducing the concentrations passing through to the reservoir. There are number of wetland systems, upstream of the Itezhi-Tezhi, reservoir that are likely to act as sediments locations for settlement arising within the Copperbelt. It is also known that environmental practices within the Copperbelt have improved significantly over the

last decade, and are likely to continue to improve. As a consequence it is anticipated that future flows of heavy metals through the Kafue River are also likely to decline.

The results of sediment analysis carried out as part of the sampling program (**Appendix H**) are consistent with previous studies undertaken (**Table 6-17**). Sediment quality is seen to be generally high, with relatively low metal concentrations. Typically, in an undisturbed environment, the presence of toxicants associated with human activity (e.g. hydrocarbons) would be expected to be negligible, whereas naturally occurring toxicants (e.g. metals) are likely to be present in very low concentrations (although varying between locations and associated standard baseline conditions). The sample analysis suggests a sediment quality indicative of a slightly disturbed environment. Observed manganese concentrations were seen to show unusually high variance (289 mg/kg – 16,976 mg/kg), contributing up to almost 2% of sediment content by mass. Without further baseline sampling it is difficult to ascribe whether this level of variation is within natural occurring levels. However, it is noted that:

- The Kafue River flows through areas of highly mineralised geology with outcrops at several locations. Therefore it is not unusual to find naturally elevated heavy metal concentrations particularly copper, cobalt and related minerals. Naturally occurring levels of copper, for example, with water quality concentrations excess of 10 000mg/l and less than 40 mg/l in close proximity to each other are not uncommon; and
- In most of copper processing operations, particularly leaching, particles rich in Ca, Mn, Cu, Co are formed in the liming processes. If elevated copper levels are likely to occur as a result of upstream mining activities, it is likely other heavy metals would be seen to be artificially elevated as well. However, this was not significantly observed in the sampling program undertaken.

Table 6-17: Sediment quality sampling results

Parameter	Canadian Sediment Quality Guidelines for the Protection of Aquatic Life		A1	A2	A3	A4	A5	A6
	ISQG	PEL						
Copper (mg/kg)	35.7	197	10.68	12.67	100.68	19.10	36.02	15.65
Cobalt (mg/kg)	-	-	<0.005	<0.005	16.29	7.24	3.94	1.77
Manganese (mg/kg)	-	-	418	289	16,976	14,599	9,938	10,895
Nitrates (mg/kg)	-	-	0.051	0.033	0.290	0.290	0.073	0.052
Phosphorous (mg/kg)	-	-	0.074	0.064	0.019	0.028	0.073	0.052

Studies undertaken on Lake Kariba (Berg *et al*., 1995; Nakayama *et al*., 2010) have identified sediment qualities showing similarly low levels of metal concentrations, although increasing over time due to local catchment development. In particular, Nakayama *et al*. (2010) identified no significant difference in total heavy metal sediment concentrations between Lake Kariba and Lake Itezhi-Tezhi. However, a comparison of copper concentrations between the two lakes did demonstrate average Itezhi-Tezhi reservoir concentrations (82 mg/kg) to be significantly greater than Lake Kariba Concentrations (30 mg/kg). Average copper concentration observed in the sampling undertaken for this ESIA was 32.46 mg/kg).

The highest copper concentrations are reported from upstream of Itezhi-Tezhi reservoir at the Hook Bridge. This is consistent with expected sedimentation patterns within the dam.

Interestingly, downstream concentrations at Namwala (A5) are also seen to be elevated when compared to sediment concentrations within the lake. This either indicates that other copper sources (past or current) may be affecting the river downstream, or that elevated concentrations are passing through the dam as part of current operations. The sampling undertaken in closest proximity to the proposed SDT inlet (A4) indentified copper concentrations to be well below the relevant Canadian ISQG values. Canadian sediment quality guidelines are not currently published for the other parameters analysed.

Metal poisoning as a result of sediment contamination is the primary risk associated with increased metal concentrations. This can affect plant, animal and human life as some metals are capable of bio-accumulating within ecological systems. Nakayama *et al*. (2010) analysed samples from sediment in Itezhi-Tezhi reservoir and Lake Kariba from fish (*Oreochromis niloticus*) and crayfish (*Cherax quadricarinatus* – the Australian red claw crayfish). Copper concentrations within fish livers (1345 ± 930 mg/kg dry-wt) were significantly higher in Itezhi-Tezhi reservoir in comparison to Lake Kariba. However, crayfish copper levels were not significantly different (279 ± 169 mg/kg dry-wt) between the lakes. This is considered to reflect the nature of feeding ecology between the species and indicates that bio-accumulation pathways can be quite species specific. The condition of the affected fish species was not seen to be materially affected by the copper concentrations. It is noted that the World Health Organisation (WHO) maximum recommended intake level for Cu is 0.9-30 mg/day. Based on this value, the consumption of 0.7-22 g/day of liver from *O. niloticus* caught in Lake ITT would exceed the WHO guideline. On this data, it is considered that a heavy *O. niloticus* liver diet could be harmful to human health. Levels of copper within fish flesh itself would be significantly lower.

In regards to nutrients, there are no set international guidelines for sediments. The risk of high nutrient loads is primarily a concern in terms of the potential for eutrophication events to occur. The observed nitrate and phosphorous levels within the samples taken (**Table 6-17**) were not seen to be high in comparison, and are considered to be consistent with expected lake sediment detention properties.

It is considered that the sediment quality within Itezhi-Tezhi reservoir is reflective of a partially disturbed environment. Previous studies have identified sediment quality to be consistent with other lakes in the region, and the current sampling regime did not identify any significant exceedances of PEL guidelines. Copper levels are seen to be elevated at the northern end of the dam, although not to levels of significant concern. There is some evidence of bioaccumulation occurring within the dam in regards to copper, although no detrimental impacts of this have been recorded to date (e.g. observable metal poisoning in plant or animal species, or humans).

Water Quality

Several studies have examined the existing water quality both of the Kafue River in the vicinity of Itezhi-Tezhi reservoir and within the reservoir itself. The majority of studies indicate the reservoir waters to be of relatively high quality, with limited evidence of human disturbance as a result of upstream mining operations. However, given the size of the reservoir, and the varied scope and methodologies of the studies undertaken, the results observed are typically variable and do not provide a cohesive baseline. Further, discussion as to previous water quality findings in relation to the dam are provided in **Appendix D**.

Many enclosed water-bodies exhibit thermal stratification. The density of water reduces with increasing temperature and this can result in distinct layers forming within a lake: a warmer, less dense epliminion at the surface, underlain by a denser, cooler hypolimnion, separated by a thermocline (a discontinuity in temperature gradient). Depending on the physical and climatic surroundings, this situation can persist indefinitely or occur on a seasonal basis. In lakes exhibiting seasonal stratification, "turnover" (complete mixing of the water body) may occur annually (monomictic) or several times per year. The hypolimnion of a stratified lake

can exhibit very different characteristics from the eplimnion. The hypolimnion is isolated from the atmosphere and therefore cannot replenish any reduction in dissolved oxygen content by gas exchange with the atmosphere. The dissolved oxygen content of the hypolimnion becomes depleted as a result of biological and geochemical processes and can result in a situation where the dissolved oxygen concentration in the hypolimnion is either reduced (hypoxic) or negligible (anoxic). Under anoxic conditions, sulphates may be oxidised to sulphites, and nutrients (predominantly nitrogen and phosphorus) are released from sediments to the water column.

Previous studies (e.g. Kunz, 2011) have demonstrated that Itezhi-Tezhi reservoir is a thermally stratified monomictic lake. Throughout most of the year, the lake is thermally stratified, with the thermocline lying between 20 m and 30 m below the surface (maximum reservoir depth: 57 m, mean reservoir depth: 15 m). The temperature in the hypolimnion is between 18 to 20^{o}C throughout the year, whereas the epilimnion reaches a temperature of up to 29^{o}C. Lake turnover and mixing is believed to occur during the dry winter (June to August) during which time temperature equilibriates at around 18^{o}C throughout the water column. Dissolved oxygen levels in the hypolimnion are reported to be increasingly depressed from October and entirely depleted (i.e. anoxic conditions) from December to May.

It is therefore likely that for much of the year (i.e. September – May) the lake waters released over the Itezhi-Tezhi dam spillway will have differing physio-chemical parameters to water released at depth via the NDT. Current dam operations include periodic releases of water through the NDT when dam water levels drop below the level of the main spillway (1018.7 m AMSL; approximately 8 m from normal operating conditions). This has previously resulted in continuous NDT discharges of over 5 month periods. As such, the incorporation of bottom waters and associated water quality parameters within the Kafue Flats is considered part of the existing baseline conditions. The exact water quality conditions and extents of the hypoliminion that forms within Itezhi-Tezhi reservoir has not been quantified within previous literature and, due to timing of hypolimnion formation, was not captured able to be captured as part of this ESIA.

However, it is reasonable to expect that the hypolimnion willl be characterised by decreasing dissolved oxygen over the September to May period, and associated with reducing conditions and increased ion and nutrient concentrations (e.g. $Mn^{2}+$, $Fe^{2}+$, H_2S, CH_4, $NH^{4}+$, Phosphorous). This deterioration in water quality can lead to bad odours, tastes, acidity, and metal concentrations that would lead the water to be unsuitable for drinking. Low dissolved oxygen concentrations create inhospitable environments for aquatic species and can lead to fish kills. Upon the initial use of the NDT as a discharge location in the 1970's fish kills were reported downstream (Scott Wilson Piesold, 2003). Subsequent to this, the use of intake towers to oxygenate the water and utilising simultaneous release of highly-oxygenated spillway discharges, appears to have mitigated the risk of fish kills occurring. However, the ongoing known presence of H_2S associated with current usage of the NDT indicates that anoxic conditions do persist to some extent within the dam and are being passed downstream. Typically, man-made reservoirs, involving the permanent inundation of surrounding vegetative matter, generate decreasing volumes of H_2S as the inundated organic matter decays. The on-going production of H_2S within Itezhi-Tezhi reservoir, almost four-decades after construction, suggests that a significant volume of organic content remains present within the reservoir.

The results of water quality analysis undertaken as part of the current study are shown in **Table 6-18** below. Results presented represent those obtained from the University of Zambia. No significant differences between University of Zambia analysis and results from Alfred H Knight laboratories were observed. For sampling location A4, samples were taken from the surface, 30m above bottom, 10m above bottom and the bottom of the water column. Sampling was carried out August 2012.

Table 6-18: Water quality sampling results

Parameter (mg/L unless stated)	ANZECC (2010) Freshwater Guidelines	Zambian Drinking Water Standards	Zambian effluent discharge Standards	A1	A2	A3	A4				A5	A6	A7
							Surface	Bottom + 30m	Bottom + 10m	Bottom			
COD	-	-	90	50	56	50	53	52	52	58	56	55	52
Total Coliforms (#/100ml)	-	0	2500	4800	3200	4200	3800	1900	2100	2300	1700	2300	4300
Faecal Coliforms (#/100ml)	-	0	5000	1200	1300	1300	1400	1300	1400	8200	800	1400	1600
Total Dissolved Solids	-	1500mg/l	3000 mg/l	87.5	87.7	138.0	88.7	82.6	83.5c	82.9	88.5	87.4	90.8
Total Suspended Solids	-		100 mg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Sulphides	0.002mg/l		0.1	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
BOD	-		50	18	18	18	12	18	18	22	12	10	12
Nitrates	-	10mg/l	50 mg/l	0.04	0.02	0.25	0.21	<0.01	<0.01	<0.01	0.22	0.45	0.05
Dissolved Sulphates	-	400mg/l	1500 mg/l	49.7	49.20	72.6	55.0	42.2	46.2	48.3	53.30	49.70	50.60
Temperature (C)	-		400C at entry	23.8	23.9	23.0	23.	23.8	24.1	23.9	23.0	23.8	23.8

Parameter (mg/L unless stated)	ANZECC (2010) Freshwater Guidelines	Zambian Drinking Water Standards	Zambian effluent discharge Standards	A1	A2	A3	A4				A5	A6	A7
							Surface	Bottom + 30m	Bottom + 10m	Bottom			
Potassium	-		-	15.6	16.7	16.0	15.6	19.3	17.1	17.5	15.8	15.3	15.5
Dissolved Oxygen	>6mg/l		5	5.35	5.70	7.25	6.40	5.54	5.33	5.48	6.20	5.45	5.54
Chlorides	-	250 mg/l	800 mg/l	5.0	5.0	10.0	3.0	8.0	15.0	8.0	4.0	3.0	5.0
Iron	1mg/l	1.0 mg/l	2.0 mg/l	0.14	1.23	0.11	0.35	0.21	0.18	0.17	0.26	0.06	<0.01
Copper	0.002 – 0.005 mg/l	1.0 mg/l	1.5 mg/l	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003	<0.003
Cobalt	-	0.5 mg/l	1.0 mg/l	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Calcium	-	200 mg/l	-	21.6	23.2	35.2	24.8	21.6	10.4	32.8	24.8	27.2	28.8
Magnesium	-	150 mg/l	500	13.44	12.48	12.40	8.16	14.58	78.24	9.60	12.96	12.0	11.52
Sodium	-		-	19.4	20.0	22.7	20.0	24.0	21.9	24.3	19.6	20.2	19.5
Zinc	0.005 – 0.050 mg/l	5 mg/l	10 mg/l	**0.064**	0.021	0.011	0.001	0.011	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel)	0.015 – 0.150 mg/l		0.5 mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
pH	6.5 – 9	6.5 – 8.0	6.0 – 9.0	7.90	8.15	8.18	8.32	8.22	8.08	8.09	8.32	8.40	8.54
Electrical Conductivity (µS/cm)	1500µS/cm		4300 µS/cm	175.4	175.2	275.0	180.6	165.3	167.2	166.2	178.3	175.3	180.6
Phosphorous	-		6.0 mg/l	0.13	0.05	<0.01	0.01	0.29	0.30	0.38	0.06	0.04	0.09

Parameter (mg/L unless stated)	ANZECC (2010) Freshwater Guidelines	Zambian Drinking Water Standards	Zambian effluent discharge Standards	A1	A2	A3	A4				A5	A6	A7
							Surface	Bottom + 30m	Bottom + 10m	Bottom			
(PO4-P)													
Lead	0.001.0 – 0.005 mg/l	0.05 mg/l	0.5 mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

The results at location A4 indicate that thermal stratification was not evident at the time of sampling. This is consistent with Kunz's (2011) observation that mixing occurs during June to August. Further, no stratification, or relationship with depth of measurement, was observed with any of the other parameters assessed. Thermal stratification is likely to result in observable trends in dissolved oxygen concentrations and other dissolved gases (e.g. methane, sulphates).

The concentration of contaminants did not exceed the Zambian Drinking Water Quality standards for inorganic contaminants, indicating generally good water quality. Significantly, all dissolved copper concentrations were below the limit of detection within the laboratory analysis and within national and international guidelines. However, concentrations of microbial contaminants (i.e. total and faecal coliforms) were seen to exceed drinking water quality standards. The observed microbial contaminants may suggest either the presence of animal populations (i.e. within the Kafue National Park) or potential untreated discharge of sewage into the reservoir. The observed levels are seen to be lower than concentrations recorded in Lake Kariba (i.e. greater than 10,000 cfu/100ml).

Zinc concentrations at A1 (the water treatment plant intake) were seen to marginally exceed ANZECC (2010) requirements, but were within Zambian standards.

Interestingly, there were no significant differences in the observed water quality levels within the reservoir and to those downstream. However, as only one-off sampling was undertaken, it is difficult to assess the veracity of this finding as water quality can vary diurnally, seasonally and annually.

Wamulume *et al.* (2011) undertook a year-long sampling program, assessing sites both upstream and downstream of the dam, including immediately downstream of the main spillway and diversion tunnel outlets. Water quality results at this location were typically high, and showed less monthly variation in regards to most parameters assessed than sites further downstream. Overall the parameters sampled (orthophosphates, nitrates, ammonia, total nitrogen, and total organic carbon) were indicative of a relatively undisturbed riparian system, in which:

- the quality of water discharged from the dam is relatively high. No significant variation in quality was seen to be associated with discharge of waters drawn from the bottom of the reservoir; and
- the influence from tributaries and human activities downstream of the dam was seen to introduce significant annual variation in water quality within the Kafue Flat wetlands.

In particular, Wamulume *et al.* (2011) studied the exchange between the floodplain and the river and observed that the exchange appeared to play an important role in nutrient and carbon export to the river's main channel and out of the wetland (i.e. that the Kafue Flats were a net source of phosphate, total nitrogen and total organic carbon to the downstream system rather than a net receiver of nutrients from the river). Similarly, it was observed that dissolved oxygen levels within the flats are typically low, with the highest levels being associated with the turbulent flows resulting from discharge from the Itezhi-Tezhi dam spill gates. The dissolved oxygen levels assessed in the sampling program undertaken for this ESIA did not demonstrate any significant association with depth. This is considered to reflect the undertaking of sampling during the "mixing" phase of the reservoir's monomictic cycle.

Further data in regards to water quality within the dam was provided by ITPC, as part of an annual water quality sampling program undertaken by ZESCO as part of operation of the existing water treatment plant that supplies Itezhi-Tezhi town and is proposed to be upgraded as part of the Project (**Section 3**). Fourteen samples from 2007 – 2012 were taken at the intake location for the water quality treatment plant (i.e. A1), assessing:

- pH;

- Turbidity;
- Conductivity;
- Total Dissolved Solids;
- Total Suspended Solids;
- Total hardness;
- Calcium hardness;
- Alkalinity
- Iron;
- Ammonia;
- Sulphates
- Chlorides
- Nitrites;
- Nitrates;
- Acidity;
- Total Phosphates;
- Magnesium;
- Calcium;
- Fluorides;
- Potassium;
- Sodium;
- Manganese;
- Total coliforms; and
- Faecal coliforms.

Of these, comparison with the World Health Organisation standards for drinking water only identified exceedances for the following parameters prior to treatment:

- Turbidity (three occasions);
- Iron (three occasions);
- Total coliforms (two occasions);
- Faecal coliforms (two occasions); and
- Ammonia (one occasion).

These results are considered to be consistent with findings of the sampling undertaken as part of this ESIA and other water quality studies done in the region. Overall, the water quality within the reservoir is considered to be of better quality than would necessarily be expected for a reservoir downstream of the Copperbelt mining activities that has been active for over 30 years. It is noted that the sampling regime did not allow for observation of conditions within the reservoirs stratified phase, to give an indication as to whether nutrient, temperature and oxygen levels significantly alter annually. However, the water quality findings are generally consistent with previous studies on the reservoir.

6.3.3 Potential Impacts

The potential impacts to water quality as result of Project development will vary between the construction and operational phases.

Construction

- Water quality impacts during construction may arise due to releases of surface water run-off or pumping from excavations containing elevated levels of sediment or other deleterious substances (e.g. concrete);
- Releases to water of hazardous substances (including oil) due to accidental spillages; and
- Releases to water of sewage arising from the employed construction workforce.

Surface run-off following wet weather events has the potential to mobilise sediment and other contaminants, ultimately discharging into and degrading the water quality within the Kafue River. During construction the following activities are likely to lead to the exposure and disturbance of soils:

- Stockpiling of fill material;
- Bulk earthworks and grading of the site;
- Compaction of soils;
- Excavations for foundations;
- Road works; and
- Passage of construction vehicles over unsealed surfaces.

The topography of the site is such that sheet flow rates following wet weather events are likely to be moderate, capturing flows on the immediately surrounding hills. Surface flows are likely to entrain any loose surface sediment. Without sedimentation controls (e.g. cut-off drains, detention basins) run-off may increase sediment load and turbidity within the river. However, the extent of sediment impacts, and the likely turbid nature of the river itself during wet weather events means that any such impacts are likely to be minimal. Application of appropriate sediment and control mitigation measures will significantly reduce the extent of potential impacts.

Construction materials (e.g. concrete and diesel) used and stored at the proposed site have the potential to cause an adverse impact on the aquatic environment in the event of either their spillage or the incorrect disposal of materials. In particular, the proposed construction works will require the use of mobile plant such as excavators, trucks and cranes. These will require regular fuelling and maintenance and hence there will be a requirement to store quantities of diesel and lubricants on-site, and to correctly dispose of any waste oils. Potential impacts may arise if these materials either leak during storage/fuelling, or in the case of incorrect disposal of waste oils. Mitigation actions will need to be implemented in order to manage such potential impacts.

Sewage and waste water associated with worker facilities and ablutions typically can contain high concentrations of ammonia, BOD and pathogens and, if discharged to the surrounding environment without adequate treatment, would have a deleterious effect on receiving water bodies as well as posing a potential human health hazard. Mitigation actions will need to be implemented in order to manage such potential impacts.

Most releases into the river during construction are likely to be of short duration and limited volumes. More significant releases may occur in the event of, for instance, leakage of fuel storages areas or run-off from specific construction activities. It is considered that any of these

impacts will be of limited duration and typically affect only small stretches of watercourse. More persistent discharge may be expected from de-watering of deep excavations and run off from the batching and crushing plants. These discharges will require specific settlement ponds and treatment areas prior to discharge.

In addition to these impacts it is noted that prior to commencement of operations, water within the SDT will be flushed to both enable construction and subsequently hydrotest the constructed tunnels. Flushing is anticipated to take less than one week. Waters flushed through the system may include stale waters that may have persisted within the SDT for a long period of time with limited circulation. This is considered similar in nature to the sporadic opening of the NDT. As such it is considered that this initial flushing will not significantly impact the downstream water quality. However, it is recommended that mitigation measures be applied to ensure associated impacts (e.g. discharge of anoxic waters) are minimised. It is also considered that flushing may mobilise construction associated sediments (e.g. concrete dust, rock dust) and accidental spillages within the tunnels (e.g. oils, grease) which may deteriorate local water quality. The magnitude of such sediments disturbed and spillages in comparison to the volume of water flow is likely to be low.

Some dredging works will also be undertaken as part of construction. An area of 200m x 50m will be dredged to a depth of approximately 30cm directly in-front of the water intake. Dredging can create localised sediment plumes within the reservoir. Impacts associated with sediment plumes are likely to be short-lived and sediments will re-settle to the bottom of the reservoir. Due to the depth of water at the intake, it is unlikely that sediment plumes would lead to smothering of vegetation or disturbance of critical habitat for species within the reservoir. Most species within the dam are mobile and able to avoid the dredging construction works.

Dredged spoil from these operations will be brought to the surface and stored on-shore. Based on the available literature and findings of the sampling undertaken for this ESIA it is unlikely that the spoil will contain high levels of contaminants. However, it is recognised that there is potential for spoil material to contain metal contaminants, generate odours and acidic run-off in dewatering and appropriate storage and disposal mitigation measures will need to be applied to ensure potential impacts associated with this material are minimised.

Operation

The main water quality impacts that may arise during operation include:

- Release of deep lake water to the downstream river environment, resulting in changes to downstream river water quality and possible release of odorous and toxic hydrogen sulphide gas (H^2S) (air quality impacts assessed in **Section 7.1**);
- Remobilisation of lake sediment and release to the downstream river;
- Accidental release of hydraulic fluid, lubricants, untreated sewage or biocides from the power station;
- Waste water from the operational facilities and accommodation camp; and
- Water quality impacts within the Itezhi-Tezhi reservoir.

Given the high sensitivity of the downstream catchment in terms of both ecology and socio-economics, the operational impacts on water resources require careful consideration.

<u>Discharge of Deep Lake Waters</u>

The effects of the low-level release on the thermal stratification will depend on several factors including timing of releases, relative rate of release over spillway and via SDT or NDT, water depth at the inlet point, and total inflows and outflows to the reservoir. There are many cases reported where low level releases from reservoirs coexist with thermal stratification and result

in persistent release of hypoxic or anoxic hypolimnetic water; indeed, selective hypolimnetic release may be used as a deliberate management tool in some cases.

The current water flow through the reservoir to the Kafue River downstream is a combination of flows from both the Itezhi-Tezhi dam main spillway, as well as flows from the NDT. Current practice is such that the majority of flows (over 90%) proceed over the main spillway. Flows from the spillway are typically well-oxygenated surface water, which becomes highly-oxygenated following discharge and mixing over the spillway. Flows through the northern diversion tunnel, draw water from the bottom of the dam. These flows have the potential to discharge oxygen depleted waters. Previous discharges from this tunnel have been linked to fish kill events downstream, most likely due to the discharge of anoxic waters (dam discharge mitigation measures were subsequently adopted to address this issue). The potential for anoxic discharges will increase over the months of September – May, during which the lake is stratified. The operation of the power station will lead to the continuous discharge of waters from the bottom of the dam via the SDT, and reduced flows over the spillway during the wet season in accordance with the regime described in **Section 3**. The power plant will be operated such that the existing discharge regime (**Figure 3.8**) shall be adhered too (i.e. there will be no change to the average volume of water passing down-stream).

However, as the predominant source of the waters will change (i.e. the majority (approximately 90%) of waters to be discharged through the SDT), it is possible that there will be difference in the quality of water discharged. Waters released through the SDT are likely to differ to waters released through the spillways in terms of:

- Dissolved oxygen;
- Reducing conditions and associated ions (e.g. Mn^{2+}, Fe^{2+}, H_2S, CH_4, NH_4^+, Phosphorous);
- Temperature; and
- Turbidity.

In terms of dissolved oxygen, discharges that draw from the bottom of the dam will be increasingly anoxic from September to May (e.g. oxygen concentrations from 0-5 mg/l). The discharge of anoxic waters may lead to restricted productivity or even fish kills downstream. However, once waters pass out of the powerhouse they will flow along the above ground tailrace, providing the potential for mixing and aeration prior to discharge into the Kafue River downstream. The sampling undertaken revealed four of the seven sites sampled as having naturally low dissolved oxygen concentrations, and it is understood that dissolved oxygen concentrations are typically low within the Kafue Flats. It is also noted the time in which anoxic conditions are most likely to occur within the reservoir (i.e. February – May) also coincides with the wet season, at which time discharges through the reservoirs main spillways are also likely to occur. The mixing of power plant discharged waters with the highly oxygenated waters passing over the spillway will further reduce the risk of anoxic waters passing downstream.

However, detailed modelling of dissolved oxygen concentrations was not undertaken as part of this ESIA and it is recommended that further mitigation measures be applied to ensure adequate aeration of the water prior to discharge. The potential for dissolved oxygen concentrations to affect downstream water quality is considered to be a risk of concern to the Project. However, it should also be noted that current dam operation practices do involve discharges from the NDT and, when combined with operational mitigation measures (e.g. aeration within the open-to-surface intake towers), do not typically result in reported differences in downstream water quality conditions. For example, dam operation involved a period of 154 days, September 2005 to February 2006, (i.e. through the increasingly anoxic period of the dams monomictic cycle) in which discharge was solely through the NDT. No adverse impacts on the downstream environment were reported following this period. It is considered that the operating conditions and aeration provided through the tailrace may provide more oxygenated flows than current NDT discharges.

Anoxic conditions also tend to lead to reducing conditions, increased concentrations of soluble ions and compounds, and potential changes to pH levels. These changes can lead to negative odours (**Section 7.1**) and taste associated with water quality and potential eutrophication events as nutrients are recycled from sediment back into the water column. Typically freshwater lakes like the Itezhi-Tezhi reservoir, often have lower H_2S volumes than salt-water lakes/estuarine conditions, but often have greater methane levels (WHO, 1996). Site inspection by URS specialists identified the presence of H_2S within the diversion tunnel intake towers and at the outlets, indicating that anoxic conditions do form within the lake. Dissolved H_2S is also highly toxic to fish, and may form an explosive atmosphere in enclosed spaces (e.g. turbine halls). There is also the possibility that other toxic or flammable gases (e.g. methane) may be present in dissolved form and may be liberated to the atmosphere during water release, causing potential hazards.

According to Kunz (2011), computer simulations of the release of water from the SDT rather than the spillway may give rise to large increases in the overall loading of dissolved inorganic nitrogen (DIN) and soluble reactive phosphorus (SRP) to the downstream Kafue River (two – four-fold increases). This significant increase in nutrient loading may have positive impacts on downstream ecology. Primary productivity (and hence fish harvest) may be increased, but there is also the possibility of the higher level of nutrients encouraging invasive species or otherwise affecting the ecological balance of the system. The ions generated in the reducing anoxic conditions will tend to precipitate out following aeration through the power plant and downstream. Precipitation following aeration can cause significant discolouration and deposition in discharges. This has not been noted to occur following discharges from the NDT to date.

As with dissolved oxygen concentrations it is noted that the timing of peak anoxic periods also coincides with periods in which discharges over the main spillway will occur, helping both re-oxygenate the water as well as dilute concentrations fine metal / nutrient particles within the discharged waters. This will reduce the potential for nutrient and particularly metal accumulation and bio-accumulation. It is also noted, that Wamulume et al. (2011) indicated that the Kafue Flats were a net source of phosphate, total nitrogen and total organic carbon to the downstream system rather than a net receiver of nutrients from the river. As such, any downstream changes to water quality would tend to be restricted to the main river channel, rather than the surrounding floodplain which are heavily influenced by local catchment conditions and rainfall for their nutrient dynamics. Similarly, it was observed that dissolved oxygen levels within the flats themselves are typically low, with the highest levels being associated with the turbulent flows resulting from discharge from the Itezhi-Tezhi dam.

In terms of temperature, the waters discharged from within the hypolimnion may be of 18ºC - 20ºC. This may be up to 10ºC below surface temperatures within the reservoir or within the Kafue River downstream. Large differences in temperature can impact aquatic species as well as affecting productivity. Sudden temperature shocks may result in fish kills for local populations. Discharges of cooler waters can form a hypolimnetic layer along the bottom of the receiving water body. However, mixing within shallow rivers is typically greater than within lakes, and such layers tend to breakdown over time and distance. The current practice of releases from the NDT as part of dam operations has not been associated with an in-stream hypolimnion or reported complaints of temperature impacts along the Kafue River downstream. Additionally, it is considered that the open air tailrace will aid returning the water to ambient river temperatures. However, mitigation measures will need to be applied to ensure discharged waters are close in nature to seasonal ambient in-stream temperatures.

The flow of water through the power plant is likely to affect turbidity by both entraining benthic sediments within the reservoir (discussed further below) or as a result of scour upon discharge into the Kafue River. The release of up to 312 m^3/s into the Kafue River at a new discharge location (**Figure 3.4** and **3.5**) will significantly alter the immediate local hydrology at the outlet. The narrow vegetated sandbank immediately offshore from the discharge location is likely to impede discharges and reduce scour. However, it is possible that this bank will be gradually

eroded, increasing turbidity loads downstream and altering local bathymetry. However, the tail race is proposed to be designed with a wide outlet to minimise scour depths. It is also considered that the existing discharge of water over the main spillway of the dam generates elevated turbidity levels immediately downstream of the dam. Given the size and volume of the Kafue River it is unlikely that turbidity levels as a result of power plant discharge would be materially different in magnitude to existing levels. Discharge scour impacts are considered likely to be localised in nature and the application of mitigation measures would further minimise the extent and likelihood of impact.

Other physico-chemical parameters and concentrations are unlikely to materially vary with depth along the reservoir water column. This is particularly so given that annual cycling and mixing of the reservoir does occur, limiting long term development of differences in water quality. As such, the change in discharge source is considered unlikely to significantly affect the received downstream water quality in comparison to current discharges for these parameters. The general water quality within the dam, as is currently discharged, is seen to be of relatively high quality and its continued discharge is unlikely to negatively impact on the Kafue Flats downstream.

Sediment Mobilisation

The location of the SDT intake, at the bottom of the water column, may lead to increased mobilisation of sediment in the discharge from the Itezhi-Tezhi reservoir. The effects of any such increase may include:

- Increased concentrations of contaminants (particularly heavy metals);
- Increased levels of nutrients entering downstream water bodies; and
- Smothering of aquatic vegetation.

The impacts of sediment release on downstream water resources will depend on:

- Sediment quality – the concentration of contaminants of concern in the sediment that would be entrained by the SDT discharge;
- Sediment concentration – the amount of sediment that is mobilised by the discharge; and
- Timing of sediment release – the extent to which there will be a “first flush” effect once the SDT commences operation, and whether or not the sediment releases will significant vary throughout the year.

Recognising the potential for sediment entrainment, as part of the project, the proponent plans to carry out dredging to remove sediments around the SDT inlet. Dredging will clear an approximately 200m x 50m area in front of the tower intake, removing sediment to a depth of 30cm (i.e. to reservoir basin substrate) where possible (i.e. approximately 3,000 m^3). This is considered sufficient to capture any sediments that have been deposited since reservoir formation based on average core depths observed by Kunz (2011)[20]. This dredging work is likely to reduce the amount of entrained sediment that would be present in the SDT discharge. However, modelling has not been undertaken to establish to what extent this will reduce sediment loads in comparison to discharges from sediment loads entrained in the current NDT discharges as part of dam operation. The observed exponential decrease in sediment deposition along the length of the reservoir (Kunz, 2011) suggests that any sediments dredged are unlikely to resettle within the area in the short-term. Current releases through the NDT generally occur at rates of greater than 300 m^3/s. However, under power house operation, intake through the SDT will typically be less than 200 m^3/s and likely to entrain lower sediment

[20] Core samples undertaken by Kunz (2011) at sites in close proximity to SDT only extended to 12cm depth before striking rock substrate.

volumes than NDT operation. In comparison to discharges over the main spillway the SDT is likely to carry a greater sediment load. However, it is noted that once any initial scour occurs, the rate of sedimentation is likely to stabilise.

There is insufficient information to determine whether or not the extent of dredging is sufficient to reduce entrainment volumes to average existing sediment loads. The discharge of additional sediment volumes may lead to both positive (i.e. additional nutrients for the Kafue Flats) and negative impacts (transfer of pollutants downstream or smothering of vegetation). Sediment transfer effects are likely to be largest over the short term following commencement of operations, with sediments loads likely to stabilise toward natural deposition rates once loose surface sediments have been entrained. In particular, it is expected that a "first-flush" effect is likely to carry the greatest sediment and potential contaminant loads.

In regards to the potential smothering of vegetation, existing suspended solid concentrations in water in both the reservoir and downstream were measured during this study as being very low (<1.0 mg/L), although this analysis was carried out during the dry season. Suspended solid concentrations and turbidity are likely to be greater during the wet season. It is noted that all sediment trapped within the reservoir would have previously passed through to the Kafue Flats prior to its construction. Previous discharge through the NDT has not been associated with vegetation smothering suggesting that short term sediment discharge volumes are not significant. As the potential for entrainment is likely to diminish over time, it is considered unlikely that aquatic habitat smothering will arise as a long term impact. However, the potential for short – medium term is recognised and appropriate mitigation measures will need to be applied to minimise any potential impact.

The information available at present suggests that the concentration of metal contaminants in sediments close to the SDT inlet are not significantly different to the existing concentrations in sediments in the Kafue River downstream of the reservoir. Based on this it is considered that the mobilisation of reservoir sediment and subsequent deposition further downstream should not have significant impacts on the downstream concentrations of these contaminants. However, it is recommended that careful monitoring plans and mitigation measures be applied to confirm this finding.

<u>Waste water from accommodation camp and associated facilities</u>

A permanent accommodation camp will accommodate approximately 47 staff. This camp will generate sewage which has the potential to have impacts on downstream water quality in the Kafue River, and will require adequate treatment prior to discharge. Provision of formal stormwater site drainage, sewer and waste disposal systems will minimise the risk of site run-off leading to deterioration of river water quality. In particular, the switching yard and transformers present utilise oils, potentially including polychlorinated biphenyls (PCBs) which are highly toxic to the environment.

Similarly, the associated project facilities have the potential to affect water quality through the generation of waste and sewerage, with uncontrolled releases, accidental spills and litter potentially impact local waterways.

<u>Water Quality Impacts within the Dam</u>

There is some potential that the operation of the power plant will lead to the breakdown in thermal stratification within the Itezhi-Tezhi reservoir. Insufficient information is available in regards to the formation and extent of the stratification and, in particular, the development of the hypolimnion within the reservoir to accurately determine this likelihood. If the operation of the plant does not breakdown the hypolimnion then the operation of the plant is unlikely to impact upon reservoir water quality. Given the size of the reservoir and general low magnitude of releases associated with the power plant it is considered unlikely that the intake will entirely break down the hypolimnion. More likely is a localised breakdown of the hypolimnion

surrounding the intake. In the event that the hypolimnion were to break down, mixing within the lake will improve. However, it is noted that the presence of a hypolimnion within a lake that has periodic mixing can improve the productivity of the lake by aiding in recycling nutrients within the water column. Itezhi-Tezhi reservoir is considered likely to receive some benefit from this recycling process.

6.3.4 Mitigation Measures

Construction

A construction phase water quality environmental management plan will be prepared and implemented to manage the potential water quality impacts of construction activities across all sites. This will include specific measures to mitigate impacts on surface and groundwater. These will include the following general measures:

- Avoiding earthworks during periods of heavy rainfall, to the extent practicable;
- Minimising the length and steepness of slopes to reduce run-off velocities and hence minimise sediment mobilisation;
- Re-vegetation of areas of bare soil as quickly as practicable;
- Lining and/or protection of steep drainage channels to minimise erosion;
- Design of temporary site drainage works to control run-off, including the use of settlement basins to minimise off-site sediment mobilisation;
- Segregating run-off from areas prone to erosion from other areas, for ease of treatment;
- Provision of covered storage for materials such as cement with potential to impact on water courses; and
- Provision of designated concrete wash-out areas for controlled disposal of concrete, comprising suitably lined and contained area remote from drainage channels.

In order to mitigate potential impacts from spillage of materials, the following measures will be adopted:

- Provision of adequate secondary containment for fuel and oil storage tanks, e.g. secure bunded areas;
- Restriction of refuelling and other fluid transfer to areas covered with impervious surfacing; and
- Provision of spill containment and cleanup equipment and training of workers in correct procedures for fluid transfer/fuelling and emergency spill prevention and cleanup measures.

Operation

<u>Discharge of Deep Lake Waters</u>

Although the current operation of the dam does involve occasional release of deep-waters that are likely to be anoxic, the Project will differ from the existing baseline conditions in providing a continuous discharge of the potential anoxic waters associated with hypolimnion formation. The potential impact of this long-term change is difficult to predict, and will likely vary with seasonal and annual conditions. As such it is recommended that:

- a detailed monitoring program is established both pre- and post-operation commencement; and

- mitigation measures are applied and further measures considered for implementation pending the results of the monitoring program.

It is recommended that a monitoring program be developed and instituted at least one year prior to commencement which shall involve monthly sampling at representative locations within the reservoir and downstream to establish a more rigorous baseline of how water quality varies over time and depth within the reservoir and downstream of the reservoir. In particular, sampling shall coincide with releases from the NDT (in the absence of main spillway discharge) on at least three occasions within the hypolimnetic phase of the reservoir's cycle. Water quality parameters to be assessed shall focus on:

- Dissolved oxygen;
- Key ions and nutrients associated with the development of anoxic conditions;
- Temperature;
- Suspended solids; and
- Key metals likely to be associated with mining tailings.

This monitoring regime shall be continued into the operational phase of the power plant. **Section 11** provides further detail as to the monitoring plan to be adopted, including on-going sediment monitoring. Results of monitoring will inform the appropriate level of direct mitigation measures to be applied.

Various techniques are available for mitigating the impacts associated with the release of hypolimnetic water from reservoirs. The dissolved oxygen concentration of the released water can be enhanced by three main techniques:

- In-situ aeration or oxygenation of the hypolimnion within the reservoir (i.e. prior to release);
- Aeration of releases whilst passing through turbines; or
- Aeration of tailwaters.

The hypolimnion can be oxygenated by using either air or oxygen pumped into the reservoir at an appropriate depth and allowed to diffuse through the water column. These systems require the use of powered pumps/compressors, and possibly also supplies of oxygen. The pipework and diffusion equipment needs to be adequately managed and maintained. Mechanical mixing is another technique which has been used in some cases to prevent thermal stratification from occurring. Given the large size of Itezhi-Tezhi lake, mechanical mixing is unlikely to be feasible in this case.

Turbine venting is the process of injecting air into water as it passes through a turbine, either directly or by using a turbine designed to use the low pressure zone below the turbine wheel to draw air into the water stream. Various technologies are available, and may be suitable for use at the power house. It is recommended that this element is considered for adoption within the power house design following review of monitoring results.

Physical structures can be included in the tailwaters of a release which use agitation and turbulence to ensure rapid mixing of the released water with the atmosphere and thus increase the dissolution of atmospheric oxygen. Structures may consist of weirs or gated conduits. Care may be needed to avoid supersaturation of some types of gases (e.g. nitrogen) which may have deleterious effects on aquatic life. These mixing techniques may be suitable for use at the power house. It is recommended that as a minimum, this element is adopted within the power house design.

There are numerous worldwide examples of mitigation measures being successfully used to increase the dissolved oxygen concentration of hypolimnetic reservoir releases. Suitable techniques should be evaluated and incorporated into the detailed design of the project.

Aeration of hypolimnetic water should also eliminate the presence of H_2S by oxidation to sulphates. However, there may still be the possibility of releases of H_2S gas within the turbine halls or tailrace, depending on where and how aeration occurs. Appropriate ventilation or scrubbing facilities may need to be provided

The impacts of any increased nutrient release would be difficult to adequately mitigate, and further investigation would be required in order to determine whether or not the impacts on the downstream ecosystem are significant or not. This is discussed further in **Section 6.1**.

In the event that operational monitoring indicates that the adopted mitigation measures are insufficient a more fundamental approach to mitigating the impacts of release of hypolimnetic water would be to use an intake tower to control flows into the SDT such that the water intake is predominantly from the eplimnion. This would resolve the issues associated with anoxic waters, temperature and sediment entrainment. However, such an approach would also affect the water balance of the dam and power plant and a detailed assessment would be required to evaluate the technical feasibility of this approach.

It is noted that under IFC PS 6 there is a requirement to undertake an assessment of ecosystem services. In the event that the Project would lead to impacts on water quality or hydrological flows (**Section 6.4**) it is considered that the utilisation of the Kafue Flats by a large number of communities would generate a high significance of impact. However, based on the level of information available in regards to the likelihood and extent of potential impacts, recommended monitoring requirements and the availability of operational design mitigation measures, the Project was considered likely to provide a low significance of impact on ecosystem services. Consequently, no specific ecosystem services review has been undertaken for the project to date. It is recommended that the need for a detailed review of ecosystem services be reassessed following review of pre- and post-operation commencement water quality monitoring results.

<u>Sediment Mobilisation</u>

The project is understood to include dredging to remove sediments from the vicinity of the SDT inlet. Prior to commencement of dredging works, confirmation will be provided as to the adequacy of a 200m x 50m dredge area, and detailed descriptions of how the associated spoil will be stored and disposed. This shall be developed within an approved Dredging Management Plan.

Given the large volumes of water to be released, it is considered that mitigation measures should be focused on minimising sediment entrainment prior to release, since rapid removal of sediment load by settlement after release is unlikely to be feasible. Further investigations and modelling may be required in order to evaluate the adequacy of the proposed mitigation measures. As a minimum, it is recommended that water quality monitoring, assessing the level of suspended sediment and turbidity, be undertaken both pre- and post-dredging works. This will allow review of the effectiveness of dredging works undertaken.

<u>Waste Water from Associated Facilities</u>

A sewage treatment plant (STP) will be installed to treat sewage arising from the new accommodation camp. The plant will be located adjacent to the Itezhi-Tezhi dam secondary spillway and the existing local STP. The treatment plant will have an average processing capacity of 300 m^3/day. Sanitary wastewater will be treated to meet Zambian standards for effluent discharge prior to release to the Kafue River.

Similarly, the operation of the Facility will include the use of lubricants, solvents, and storage of hazardous goods, as well as being likely to generate fine particulate metal matter. Without the application of appropriate clean-up / safety mitigation measure, there is potential for stormwater run-off to become contaminated. The design of the facility is such that the majority of works likely to produce such contaminants will be undertaken within covered and bunded areas to minimise contamination risk. In particular, use of appropriate bins/containers/tanks to store hazardous wastes, prior to disposal off-site, form a key component of the Facilities operational procedures and will minimise the risk of contamination events occurring.

Table 6-19 provides a summary of the all the recommended monitoring and mitigation measures to be applied during construction and operation phases.

Table 6-19: Mitigation Measures to Reduce Impacts on Water Quality

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
15	Release of untreated or inadequately treated sewage by construction and operational workforce	Construction and Operation	Very Low	Site waste water infrastructure to be regularly inspected and maintained. Waste water treatment facility will operate at design specifications to meet Zambian water quality standards	Negligible
16	Spillage of oil or other harmful substances from storage or maintenance facilities (e.g. explosives magazine, maintenance depots) , vehicles and equipment.	Construction and Operation	High	Functioning "spill kits" will be kept on-site at all time during construction. Workers will be provided with training on use of spill kits and response to spillages and appropriate waste management actions Wastes to be disposed of in accordance with a waste management plan which provides appropriate receptacles for all wastes that are regularly emptied. Hazardous materials to be stored and disposed of in accordance with material safety data sheet requirements. As a minimum, hazardous materials to be stored in sealed containers within secure bunded and sheltered storage areas. Construct oil interceptors and containments chambers around transformers in substations and hydraulic plant; Setup workshops in less sensitive areas with appropriate oil interceptors	Medium
17	Run-off of surface water from stockpiles or bare soil surfaces containing high concentrations of suspended solids.	Construction	High	Erosion and sediment control measures will be outlined in the Stormwater Management Plan developed as part of the detailed design. As a minimum, this will include:	Medium

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
				• Avoiding earthworks during periods of heavy rainfall, to the extent practicable; • Minimising the length and steepness of slopes to reduce run-off velocities and hence minimise sediment mobilisation; • Revegetation of areas of bare soil as quickly as practicable; • Lining and/or protection of steep drainage channels to minimise erosion; • Design of temporary site drainage works to control run-off, including the use of settlement basins to minimise off-site sediment mobilisation; • Segregating run-off from areas prone to erosion from other areas, for ease of treatment; • Provision of covered storage for materials such as cement with potential to impact on water courses; • Provision of designated concrete wash-out areas for controlled disposal of concrete, comprising suitably lined and contained area remote from drainage channels; • Visual inspection of discharge locations on a regular basis and following rainfall events	

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
18	Discharge of wash-out water from concrete trucks or other vehicles used from construction works	Construction	Low	All vehicles will be washed out and maintained within bunded areas. Design of temporary site drainage works to control run-off, including the use of settlement basins to minimise off-site sediment mobilisation and allow settlement of potentially contaminated washout	Very Low
19	Dredging of reservoir areas generating sediment plumes affecting local species	Construction	Low	Dredging works will be undertaken in accordance with a dredge management plan. Dredging works will be undertaken during the hypolimnetic phase if practicable to utilise natural thermoclines and in fine weather to contain plumes. Dredging extents will be suitable to minimise the need for future dredging events	Very Low
20	Dewatering of spoil or spoil run-off entering the either the Itezhi-Tezhi reservoir or Kafue River	Construction	Low	Dredge spoil sites will be located in bunded areas and under cover where possible. Dewatering will be controlled and waste water disposed of to an appropriate location in keeping with the chemical properties of the capture water.	Very Low
21	Discharge of anoxic waters from within the Itezhi-Tezhi hypoliminion leading to reduced dissolved oxygen concentrations downstream and potential fish-kills / reduced productivity	Operation	Extreme	A Water Quality Management Plan will be developed which will include a detailed monitoring plan for dissolved oxygen levels discharged (both pre and post construction). The tail race shall be fitted with suitable turbulence devices (e.g. aeration weirs) to aerate the water	High

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
				prior to discharge into the river. Where practicable, releasing discharges over the main spill way will occur during the months of March – May. Monitoring results will be regularly reviewed and the need for additional physical mitigation measures to be considered, including turbine venting. Temporary shut down of the plant in the event of fish-kills until modified mitigation measures are applied.	
22	Discharge of anoxic waters from within the Itezhi-Tezhi hypolimnion leading to increased nutrient and ion concentrations downstream and potential eutrophication events	Operation	Very High	A Water Quality Management Plan will be developed which shall include a detailed monitoring plan for nutrients and suspended solid levels discharged (both pre and post construction). The tail race shall be fitted with suitable turbulence devices (e.g. sluices) to aerate the water prior to discharge into the river. Where practicable, releasing discharges over the main spill way will occur during the months of March – May. Regular visual inspections of down-stream waters for growths in weed species or algal blooms.	Medium

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
				Temporary shut down of the plant in the event of significant algal blooms until modified mitigation measures are applied.	
23	Discharge of cold waters from within the Itezhi-Tezhi hypolimnion leading altered river productivity and potential	Operation	High	A Water Quality Management Plan will be developed which will include a detailed monitoring plan for temperature levels of discharged water (both pre and post construction). The tail race shall be fitted with suitable turbulence devices (e.g. sluices) to mix and disturb the water prior to discharge. Where practicable, releasing discharges over the main spill way during the months of March – May. In the event that discharges are seen to cause riparian stratification, fish kills, or reductions in overall ambient temperatures, the plant shall be shut down until mitigation measures (e.g. heating of draft tubes, extension of tail-race) are applied.	Medium
24	Discharge of bottom waters entraining increased sediment loads leading to the smothering of aquatic vegetation	Operation	Medium	A Water Quality Management Plan will be developed which shall include a detailed monitoring plan for suspended solid levels discharged (both pre and post construction). Regular inspection of key sedimentation and erosion areas downstream of the discharge location	Low
25	Discharge of bottom waters entraining contaminated sediments leading to potential	Operation	High	A Water Quality Management Plan will be developed which shall include a detailed monitoring plan for suspended solid levels discharged (both	Low

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
	contamination downstream and potential bio-accumulation.			pre and post construction). Undertaking appropriate dredging in-front of intake towers to minimise the likelihood of sediment entrainment.	
26	Discharge of power plant waters leading to scour downstream.	Operation	Medium	Installation of appropriate scour prevention devices (e.g. rip rap) and scour protection at key sites. Regular inspection of key sedimentation and erosion areas downstream of the discharge location to assess the need for further scour protection.	Low

6.3.5 Residual Impacts

As can be seen in the mitigation table, there is a need to provide further information to confirm the findings of the impact assessment undertaken. Based on the information available it is considered that most of the impacts are manageable, however the potential for significant downstream impacts is recognised as of concern. By undertaking on-going rigorous monitoring and adaptive mitigation it is considered that any significant impacts to ecological or social systems which may be affected by water quality changes may be able to be prevented and managed at an acceptable level of risk. However, in the current absence of detailed monitoring or modelling studies, the residual risks have been conservatively assessed as being high.

It is recommended that further quantitative assessment is carried out and adequate mitigation measures are incorporated into the design where feasible. Where residual risks are identified as being high or mitigation is ineffective, then more fundamental design changes or extensive downstream mitigation measures may be required.

In contrast the risks associated with construction-phase impacts on water resources are generally low, and can be readily mitigated with the adoption of suitable environmental management techniques.

6.4 Hydrology and Flooding

6.4.1 Baseline Conditions

The Kafue River basin forms part of the broader Zambezi River Basin (**Figure 6-11**). The Kafue River Basin covers a significant portion of central Zambia, and is one of the main sub-basins of the Zambezi Basin. The Kafue River is 1,500km long, and has a total catchment of approximately 154,000 km2, and is a tributary of the Zambezi.

The Kafue River Basin can be divided into four sub-basins, each of which have unique hydrological characters. **Table 6-20** details the sub-basins of the Kafue River. The Itezhi-Tezhi Reservoir is located with the Middle Kafue sub-basin, it discharges to the Kafue Flats downstream, and is affected by the flows received from the Upper Kafue flats. The Lower Kafue sub-basin is considered outside of the area of interest for this assessment.

Figure 6-11: The Zambezi River Basin in Southern Africa and the location of the Kafue River Basin and Kafue Flats[21]

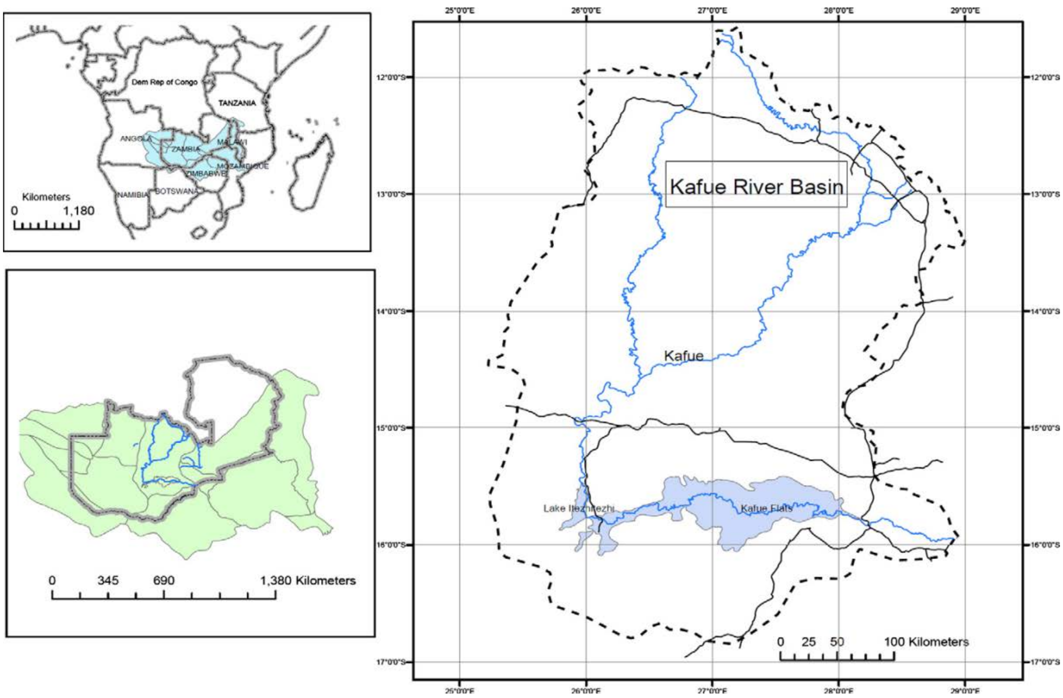


Table 6-20: Sub-basins of Kafue River.

Sub-basin	Area (km^2)	Area (%)	Comments
Upper Kafue	23065	15	Activities in Copperbelt Districts and other industrial, agricultural and residential areas are known to have a significant impact on water quality in the river.
Middle Kafue	84126	54	Inflows into the Itezhi-Tezhi reservoir.
Kafue Flats	41074	26	The release of water quality depending on the sediment load that may be flushed and the quantity of water released will alter present flow patterns
Lower Kafue	8730	5	Dominated by the Kafue Gorge Upper Hydropower Project
Kafue Basin	**156995**	**100**	

The Upper Kafue captures a number of tributary catchments, comprising the headwaters of the Kafue River. The sub-basin has undergone significant anthropological disturbance, with extensive deforestation and mining development altering seasonal water volumes and sediment yields, while also leading to the introduction of contaminants into the river. Water

[21] Wamulume *et al*., 2011, Exploring the hydrology and biogeochemistry of the dam-impacted Kafue River and Kafue Flats (Zambia) in *Physics and Chemistry of the Earth 36 (2011) 775-788*

demands within the region are high and have lead to a need for increased utilisation of groundwater supplies or reservoir storage during the dry season.

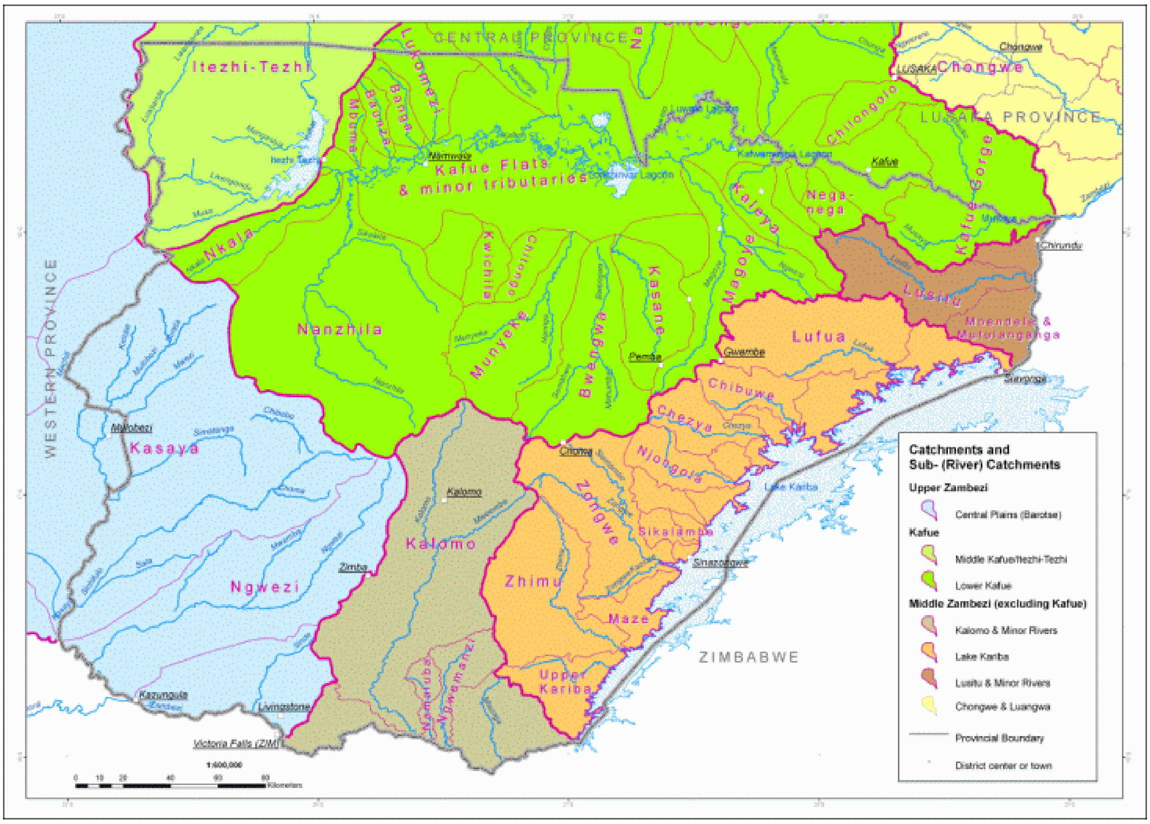
The Middle Kafue sub-basin is significantly larger than the Upper Kafue and represents the predominant factor for hydrological impacts downstream. The sub-basin catchment is dominated by the native vegetation areas of the Kafue National Park, the Lunga-Lusishi Game Management Area (GMA), Kasonso-Buanga GMA, Machiya-Fungulwe GMA, Mumbwa GMA and Namwala GMA. In comparison to the Upper Kafue sub-basin the degree of anthropological disturbance is minimal and in general it is considered that the catchments provide natural hydrological yields and sediment loads.

Within the vegetated areas there is significant diversity of geology, topography and ecological conditions. In particular, there are a number of wetlands including the Lukanga Swamp (over 2,590 km^2) and the Busanga Swamp. Wetlands acts as significant settlement sites for entrained sediment, lower flow rates, recharge local groundwater, and store flood waters in dry seasons. However, it is also noted that vast expanses of wetlands can significantly lead to reductions in water availability by increasing evaporation rates.

The Itezhi-Tezhi dam represents the downstream boundary of the Middle Kafue sub-basin, acting as a large wetland and reservoir for local communities. The construction of the reservoir represents the largest alteration to the hydrological conditions within the Upper and Middle Kafue sub-basins.

From the Itezhi-Tezhi dam the Kafue River meanders for approximately 400km into the Kafue Flats sub-basin, a large expanse of wetlands and floodplains. The gradient of the river through these flats is shallow ranging from 0.01 to approximately 0.04m per km from East to West. The Kafue Flats wetlands covers approximately 6,500km^2 and extends 40 to 56km at its widest point (Scott Wilson Piesold, 2003). The rate of flow is such that travel times through the wetlands are approximately 80 – 90 days. It is noted that ZESCO adopted an operational travel time for water releases from Itezhi-Tezhi dam to reach the Kafue Gorge Upper dam of 60 days (Scott Wilson Piesold, 2003) The area of the flats flooded by the Kafue River varies seasonally and inter-annually. **Figure 6-12** presents the location of the Kafue River basin and the Kafue Flats. It can be seen that in addition to the Kafue River itself (fed by discharges from Itezhi-Tezhi dam) the Kafue Flats do capture flows from a large number of tributaries.

Figure 6-12 Surface Water catchments of Southern Province[22]



Rainfall within Zambia decreases with latitude, north to south. As such, although the Kafue Flats sub-basin has a larger catchment area than the Upper Kafue sub-basin, a greater volume of water is received through the Kafue Flats from main channel flows from the Upper and Middle Kafue sub-basins than are received through local rainfall and catchments (Haller, 2007) . However it is noted that the main channel is bounded by discontinuous levees along both banks for much of its length as well as elevated river beds at some locations. This serves to retain river flows within the channel when not in flood as well as increase surface water retention times within the floodplain and wetlands following flood events. This is consistent with the findings of Wamulume *et al.* (2011) which suggests local catchment rainfall and tributaries play a significant role in regulating the hydrology of the Kafue Flats in addition to upstream flows, this effect increases with downstream distance from Itezhi-Tezhi reservoir. The water balance studies undertaken by Wamulume *et al.* (2011) suggest that up to 55% of water within the flats originated as direct precipitation within the Kafue Flats and local tributaries. The main channel of the river within the Kafue Flats has a conveyance capacity of approximately 250 m^3/s. At flow rates above this, over-topping occurs and flows separate out into multiple channels and open water (**Figure 6-13**). Waters leaving the river at one location often return to the main channel further downstream.

[22] Baumle, et al., 2007. Groundwater Resources for Southern Province: A Brief Description of Physiography, Climate, Hydrology, Geology and Groundwater Systems of Southern Province

Figure 6-13: Kafue River within the Kafue Flats Post Flooding Inundation[23]

Table 6-21 summarises the typical inundation and drying cycle that occurs within the Kafue Flat sub-basin. Flows vary year by year in response to variations in annual rainfall, but the pattern of the annual flow regime is consistent and shows an annual maximum in March (mean flows of around 750 m^3/s) and a minimum during October and November (< 50 m^3/s). March flows in excess of 500 m^3/s occur in all but the driest years. Flows are below 100 m^3/s for an average 139 days each year (Mumba, 2005).

Table 6-21: The flooding Cycle of the Kafue Flats[24]

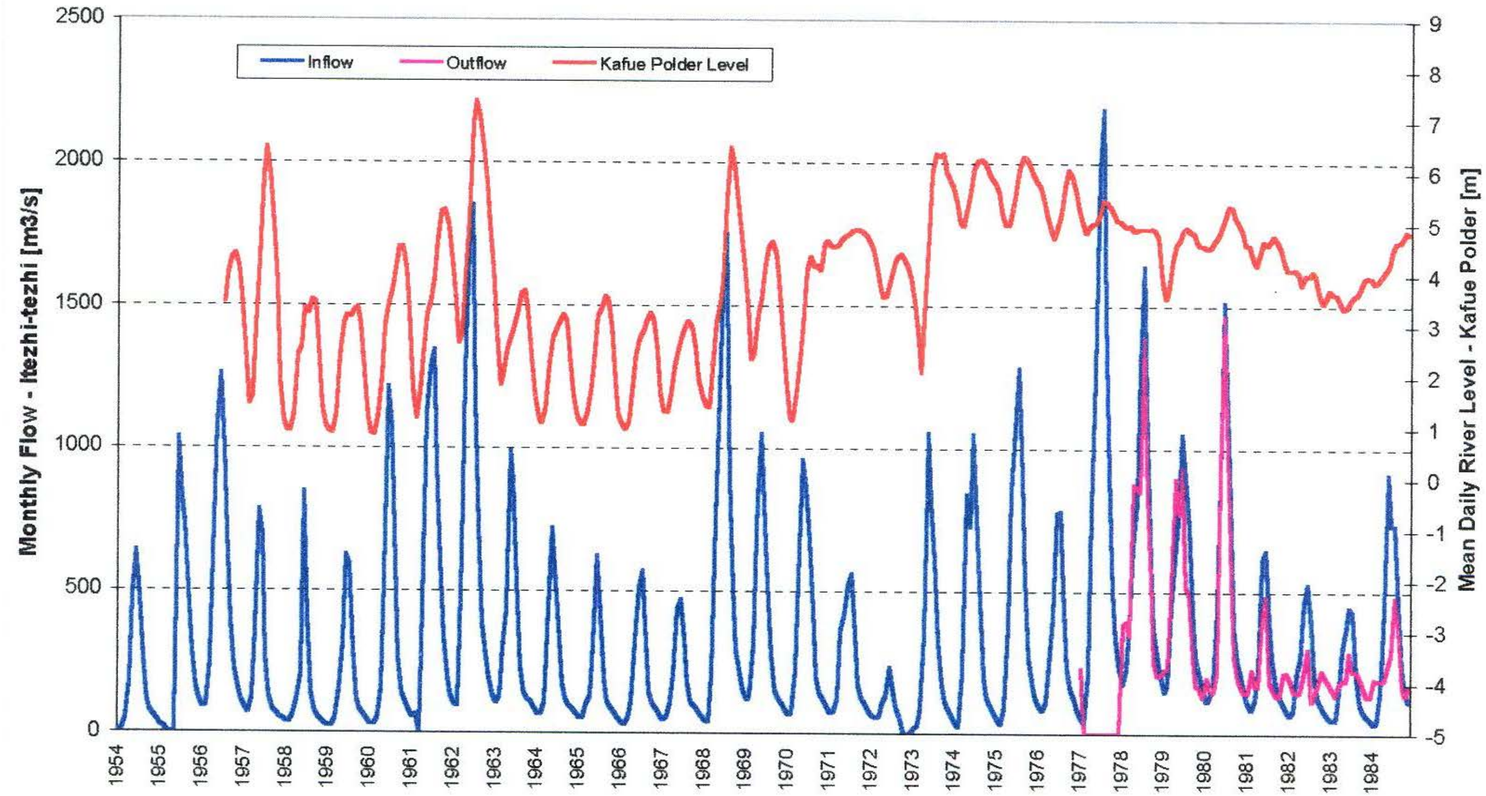
Season	Months	Flooding Pattern
Start of rainy season	November to January	Minor flooding from local rains and tributaries, towards end main river and tributaries are connected
End of rainy season and major floods	February to April/ May	Little local rainfall, but massive discharge of water from the Kafue. The whole flood plain is inundated
Retreat of water/ early dry season	May to July	River level falls again but there are many pools, oxbows and lagoons formed
Dry season	August to October	Water completely retreats, some ponds, lagoons, oxbows remain

[23] Scott Wilson Piesold, 2003. Integrated Kafue River Basin Environmental Impact Assessment Study: State of the Environment Report.
[24] Haller, T., 2007. The Contested Floodplain: Institutional Change of Common Pool Resource Management and Conflicts among the Ila, Tonga and Batwa, Kafue Flats (Southern Province), Zambia.

The Kafue Gorge Upper dam is located at the eastern extent of the Kafue Flat sub-basin. The construction of both the Kafue Gorge Upper dam (1972) and Itezhi-Tezhi dam (1978), have significantly altered the hydrology within the Kafue Flats. The development of the Kafue Gorge Upper dam, led to a significant increase in the extent of flooded area during the dry season as a result of backwater effects and raised water levels. Impacts during the wet season are considered to be less significant.

Similarly, the development of Itezhi-Tezhi dam significantly altered the hydrological processes within the Kafue Flat sub-basin. Most significantly, the dam reduced the inflow to the Kafue Flats during the wet-season (as the dam fills) while also increasing the inflow during the dry season (**Figure 3-8, Table 3-4**). This is considered to have resulted in up to a 25% reduction in average flood extent during the wet season (Scott Wilson Piesold, 2003). This is likely to have had significant impacts (in comparison to the pre-dam conditions) on the ecological and agricultural functioning and land use of the flats. **Figure 6-14** demonstrates the impacts of the reservoir creation of both dams at Kafue Polder, in the eastern extent of the flats. Both the impacts of Kafue Gorge Upper (increasing water levels) from 1972, and the subsequent impacts of the Itezhi-Tezhi dam (attenuated inflows) from 1978 are visible.

Figure 6-14: Inter-annual Variation in Water Levels at Kafue Poder[25]



[25] Source: Scott Wilson Piesold, 2003. Integrated Kafue River Basin Environmental Impact Assessment Study: State of the Environment Report

The Itezhi-Tezhi dam was developed primarily to provide stability in flows to the Kafue Gorge Upper hydropower plant which requires a minimum discharge of 120 m^3/s through its turbines to maintain its energy generation target, supplying in average approximately 170 m^3/s. ITT effectively smoothes the annual flow pattern, thereby ensuring sufficient flows for downstream power generation in the dry season and reducing the impacts of flooding in the wet season. In particular, the operation of the dam was designed to stabilise river flows below 250m^3/s to prevent overbank flooding at the Kafue Gorge Upper (Beilfuss and Dos Santos, 2001). In addition to these requirements, as part of the approval granting ZESCO the right to operate the Itezhi-Tezhi Dam, a series of conditions relating to the operational flows of the dam were issued by the Zambian Government, including:

- ZESCO shall store and release from the Itezhi-Tezhi Dam a minimum of 300 m^3/s over a period of four weeks in each year (typically March) to preserve the ecological balance of the Kafue Flats.
- ZESCO shall store and release sufficient water to ensure that a minimum of 15 m^3/s is available for other users between Itezhi-Tezhi Dam and Kafue Gorge Dam at all times; and
- ZESCO shall ensure that a minimum flow of 25 m^3/s is maintained in the river between the Itezhi-Tezhi dam and Kafue Gorge Dam at all times.

The balancing of these conditions with demand from the Kafue Gorge Upper dam have resulted in the observed discharge pattern described in **Figure 3-8**. Mean monthly flows in March have reduced from around 700 m^3/s to around 500 m^3/s, and dry season flows have increased such that they are above 170 m^3/s for 9 months of the year, and fall below 100 m^3/s for only 50 days per year on average (Mumba, 2005). In addition to the operating rules for the dam itself, it is noted that a Strategy for Flood Management for the Kafue River basin, Zambia has been established (APFM, 2007), which provides further flood management measures for the basin as a whole.

While the extent of these impacts may be of concern, it is recognised that these impacts upon hydrology are not directly relevant to this ESIA. This altered hydrological system represents the base line conditions against which impacts associated with the development of the power plant are to be assessed.

6.4.2 Potential Impacts

Construction

During construction the Project will alter local hydrology and flooding both on-site and in the immediately surrounding areas, due to:

- Altered topography through excavation, erection of buildings etc.;
- Changes to local flow paths; and
- Increased imperviousness and surface flows through vegetative clearance;

It is considered that the extent of impacts in this regard is very low for both the power house site and the site of the off-site ancillary facilities. The power house site is highly isolated and located immediately adjacent to the river. Any localised changes in hydrology are not anticipated to extend outside of site boundaries. In order to permit safe construction, adequate stormwater drainage will need to be established.

Located both in the shadow of the dam as well as immediately adjacent to the Kafue River the site is at risk of riparian flood inundation. No flood modelling assessment was undertaken as

part of the ESIA. However, the dam is operated in such a way that controls flood events and effectively mitigates the risk of riparian flooding immediately downstream except under dam-break scenarios.

On-site flood risks will be limited to local catchment areas, downstream of the dam. The local catchment for the power house site is limited to the hill directly behind it, and has an estimated catchment area of approximately 70ha. Surface flows have the potential to erode site surface as well as entrain contaminants leading to a deterioration of water quality downstream.

In contrast, the Project's off-site ancillary facilities are elevated above the level of the dam main spillway and not located next to waterways or within local catchments likely to generate significant flood risks. The expanded sewerage treatment plant is considered to have the greatest flooding risk, being located adjacent to the dam's emergency spillway.

The extent of bulk earthworks and scale of infrastructure associated with the ancillary facilities are not considered likely to generate significant changes to local flooding extents, however, suitable stormwater management measures will need to be applied to ensure potential impacts are mitigated.

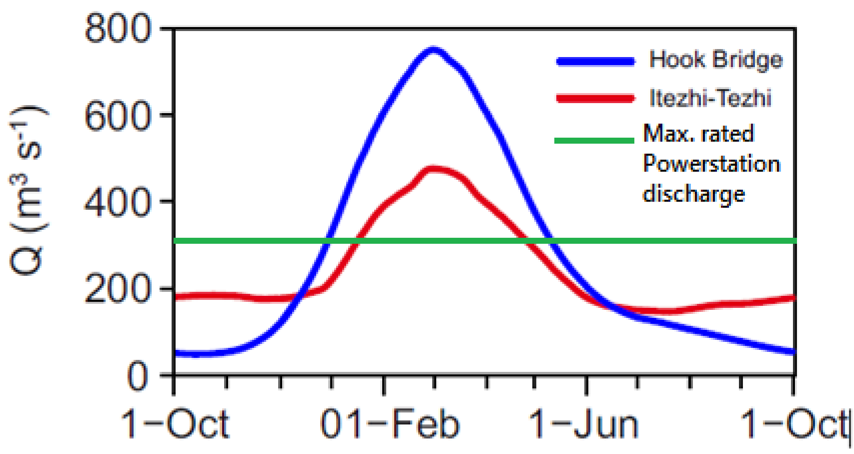
Waste water disposal requirements associated with construction worker accommodation camps and activities are considered to be low and unlikely to significantly alter hydrological flows. Water extraction from the reservoir / river to meet construction activity and worker needs is considered to be negligible in terms of hydrological impacts.

<u>Operation</u>

The operation of the power plant will be undertaken in cooperation with the operation of the dam, taking into consideration the flow requirements of the Kafue Gorge Upper dam, as well as agreed discharge requirements. As such, the powerplant will discharge waters in a manner which follows the existing discharge regime of the dam (**Figure 6-15**). Consequently, it is noted that the powerplant will typically operate at levels below its maximum rated flow of 312 m^3/s, producing:

- Approximately 80 MW from October to January (at a discharge rate of approximately 200 m^3/s)
- Approximately 120 MW from February to May (at a discharge rate of approximately 312 m^3/s), with additional releases provided by the spillway; and
- Below 80MW from June to September (at a discharge rate of approximately 150 to 170 m^3/s),

Figure 6-15: Comparison of inflows from Hook Bridge to outflows from Itezhi-Tezhi Dam and discharge required for constant 120 MW electricity production



ITPC have indicated that water levels within the dam will be managed such that the additional flows required to meet the current Itezhi-Tezhi discharge profile (**Figure 6-15**) during the wet season will be able to be discharged over the main spillway (preferentially) or via use of the NDT if the main spillway is not able to used. As such, downstream hydrological impacts upon the Kafue Flats are considered to be negligible. However, appropriate mitigation measures will need to be implemented to ensure this is achieved.

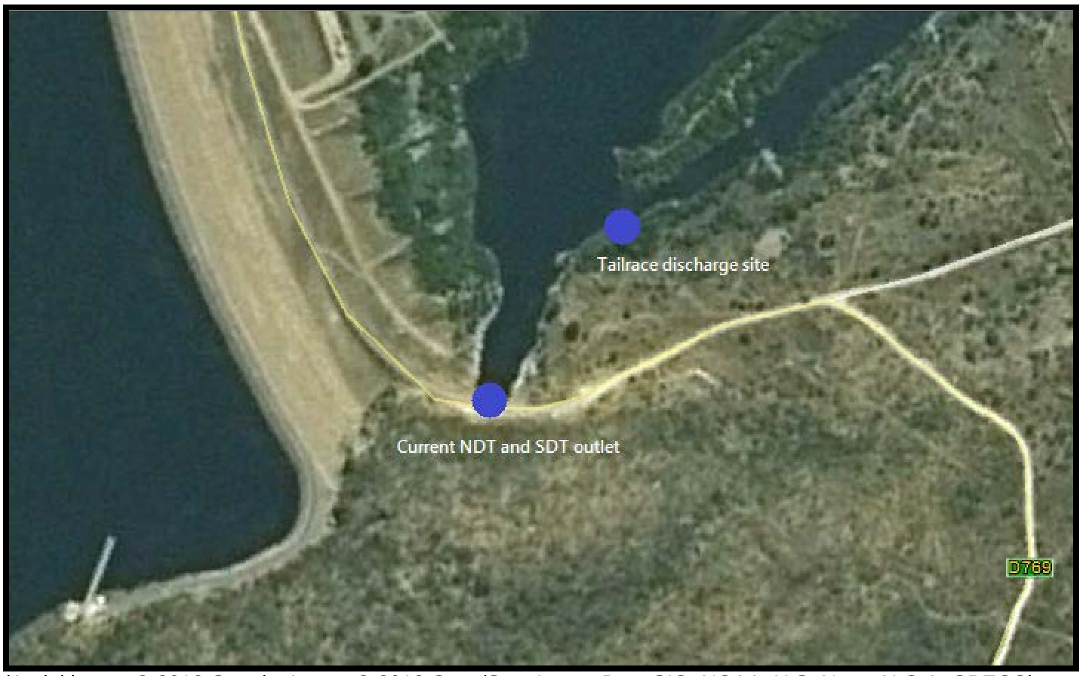
It is noted that precipitation levels can vary significantly between years and can follow larger climatic cycles. For example, the Middle Kafue sub-basin and Kafue flats experienced generally wet conditions during the 1960's and 1970's and considerably drier periods during the 1980's and 1990's. As such, it is understood that discharges from plant will also be informed by advice from the Zambian national government environmental and meteorological agencies. In adverse conditions, the proposed discharges may differ from the mean operating profile. However, it is noted that, without the power plant, adverse conditions would similarly generate altered discharge profiles.

It is considered that most hydrological impacts associated with operation of the power house and associated facilities will be local hydrological impacts associated with:

- Discharge of waters through the power plant tail race;
- Discharge of stormwater and waste-waters associated with Project infrastructure; and
- Increased imperviousness of catchment area through increased hardstand areas.

In comparison to current practices, the average volume of water to be discharged as a result of dam operation will not significantly alter. However the location of discharge will change. The tail race of the power plant will discharge approximately 230m to the north-east of the existing NDT outlet (**Figure 6-16**) and a proportion of the downstream discharge will be transferred from the spillway to the power station.. The current side channel into which the NDT discharges may experience slightly lower water levels near the tunnel entrance. There is also a vegetated sandbank immediately downstream of the discharge location (n.b. geological substrate investigations of this island were not undertaken as part of this ESIA). Discharges of up to 312 m^3/s directed towards this island are likely to result in inundation and scour of the upstream section of the island, as well as local backwater effects, potential causing localised shoreline flooding. The risk significance of any such impacts is considered to be very low.

Figure 6-16: Location of Power station and NDT outlets



(Aerial image © 2012 Google; Image © 2012 Cnes/Spot Image;Data SIO, NOAA, U.S. Navy, N.G.A, GBECO)

It is also noted that the channel of the majority of flows through the power plant will decrease the frequency and volume of flows proceeding over the main spillway. This will affect the hydrology of the approximately 300m of downstream spillway channel (reduced flow rates and volumes) prior to its joining with main channel. It is noted that under current dam operating conditions there are prolonged periods in which the main spillway is in active leading to reduced flows in the downstream channel.

The operational areas of all Project sites will capture and generate increased stormwater surface flows which will need to be either captured and re-used or appropriately channelled and discharged into the existing stormwater infrastructure system or local waterways. The channelling of water is typically associated with increased flow velocities and may lead to scour at discharge outlets. Due to the site areas of all project facilities and associated topographies, stormwater discharge rates and the potential for scour are likely to be low.

The potential for the construction of project infrastructure and alterations to local hydrology to affect neighbouring properties is considered negligible.

Operation of site facilities is unlikely to generate significant volumes of waste waters requiring treatment. The majority of waste waters are likely to be associated with general waste water and effluent associated with the worker residences which will be connected to the local stormwater infrastructure and the upgraded sewage treatment plant.

6.4.3 Mitigation Measures

The design and site-selection of Project facilities effectively minimises the potential for flood inundation to occur. However, an emergency management plan detailing flood evacuation and response procedures needs to be developed. In particular, this should consider dam-break scenarios.

If the Project is operated in accordance with the design principles it will not alter the hydrological regime of the broader Kafue Flats. However, operational management plans should include on-going monitoring and auditing of plant discharges, as well as continued

consultation with governmental environmental and meteorological bodies to ensure environmental and hydrological factors are considered in operation of the plant.

The majority of impacts are seen to relate to the potential for pluvial flooding and associated run-off during both construction and operation across all Project sites. A stormwater management plan for both construction and operation shall be developed which reflects the following principles:

- Dealing with run-off close to where the rain falls, thus encouraging natural attenuation;
- Protecting water resources from pollution (such as accidental spills) and diffuse pollution;
- Contributing to enhanced amenity and aesthetic value of the development; and
- Providing habitats for indigenous wildlife and opportunities for biodiversity enhancement of the adjacent grounds.

The key component to the stormwater management plan will be provision of stormwater collection areas which will allow for the collection of surface flows and settlement of sediment prior to controlled discharge into the river or local stormwater infrastructure. The stormwater drainage design will be updated and reviewed as part of the detailed design process so that it appropriately captures site flows, as well as providing options for stormwater harvesting or increased flow capacity in the event of increased rainfall levels as a result of climate change. A range of potential mitigation measures to be adopted during both construction and operation to minimise the identified hydrological risks are provided in **Table 6-22**.

Table 6-22: Recommended Mitigation Measures for Flooding and Hydrology

No.	Impact Identified	Stage of Work	Impact Risk	Mitigation Measures	Residual Risk
27	Altered hydrology of Kafue Flats as a result of incorrect operation of the power plant	Operation	Medium	On-going consultation with meteorological and environmental authorities as to the recommended intake rate to reflect current hydrological conditions. Regular monitoring and auditing of flow rates downstream of the tailrace discharge location.	Very Low
28	Changes to local hydrology immediately downstream of the NDT discharge location and main spillway	Operation	Medium	Discharging flows over the main spillway where possible, as consistent dam operating conditions. Periodic inspection of water quality and riparian ecology within these reaches to observe the extent of any associated impacts. Periodic inspection of the vegetated sandbank immediately off-shore as to the extent of scour and flooding. Installation of scour protection devices at the mouth of the tail race (e.g rip rap).	Low
29	Changes to existing flow paths due to altered topography as a result of bulk earthworks or infrastructure	Construction / Operation	Medium	Implement an approved Stormwater Management Plan which details stormwater infrastructure to be adopted, including use of : • Cut-off drains; • Swales and drainage lines;	Very Low

No.	Impact Identified	Stage of Work	Impact Risk	Mitigation Measures	Residual Risk
				• Detention basins; • Stormwater harvesting options • Filters and grates; • Revegetion of exposed areas. Install appropriate guttering/swales or run-off channels to direct surface flows in a controlled manner. In particular, suitable gutters for roads and hardstanding areas to be provided. Maintain and inspect discharge points of all site stormwater drainage so that they do not generate scour.	
30	Risk to worker health and safety from flood events	Construction / Operation	Low	Prior to construction and operation an Emergency Management Plan will be developed outlining procedures and responsibilities to protect worker health and safety under power station flood events.	Very Low
31	Rainfall and Flood events (pluvial or riparian) leading to: • Erosion of sediment from site; • Contamination of waters through fine metal entrainment or spills and leaks of hazardous materials; or • Destruction of property.	Construction / Operation	Medium	Implementation of erosion and sediment control measures, outlined in an approved Erosion Control Plan including: • Avoiding earthworks during periods of heavy rainfall, to the extent practicable; • Location of stockpiles to avoid proximity to drainage lines; • Regular inspection of both construction and operation stormwater capture devices (e.g. drains) for any blockages or leaks. This would form part of a site Stormwater	Low

No.	Impact Identified	Stage of Work	Impact Risk	Mitigation Measures	Residual Risk
				Management Plan; • Minimising the length and steepness of slopes to reduce run-off velocities and hence minimise sediment mobilisation; • Lining and/or protection of steep drainage channels to minimise erosion; • Design of temporary site drainage works to control run-off, including the use of settlement basins to minimise off-site sediment mobilisation; • Segregating run-off from areas prone to erosion from other areas, for ease of treatment; • Provision of covered storage for materials such as cement with potential to impact on water courses; • Provision of designated concrete wash-out areas for controlled disposal of concrete, comprising suitably lined and contained area remote from drainage channels; • In order to mitigate potential impacts from spillage of materials, the following measures will be adopted: o Provision of adequate secondary containment for fuel and oil storage tanks, e.g. secure bunded areas; o Restriction of refuelling and other	

No.	Impact Identified	Stage of Work	Impact Risk	Mitigation Measures	Residual Risk
				fluid transfer to areas covered with impervious surfacing; o Provision of spill containment and cleanup equipment and training of workers in correct procedures for fluid transfer/fuelling and emergency spill prevention and cleanup measures; and o Leaking or empty fuel/oil drums to be removed from the site immediately with measures in place to prevent contamination. All discharge of waste water and surface water to be managed in accordance with relevant local regulations and international conventions.	

6.4.4 Residual Impacts

It is not anticipated that the Project will generate any significant residual risks in regards to flooding and hydrology. The correct operation of the power plant, in-line with existing dam discharge regimes, will not affect hydrological flows within the Kafue flats.

Outside of this impact, the scale of Project and it's infrastructure development is insufficient to materially alter the received flooding regime for surrounding local sensitive receptors. The residual risks in relation of pluvial flooding and on-site stormwater management can be significantly reduced through application of mitigation measures implemented through a Stormwater Management Plan and Erosion and Sediment Control Plan.

It is noted that extreme weather events (e.g. cyclones, earthquakes), although unlikely, may occur at the site leading to flash-flooding. The emergency procedures to be adopted under such events should be specified within an Emergency Management Plan.

7 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT - MINOR RISKS

Chapter 6 of this reports addresses the identified Major Risk aspects identified for the Project; those considered to be of potential greatest concern. This chapter provides a description of the existing baseline condition for the Project, the potential impacts of the Project upon this baseline, and recommended mitigation measures for those environmental aspects considered to be of less potential importance based on the findings of the Risk Assessment (**Section 4.2**). The potentially relatively 'minor' risk aspects addressed herein include:

- Air Quality;
- Climate and Climate Change;
- Cultural Heritage;
- Groundwater;
- Land Contamination;
- Landscape and Visual Impacts;
- Lighting;
- Project Hazards and Risks;
- Solar Access;
- Traffic and Transport;
- Transboundary Watershed Issues;
- Topography, Geology and Soils; and
- Waste and Waste Management.

7.1 Air Quality and Odour

7.1.1 Baseline Conditions

Air Quality

The proposed road upgrade and extension is located within the Itezhi-Tezhi air shed.

Air quality within the Itezhi-Tezhi District is generally very good, with the exception of occasional elevated concentrations of particulate matter associated with the burning of rubbish, open fires, or occasional regional bushfires. The region as a whole is a mixture of undisturbed native vegetation, pockets of agricultural development, and small scale towns and villages, often incorporating light industrial/commercial facilities (e.g. car workshops etc.).

Within the immediate vicinity of Itezhi-Tezhi town, emissions associated with road transport contribute to deterioration in air quality. Zambia has established fuel specifications in regards to petrol and diesel use to help limit the extent of vehicle associated emissions. The closest airport is the Ngoma Airport, approximately 30 km to the south of the Itezhi-Tezhi dam. Emissions associated with the airport are unlikely to extend to the Project area of influence. The impact of emissions associated with domestic waste burning, tailing dumps, forest fires and increasing traffic is not quantified but is considered to be insufficient to generate significant toxicant levels.

The majority of air emissions within Zambia are associated with the mining industry (e.g. SO_2 emissions associated with copper smelters, foundries, cobalt plant, quarrying, lime manufacturing etc.). The majority of these industries are located within the Copper Belt province to the North (approximately 200 km distance) and are unlikely to influence air quality within the Project area. No significant air quality sources are known to occur within 5km of the proposed Itezhi-Tezhi Hydropower Project. The closest mine site is an underground pyrite mine and concentrator located approximately 170 km to the north-east. Commercial mining of gypsum may also occur approximately 130 km east at Lochnivar in Monze District (Parliament of Zambia, 2009).

Dust associated with disturbance of exposed surfaces is a local source of air quality pollution. In particular, unsealed roads which occur both to the south and north of Itezhi-Tezhi dam (**Figure 7-1**), generate significant volumes of dust following the passage of vehicles. An approximately 3km section of the D769 road is sealed between Itezhi-Tezhi town and the power house site. The soils of the area are relatively fine and prone to wind erosion and disturbance (**Section 7.11**).

The national Environment Protection and Pollution Control Act (1997) and its associated Regulation detail national ambient air quality guidelines which are to be adhered to. However, there is currently no routine air quality monitoring network nor any studies of air quality and health within Itezhi-Tezhi town.

Figure 7-1: The D769 road provides the main route to Itezhi-Tezhi Town.

Odour

The location of the proposed site is such that the number of external odour sources potentially influencing the site is minimal. The closest settlement of Itezhi-Tezhi (3 km to the north of the power house site) does not contain any industries considered likely to generate significant odour emissions. The majority of emissions are considered to be highly localised in relation to wood fire burning, rubbish and septic tanks.

However, the operation of the dam, and in particular, discharges from the dam's low level outlets (i.e. the northern tunnel) are known to be associated with offensive odours, capable of extending several hundred metres down-wind of the site. Odour issues are commonly associated with the discharge of water drawn from the base of dams and reservoirs. Typically, this is associated with the creation of anoxic conditions within the hypolimnion (the base layer of water within a stratified water body). Bacterial degradation of organic material within the anoxic conditions generates hydrogen sulphide (H_2S), which when released to air generates the strong "rotten egg" odour. This process is also commonly associated with acidification of water and sediments (**Section 6.3**).

Site inspection of the dam by ESIA team members from 14 to 18 June 2012 identified the presence of H_2S on multiple occasions, at various locations around the dam, varying with the prevailing wind conditions. The low level discharge outlet was not operational at the time. However, the odour was associated with the mouth of the outlet as well as the low level intake gates (**Figure 3-6** and **3-7**). The distance from which the odours were noticeable varied with the strength of the prevailing wind, approximately up to 500m. No odours were noticed at the nearest sensitive receptors (New Kalala Lodge and Cho'onga Farm) and it is considered unlikely the odours would travel this far (1.2km southwest, 1.6km northeast respectively) before dispersal.

Available literature on water quality of the Itezhi-Tezhi reservoir (**Section 6.3**) indicates that for much of the year (i.e. September to May) the reservoir is in a hypolimnion state at depths of between 20m and 30m below the surface .

Organic content within the layer is likely to provide from both upstream reaches of the Kafue River, and, in particular, the vegetation immediately fringing the reservoir. Other potential

mechanism by which sulphates may enter the reservoir include contaminated and nutrient rich inflows associated with copper mining facilities upstream (the closest upstream mine to the reservoir is approximately 380km to the northeast) or over-flow of septic tanks (particularly following wet weather events) from surrounding villages and communities. Water quality sampling (**Section 6.3**), indicates that it is unlikely that mining tailings are a significant contributor to the occurrence of sulphates within the reservoir.

It is likely that odours associated with the operation of the dam are significantly greater during the operation of the low level outlets.

7.1.2 Potential Impacts

Construction

During construction, air quality impacts are likely to occur during dry and windy conditions as a result of dust and particulate matter generated from construction works. Dust is defined as particulate matters in the size range 1-75 micrometers (µm) in diameter and is primarily composed of mineral materials and soil particles. Particulate matters (PM_{10}) is composed of particles with an aerodynamic diameter of less than 10 µm and include the size fractions of greatest concern to impacts on human health.

The majority of dusts generated by construction activities are larger than 10 µm in diameter and, therefore, increased levels of dust in the air do not necessarily equate to an increase in levels of PM10. In general, these dusts rarely represent an adverse risk to human health and are more typically associated with causing annoyance to the public through visible deposits soiling property.

Dust impacts will primarily occur as a result of the following construction activities:

- bulk earthworks and stockpiling;
- rock blasting;
- vegetation removal;
- movement of construction vehicles and machinery, both within and outside the construction sites;
- storage and disposal of waste, including burning of waste; and
- emissions from construction related vehicles and equipment.

These impacts will be generated at both the main power plant construction site as well as the ancillary facilities construction sites (e.g. water treatment plant and pipeline construction, worker accommodation camps construction, sewerage treatment plant construction).

The dust impacts associated with the construction of the power plant are likely to be minimal as there are no sensitive receivers within 1 km of the site. Dust concentrations are likely to have diminished to negligible levels by the time they reach sensitive receivers. The highest levels of dust migration offsite are expected to be associated with rock blasting works. The location of rock blasting is shown in **Figure 6-8**. The sensitive receivers most likely to be affected through these works are vehicles passing along nearby roads. The extent of this impact is considered to be minimal.

Several of the offsite ancillary facilities are in closer proximity to sensitive receivers than the power plant site. As such there is a greater potential for dust generated to intrude onto private property and act as a nuisance to individuals.

Dust also has the potential to smother vegetation and lead to degradation in water quality if produced in sufficient quantities, as discussed in **Section 6.1**. The closest agricultural crops

are within 1.75 km of the main site at which rock blasting will occur. It is unlikely these crops will be affected by dust levels. However, vegetation immediately surrounding the site (e.g. within 50m of site boundaries) may suffer some deposition of wind-blown material. Given the magnitude of dust likely to be produced, the extent of this impact is considered to be minimal.

The use of plant, equipment and vehicles during construction will also lead to emissions to air as a result of construction (see **Section 7.2** for climate change impacts). The majority of construction vehicles utilised will be diesel powered vehicles and generators. Diesel powered vehicles and machinery are typically associated with relatively high emissions of particulate matter (noting that the emissions profile is dependent on the operation of the vehicle/machinery).

Other than potential odours associated with the storage and burning of waste it is unlikely that any odour impacts would arise as the result of construction.

Operation

In operation, the Project will generate minimal air quality impacts upon the receiving environment and sensitive receivers. Emissions of plant and equipment will largely be restricted to those associated with vehicles of staff (the site is expected to maintain an operational staff of approximately 50 individuals) and generators/machinery utilised as part of maintenance. As a power plant, the site and ancillary facilities will be self-powered by the hydro-electricity produced. Other emissions associated with operational staff will be limited to any emissions associated with wood-fires and the burning of wastes. Given the likely minor scale of these impacts, an operational air emission model was considered unnecessary at this stage.

By establishing a hydropower plant at the existing Itezhi-Tezhi dam, the Project will help provide clean energy to a number of households and businesses across Zambia and potentially, have positive trans-boundary emission effects, by allowing further export of low carbon energy to surrounding countries. By reducing the national reliance on carbon based energy sources, future increase of carbon emissions will be reduced which will assist in maintaining future air quality..

In terms of odour impacts, the operation of the power plant will lead to an increased flow and discharge of the anoxic waters as the plant draws water from the base of the dam. This is considered likely to lead to an increase in oxidisation of sulphides to air, and subsequently increased H_2S odour emission. Sensitive receivers downstream of the discharge point may receive increased noxious odour levels as Shuman et al. 2004 has reported odours extending 2km downstream of a dam. H_2S, when present in high concentrations can be hazardous to the health of humans and animals (i.e. greater than 50 ppm). It would be expected that H_2S emissions associated with the dam would remain less than 0.1 ppm. As such, impacts would be associated with nuisance odours rather than health issues.

The closest sensitive receivers to the dam site are 1.2 km southwest and 1.6 km northeast (**Figure 3-3** and **Table 3-1**). It is considered possible that, depending on the prevailing wind conditions, these receptors may be affected by noxious odours. However, it is noted that:

- The distance to the receptors is quite large, and H2S concentrations are likely to be highly dispersed by this stage;
- The continuous operation of the power plant will aid in breaking down the hypolimnion. As such, elevated H2S levels are likely to decrease over time, most likely to a negligible level within the first year of operation (although H2S levels will vary seasonally);
- Based on the previous 10 years discharge levels from the Itezhi-Tezhi dam (Table 3-4), the discharge of water (312 m3/s) through the power plant during February to April is likely to comprise approximately 48 to 69% of the average daily discharge through

the dams main gates. As such, mixing of these waters downstream of the dam will capture H2S within the dissolved oxygen, limiting the escape of H2S to air and the occurrence of odour;

- Odours associated with current discharges of water from the existing northern low level outlet of the dam are known to extend for several hundred metres but have not been identified as of serious concern by stakeholders; and
- Prevailing winds are likely to blow odours in a southern and southwestern direction. This is away from sensitive receivers located to the north and east of the power house site, including Itezhi-Tezhi town, however it is within the direction of sensitive receivers located to the southwest (**Figure 3-3** and **Table 3-1**). Fauna species may also be affected by the odour.

Odour impact assessment typically considers the concentration and emission exposure associated with an odour, assessed in terms of a percentile of averages over the course of a year and expressed in odour units (e.g. European Odour Units). There are no specific odour unit standards within Zambia. Such assessment typically involves the establishment of atmospheric dispersion models which predicts average impact at receptors locations. Given, the likely short-term nature and limited range of sensitive receivers affected, this ESIA did not undertake atmospheric dispersion modelling.

Those individuals most likely to be affected by odour during the operation of the plant include:

- workers at the power plant; and
- fishermen fishing at the base of the dam and immediately downstream.

It is also noted that other odourless gaseous emissions (e.g. methane, CO_2) may be associated with the release of water from the base of the dam. Increased CO_2 and methane emission levels associated with the operation of hydropower schemes are discussed in **Section 7.2**. The emitted levels are unlikely to significantly alter local air quality.

In addition to the operation of the power plant itself, the associated sewerage treatment plant will generate odours. The plant maintains exposed pools to gradual treat sewerage associated with the worker accommodation. Odours associated with the site will be highly localised and are not likely to affect sensitive receivers.

There are no expected significant cumulative air quality impacts with other associated developments in the area or arising as a result of the Project.

7.1.3 Mitigation Measures

The majority of air quality impacts are considered likely to be experienced during the construction phase. A range of guidelines exist regarding the mitigation of construction air quality impacts (e.g. IFC EHS Air Emissions and Ambient Air Quality Guidelines and the WHO Air Quality Guidelines). Although the number of sensitive receivers present in the immediate vicinity of the power plant site is limited, it is recommended that dust monitoring be undertaken during construction to enable effective dust management.

The majority of odour impacts associated with the Project will occur during the operational phase, particularly over the first year of operation as flushing of anoxic waters occurs. There are a range of H_2S management measures that can be adopted to minimise these impacts including:

- Plant Design: increase pipe length prior to discharge to increase the likelihood of sulphides oxidising with dissolved oxygen; provision of an air bubbler within the pipeline to increase dissolved oxygen concentrations; increase pH levels;

- Reservoir Management: modify pH levels through the addition of lime; addition of iron to capture H_2S, disturbance and breaking up of the hypolimnion; and
- Watershed Management: management of how organic matter and nutrients enter the reservoir.

The current power plant design, with the exception of a relatively long intake tunnel (approximately 705m), does not currently include any infrastructure measures designed to lower odour risks. However, the majority of these management measures may be able to be added, if required, following the onset of operations and monitoring. An Odour Monitoring and Management Plan will be established to ensure odour impacts are managed over the lifetime of the project.

Recommended monitoring and mitigation measures to be applied during construction and operation phases for both the identified air quality and odour impacts are specified in **Table 7-1**.

Table 7-1: Mitigation Measures to Reduce Impact on Air Quality

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
32	The proposed works may have minor impacts on air quality during construction as a result of dust and particulate matter generated through bulk earthworks and stockpiling.	Construction	Medium	All work areas and stockpiles will be closely monitored for dust generation and stabilised where required. In the event of excessive dust generation, appropriate dust suppression measures will be implemented (e.g. wetting of exposed surfaces). Stockpiles will be covered and located in areas that are protected from the dominant wind direction. If deemed necessary this may include construction of wind breaks. Stabilisation methods will be employed such as matting, grassing or mulch. Where dust generation is unavoidable due to high winds (i.e. greater than 40km/hr), earthworks will cease. The number of stockpiles and the number of active work faces of stockpiles will be minimised. Two dust monitoring stations are to be established on site boundaries in closest proximity to sensitive receivers	Low
33	The proposed works may have minor impacts on air quality during construction as a result of dust and particulate matter generated through rock blasting and	Construction	Medium	Blasting times and locations to be publically advertised. Blasting will only occur during daylight hours. Strict boundaries will be enforced around blasting	Low

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
	concrete crushing			sites during blasting procedures. Blasting to be postponed during high wind periods at the discretion of the site manager.	
34	The proposed works may have minor impacts on air quality during construction as a result of dust and particulate matter generated through vegetation removal	Construction	Medium	Where practicable, existing vegetation, in particular trees, will be retained to minimise the extent of lost vegetation. Bare earth surfaces will de re-vegetated or sealed as soon as possible follow completion of immediate construction works (i.e. site re-vegetation and rehabilitation shall occur progressively throughout construction in accordance with a Ecology Management Plan. Cleared vegetation will be used where practicable for dust control and re-vegetation.	Low
35	The proposed works may have minor impacts on air quality during construction as a result of dust and particulate matter generated through movement of construction vehicles on and off site.	Construction	High	Truck movement will be controlled on site and restricted to designated roadways. Vehicles entering will be cleaned of mud/dust on wheels before they enter public roads to limit the generation of excess dust (e.g. use of rumble grids, or wheel wash). Vehicle movements on site will be limited to 20km/hr. All truck movements carrying spoil on or off site will be done with covered loads. Implementing dust suppression techniques such as	Low

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
				regular application of water to unpaved haul roads, stockpiles or exposed surfaces in dry and windy conditions.	
36	The proposed works may have minor impacts on air quality during construction as a result of odour and particulate matter generated through waste generation and storage and burning of wastes	Construction	Very Low	Open burning of vegetation and other solid waste will, where possible, be avoided and managed through a waste management plan. Should open burning be utilised, the contractor will take into account prevailing wind conditions and the location of sensitive receivers. Fires will never be left unattended of left to smoulder. Collection of firewood or unauthorised burning of vegetation or waste materials by project workers or contractors while working, travelling in project vehicles, and residing in project field accommodation will be prohibited. Implement appropriate inductions and education to encourage staff to comply with regulations. Excavated materials will be stored for as short a period of time as possible. Drying soils, sand and degrading organic matter will kept on site at all times. Stockpiles to be located away from sensitive receivers.	Negligible

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
				Implementation of a Waste Management Plan which specifies: • storage locations; • transfer schedules; • cleaning and washing schedule for waste storage areas and transportations vehicles; and • provision of adequate wate receptacles.	
37	The proposed works may have minor impacts on air quality during construction a result of emissions from diesel or petrol-driven equipment and vehicles.	Construction	Low	Training of workforce in safe driving practices that reduce both the risk of accidents and fuel consumption, including measured acceleration and driving within safe speed limits. Vehicles and equipment will be maintained in good working order (e.g. exhausts, tyres). Transport routes will be designated to minimise distance travelled and overall fuel use and emissions. Work vehicles, plant or machinery will not be left running or idling when not in use. Truck movement will be controlled on site and restricted to designated roadways.	Very Low
38	Dust arising as a result of construction works may result in smothering of vegetation and	Construction	Low	Vegetation surrounding the site will be regularly inspected for smothering by dust. Application of additional dust and sediment controls if vegetation is	Very Low

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
	deterioration of water quality			seen to be at risk	
39	Odour as a result of discharge of anoxic waters containing H_2S may affect downstream/upstream landholders and river-users	Operation	High	Restriction on water-users/fishermen utilising the waters within 500m of the discharge outlet for the first three months of operation. An Odour and Air Quality Monitoring and Management Plan swill be prepared. The Monitoring Plan will capture H_2S and methane concentrations immediately outside the discharge point, on top of the dam, and 500m downstream. In the event that H_2S concentrations are seen to exceed 0.15 ppm, the plan will specify the need for provision of additional mitigation measures to be adopted including: • Visitation of down-wind sensitive receivers; • Consideration of additional mitigation measures detailed (**Appendix D**); • Temporary halt of operational flows if H_2S concentrations exceed 0.4 ppm.	Medium
40	Release of methane and CO2 stored within cold lower waters of the reservoir as part of operational discharge will deteriorate local air quality	Operation	Low	Inclusion of methane concentration monitoring as part of an Odour Monitoring and Management Plan.	Very Low
41	Odours associated with the sewerage treatment plant may affect local sensitive receivers	Operation	Negligible	If needed, following complaints of sensitive receivers, application of odour neutralisers or construction of wind- shielding for the site will be carried out to minimise the risk of odour's travelling towards sensitive receivers.	Negligible

7.1.4 Residual Risks

Following the application of the specified mitigation measures listed in **Table 7-1** the residual risk in terms of air quality impacts is considered to be low. Of the five impacts identified, the highest individual risk rating was medium, as a result of odours likely to be generated from the discharge of anoxic waters from the base of the reservoir. An Odour Monitoring and Management Plan is recommended to be implemented to ensure the occurrence of any significant odours is identified as early as possible and that appropriate additional mitigation measures are installed.

A median risk rating of “Low” was observed. These low ratings are seen to reflect the relatively isolated location and low long-term impact nature of the Project. Monitoring of dust levels is proposed, at two locations for the duration of construction, to allow for effective management of dust pollution.

7.2 Climate and Climate Change

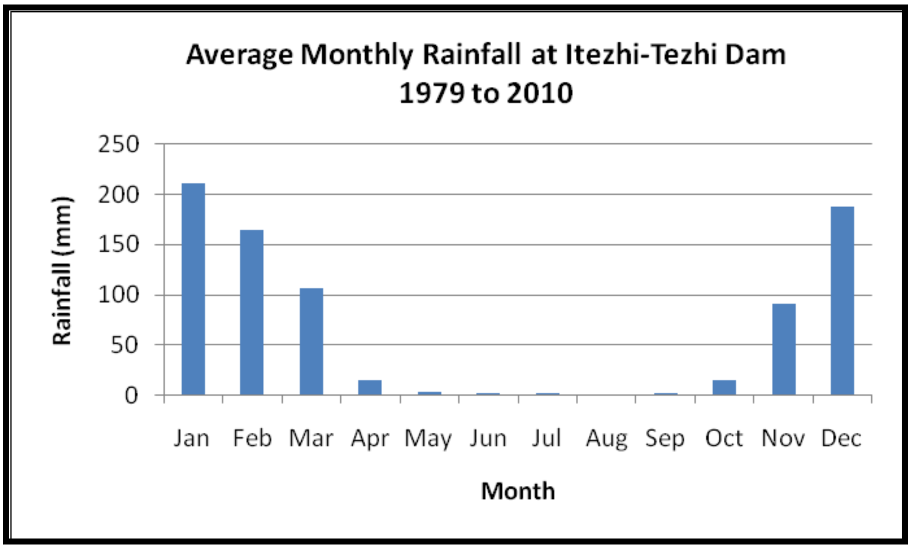
7.2.1 Baseline Conditions

Zambia is a landlocked country in southern Africa, located between latitudes 8ºS and 18ºS and longitudes 22ºE and 33ºE. It has a largely tropical climate which varies predominantly with altitude. The region of Itezhi-Tezhi, due to its altitude, is considered to have more of sub-tropical climate. Itezhi-Tezhi District’s climatic year is comprised of three seasons:

- cool dry season (May - July);
- hot dry season (August - October); and
- warm wet season (November - April).

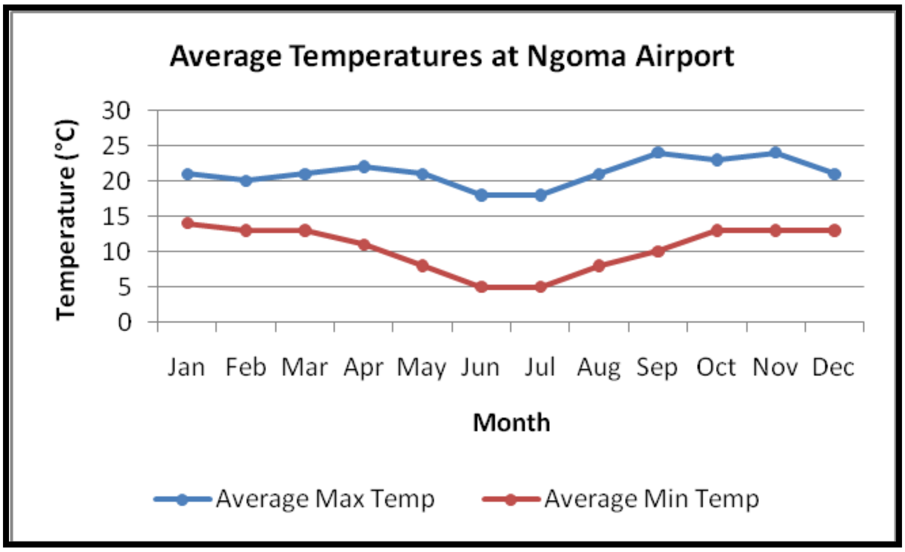
Zambian rainfall patterns generally reflect these seasonal changes. Annual rainfall volumes across the country typically decrease from north (1,200 mm/yr) to south (600 mm/yr). The Kafue Basin, the upstream catchment areas of the dam, has a mean annual rainfall of 1,057 mm/yr (Scott Wilson Piesold, 2003). In contrast, the Itezhi-Tezhi District itself has an average rainfall of 794 mm/yr based on rainfall monitoring undertaken at the dam since 1978. **Figure 7-2** demonstrates the seasonality of rainfall in the region at the dam.

Figure 7-2: Monthly Rainfall Distribution at Itezhi-Tezhi Dam[26]



Temperatures within the Itezhi-Tezhi District typically range between 8ºC in the cold season, through to 36ºC in the hot dry season (ITDC, 2009). However, average daily temperatures are about 19ºC (ZESCO, 2008), with average monthly maximums ranging between 18ºC and 24ºC (**Figure 7-3**). October and November are the hottest months while July is the coldest month. In-keeping with its seasonal character, humidity varies significantly between the seasons from a high (79%) in the warm wet season and to a low (34%) in the cool dry season (ZESCO, 2008). This humidity often generates heavy dew and early morning mists in the final cooler months of the wet season.

Figure 7-3: Annual Average Temperature Data for Ngoma Airport[27]



[26] Data provided by ITPC.
[27] Source: World Weather Online, 2012.

Long term wind data for the district is limited. However, generally, winds are predominantly light (e.g. 10 mph) and blow from north-east to south-east for the majority of the year (ZESCO, 2008). In the dry season winds are relatively stronger, while in the rainy season there is a bit of variation in wind direction. Winds in the region are strongly determined by the formation of the African Inter-tropical Convergence Zone and its associated trade winds and pressure systems.

In addition, Zambia, despite being landlocked, is strongly affected by the El Niño Southern Oscillation (ENSO), which tends to bring drier than average conditions in the wet seasons.

7.2.2 Climate change

The impacts of climate change upon Zambia are being refined as more information is obtained. However, best available estimates (McSweeney *et al*., 2010) indicate that Zambia:

- has experienced an increase in mean annual temperature of 1.3ºC since 1960;
- is predicted to experience an increase in mean annual temperature of 1.2ºC to 3.4ºC by 2060 (south-western regions, including Itezhi-Tezhi District are likely to experience increases at a faster rate than other parts of the country);
- is predicted to experience an increase in the number of “hot” days and nights, and a reduction in the frequency of “cold” days and nights;
- will not have noticeable differences in the total precipitation volume over the next 100 years; and
- will receive a greater portion of total precipitation volume in large storm events (e.g. the frequency and magnitude of precipitation events will increase, while the frequency and magnitude of small precipitation events will decrease).

Zambia can expect an increase in temperature of 1 - 3 degrees by 2060 (slower in coastal regions), while the impacts upon precipitation will be highly variable across the country. Overall it is likely that precipitation levels may marginally decrease however they will be more frequent and larger heavy precipitation / storm events. Sea Level Rise predictions indicate that increases in the order of 20 - 50cm can be expected over the next 80 years.

There is currently limited reporting within Zambia as to greenhouse gas emissions across the country. A holistic inventory of greenhouse gas emissions within the country from 1990 (CEEEZ, 1999) indicated that:

- Zambia contributed 3.2 million tonnes of CO_2 to the atmosphere (approximately 1% of Africa’s total emissions in 1990);
- 88% of CO_2 emissions were attributed to energy consumption activities[28];
- 29.5% of CO_2 emissions were associated with transportation;
- 15.8% of CO_2 emissions were associated with mining; and
- 12% of CO_2 emissions were associated with industrial processes (e.g. cement production).

Since this date the population has increased from roughly 7.8 million, to over 13 million (Central Statistics Office Zambia, 2010). Further greenhouse gas inventories undertaken by both the then Ministry for Tourism, Environment and Natural Resources (2000) and Environmental Council of Zambia (2007), suggests that greenhouse gas emissions may have decreased to 0.2 tonnes of emission per capita by 2008 (World Bank, 2012) suggesting a decrease in total emissions, however this may also be atttributed to the growth during this

[28] Sector specific energy consumption activities comprise part of the overall CO_2 emissions from energy consumptive activities.

period. There is a need for more data to be obtained to accurately determine emission levels within the country.

7.2.3 Impacts

While the proposed works should take into account specific expected annual/monthly climatic conditions in both design and construction (impacts of which are addressed in other relevant sections of the ESIA), it is considered that due to the relatively small size of the proposed works (and ancillary infrastructure), the Project will not materially impact upon the local climatic conditions of the area. This is in contrast to the initial establishment of the Itezhi-Tezhi dam itself, which would have been of sufficient magnitude to alter the local climate.

However, it is considered that both the construction and operation of the Project is likely to lead to the emission of greenhouse gases and contribute to the overall global occurrence of climate change. These impacts are likely to be received through:

- CO_2 released as a result of site clearance and maintained future clearance (loss of vegetation from power house and both on-site and off-site ancillary facility sites);
- CO_2 emissions associated with the construction and operation plant, vehicles and equipment; and
- emissions associated with the release of greenhouse gases stored within the waters at the bottom of the Itezhi-Tezhi dam and discharged by the power plant.

Site Clearance and Carbon Sequestration

The Project will involve the removal of 57.6 ha of existing vegetation, as discussed in **Section 6.1** and presented in **Table 6-10**. Carbon stored as vegetation to be removed will be released through subsequent burning or decomposition.

The ecological survey (**Section 6.1**) indicates that the vegetation across the Power house site is largely homogenous and characterised as the warm dry forest of the Miombo woodlands. It is noted that Kamelarczyk (2009) identifies Miombo woodland as the forest type of greatest risk through continuing climate change. Kamelarczyk (2009) also identifies that each hectare of Zambian (typically Miombo) forest would store up to 31 tonnes of carbon (including both above ground and below ground carbon). This equivalence value is considered to be appropriate for application to the Project site, although it is noted, that it is considerably lower than other, less specific, equivalence values created for the African biota (e.g. Gibbs et al. 2007).

In addition to the initial conversion of carbon stored in vegetation through clearing into atmospheric carbon, the long term removal of the vegetation will reduce the carbon sequestration potential (i.e. the ability for soil and vegetation to capture gaseous carbon) of the site. Muller-Landau (2009) estimates that tropical forests within Africa capture 0.6 tonnes of carbon per hectare per year. For the purposes of this assessment a conservative sequestration potential value of 1 tCO_2eq/ha/yr was adopted and applied over the adopted 25 year Project investment timeline. The annual loss of carbon as a result of both clearance and loss of sequestration potential over the project life was calculated to assess the overall greenhouse gas impact of construction related deforestation. The calculations and results are summarised in **Table 7-2**. It is noted that this assessment is considered to be conservatively high as the Project site's soils will retain some carbon sequestration potential and re-growth will be allowed as part of landscaping.

Table 7-2: Carbon Lost as a result of Project Development

Source of Carbon	Quantity	Value	Total Carbon (t)
Site Clearance - Removal of Forest	57.6 ha	31 tCO2eq/ha	1,785.6
Loss of Sequestration Potential Over the Project Lifespan (25 years)	57.6 ha	1 tCO2eq/ha/yr for 25 years	57.6
		Total	**1,843.2**

Emissions Associated with Plant and Equipment

In addition to emissions associated with vegetation clearance, there will be emissions associated with plant, equipment and vehicles associated with both construction and operation of the site. Once operational, the power plant will be self-sourcing for its energy and not be utilising fossil-fuel based energy. Similarly, the operational staff level (50 employees) is low and the commuting distance from Itezi-Tezhi is short (approximately 5km), as such operational transport emissions are likely to be minimal. In contrast, construction activities will be associated with significant emissions associated with the operation of plant and equipment (most likely diesel powered), concrete batching, and rock blasting. Emissions associated with diesel consumption and concrete production are will be the primary source. The expected amounts of diesel usage and concrete production were not available at the time of this assessment, therefore a estimate was made using the Department for Environment, Food and Rural Affairs (DEFRA) Carbon Calculator (DEFRA, 2003). Based on the calculator, the Projects is estimated to produce 4,780 tCO2eq per year.

The total estimated carbon impact of the Project as a result of vegetation removal, construction equipment operation and loss of sequestration is 18,573.2 tCO_2eq. This impact is considered to be minor. As this estimate purposely over-estimates potential emissions, the actual carbon emission impact is anticipated to be significantly lower. For the purposes of comparison, the total estimated CO_2 emission for Zambia in 2008 was approximately 1.9 million tonnes (World Bank, 2012). Over its entire life, the proposed works would comprise approximately 0.977% of one year's national CO_2 emissions.

Release of Dissolved Greenhouse Gases

One issue associated with the operation of hydropower systems is the greenhouse gases (predominantly carbon dioxide and methane) that are released into the atmosphere as a result of:

- reservoir construction leading to the flooding (and decomposition producing CO_2) of forest biomass; and
- decomposition in anoxic conditions at the base of the reservoir leading to increased dissolved methane levels in the water column that is released upon discharge from the power plant.

The effects associated with reservoir construction, were incurred as part of the construction of the dam in 1978 and are not considered part of the Project's impact. It is also worth noting that reservoir formation greenhouse impacts tend to be associated with the first 10 – 15 years of reservoir operation as biomass decays (Tremblay et al. 2008). Given the 34 years operation of the dam so far, emissions associated with reservoir construction are considered to be negligible.

In contrast, the dissolved methane concentrations associated with anoxic conditions are of concern to the Project. Modelling of anticipated methane emissions was not possible as a detailed model of hypolimnetic formation was not established as part of this ESIA. It is considered the volume of any such emissions would be well below international emission reporting standards.

Combined with vegetation clearance and construction and operation emissions (18,573.2 t), these totals are significantly below the annual reporting requirement of 25,000 tCO_2e pa under the IFC Performance Standards for operation conditions alone.

Positive Impacts in Mitigating Climate Change

While the project will contribute to the production of some greenhouse gases, the project will also have positive impacts by providing a non-fossil fuel based energy source. The Project will feed energy into the Zambian National Electrical Grid, reducing demands on fossil fuel energy sources within the country, and potentially exporting to neighbouring African countries. Locally it will also lower CO_2 emissions that would normally come from use of wood and charcoal in the Itezhi-Tezhi and Mumbwa districts. Based on a 24 hour operation the 120MW plant, the Project will annually generate approximately 1.05 billion kW-hrs. Standard carbon emission associated with coal/oil/gas fired power stations are estimated to be 430g CO_2/kW-hr[29]. It can be seen that production of the Projects 1.05 billion kW-hrs through coal based means would produce approximately 450,000 tonnes of CO_2. It is considered that the emissions associated with the operation o the Project are minimal.

Impacts of Climate Change on the Power Plant

The predicted impacts of climate change are unlikely to significantly affect either the construction or operational phase of the Project itself. It is considered unlikely that the altered rainfall patterns are sufficiently large to lead to a lack of water preventing full operation of the power plant. However, the increased frequency and magnitude of storm events is recognised to be an issue of concern for the on-going safe operation of the dam. Altered storm regimes may increase the likelihood of secondary spillway overflow from the dam, or even potential dam failure. Any such overflow of water has the potential to significantly affect both health and safety of workers and the Project infrastructure at the power plant and switchyard. The likelihood of such an impact occurring is considered to be minimal.

7.2.4 Mitigation Measures

Although the emissions associated with construction and operation of the dam are considered of immaterial magnitude in terms of international guidelines or producing significant impacts, they do represent additional and cumulative emissions which contribute to an overall deterioration of air quality and increase the potential for global warming impacts. Mitigation measures to address each of the identified greenhouse gas producing actions are provided in **Table 7-3**.

[29] Renewable UK (http://www.bwea.com/edu/calcs.html) - static figures representing UK energy mix

Table 7-3: Mitigation Measures to Contain Climate Change Impacts

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
42	Greenhouse gas emissions (and loss of sequestration) as a result of vegetation clearance at the site and ancillary facilities	Construction / Operation	Medium	Only vegetation necessarily required will be removed for construction purposes shall be removed (**Section 6.1**). Where possible, waste vegetation will be be recycled, or secondary uses identified (e.g. firewood for local villages). Following construction, the site will be rehabilitated as quickly as possible in non-hardstand areas (**Section 6.1 and 7.11**).	Low
43	Increased greenhouse gas emissions as a result of construction / operation vehicle and equipment operation and resource use.	Construction / Operation	Medium	All vehicles and construction machinery will be maintained in good working order and turned off when not in use, to minimise emissions. Work vehicles, plant or machinery will not be left running or idling when not in use. Utilise local providers of materials to minimise transport costs. Where possible, utilise existing materials on-site or known re-useable products generated from concurrent off-site projects being undertaken.	Low
44	Increased greenhouse gas emissions as a result of operational discharges from the power plant	Operation	Medium	Long-term monitoring of dissolved methane and sulfide levels at the outlet and downstream will be specified in a Water Quality Management Plan capturing water quality in the dam (along its depth profile), at the discharge point, and down-stream locations.	Medium

				An Odour and Air Quality Monitoring and Management Plan will be prepared. The Monitoring Plan shall capture H_2S and methane concentrations immediately outside the discharge point, on top of the dam, and 500m downstream. In the event that dissolved methane levels are not observed to decrease within the first six months of operation, additional mitigation measures to be considered for implementation will include: • Methane extraction and capture techniques to applied prior to discharge; and • Vegetation management around the reservoir to control biomass entering the reservoir.	
45	Loss of life and risks to health and safety as a result of climate change leading to uncontrolled overtopping of the dam or dam failure	Operation	Medium	Co-ordination with existing dam management teams and procedures, to ensure operational discharges associated with the plant do not put the dam at risk and are available to be utilised in emergency situations. This will be detailed in an Emergency Management Plan. On-going inspections and maintenance of the dam will be undertaken by appropriate personnel in-line with existing dam management practices. As more information becomes available in regards to climate change, the structural integrity and capacity of the dam is review in-line with existing dam management practices.	Negligible

7.2.5 Residual Impact

It is considered that the emission of greenhouse gases is an unavoidable consequence of the Project, both during operation and construction. However, it is noted that:

- The magnitude of emissions is negligible in terms of its direct ability to influence global climate change;
- The magnitude of emissions is negligible in comparison to national Zambian emissions;
- The total emissions over construction and a 25 year operational period are below IFC Performance Standard annual reporting requirements; and
- The positive greenhouse gas impacts through diversion of energy demand from coal based power sources are likely to exceed the emissions greenhouse gas emissions associated with the project.

However, the Project's contribution to the cumulative impacts of greenhouse gases must be recognised. To this end, best practice mitigation measures for the proposed construction and operation activities should be applied. In particular, as technology advances it is likely that strategies to combat and lower emission outputs may become available. Following the application of the identified mitigation measures it is considered that the residual impact level is likely to be minimal.

7.3 Ground water

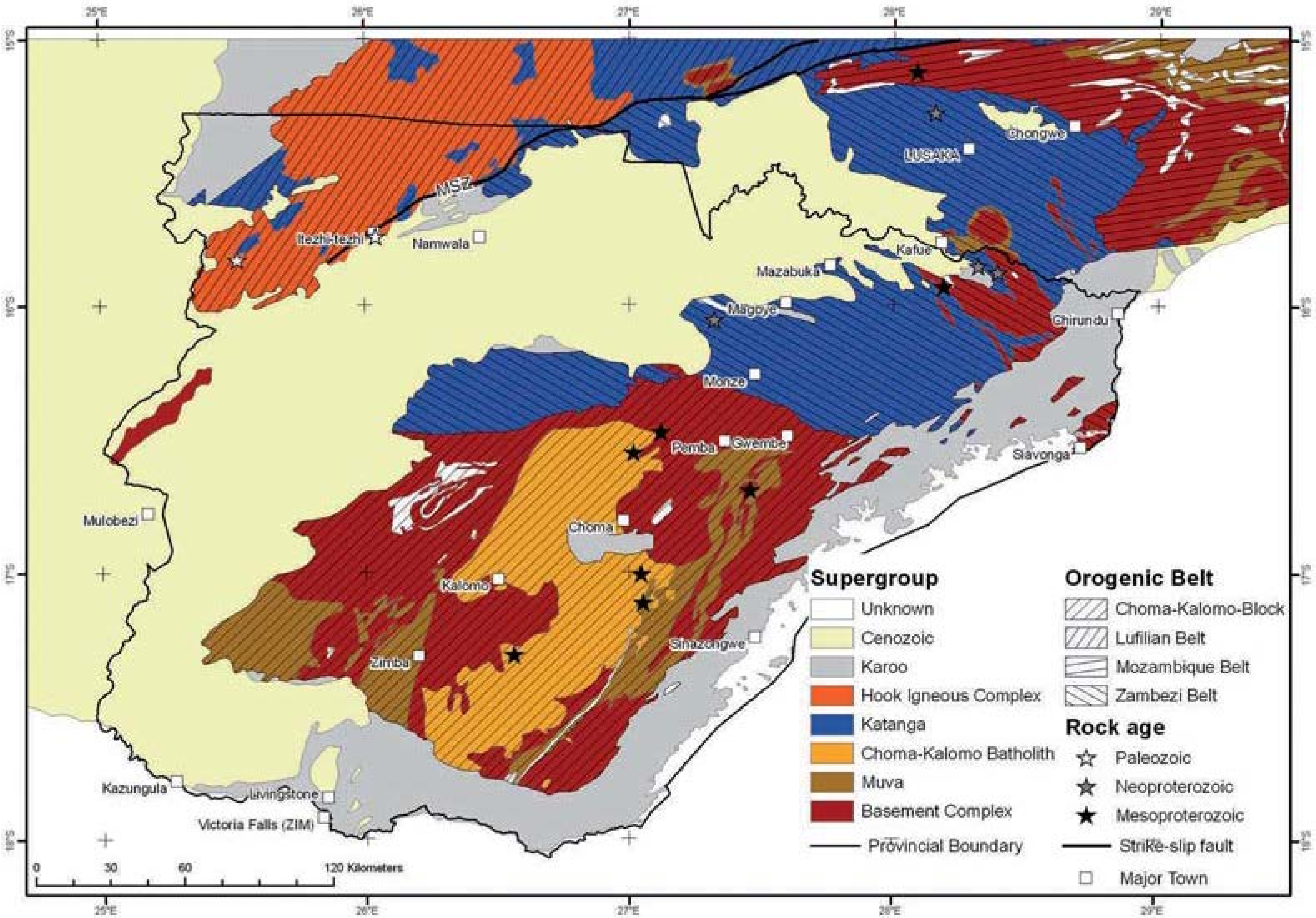
7.3.1 Baseline Conditions

Baseline information regarding groundwater and aquifer systems within Zambia is relatively limited. However, the extensive mining developments within the Copperbelt Province, and the associated risk of contamination to groundwater systems has highlighted the need for more detailed assessments to be undertaken. In particular, southern regions of Zambia, including Itezhi-Tezhi, tend to have lesser rainfall (**Section 7.2**), leading to greater reliance upon groundwater supplies by local residents (for drinking water) and farmers (for irrigation).

The lithology (i.e. the rock substrate) downstream of Itezhi-Tezhi dam is predominantly unconsolidated alluvial sediment, resulting from sediment transport, flooding, and erosion associated with the Kafue River (**Section 7.12**). As a consequence of its complex hydrological history, the region is characterised by variable and inter-bedded layers of clay, silt, sand and gravel. This structure allows for intergranular storage of water below the surface (e.g. water is stored in the pore spaces between grains of sediment). This system is considered to result in disparate pockets or layered aquifers, as the water retaining potential of the substrate varies (Baumle et al. 2007).

Immediately upstream of the dam, the rock substrate is typically more consolidated, typified by granites and metamorphic rocks of the Hook and Basement Complex (**Figure 7-4**). This lithology does typically not permit integranular flow of groundwater, and as such aquifers tend to more associated with fissures in rocks or karst terrain (Baumle et al. 2007). The development of the Itezhi-Tezhi reservoir is considered likely to have significantly altered the local groundwater levels immediately upstream of the dam. The dam itself maintains records of groundwater pressure and level recorders and deep seated aquifer pressure relief wells within the reservoir to help manage impacts associated with the formation of the reservoir. In particular, the impoundment of water in the Itezhi-Tezhi reservoir has led to the development hot springs in the area of the Kafue Flats close to the reservoir.

Figure 7-4: Geological Map of the Southern Province Demonstrating the Main Orogenic Belts[30]

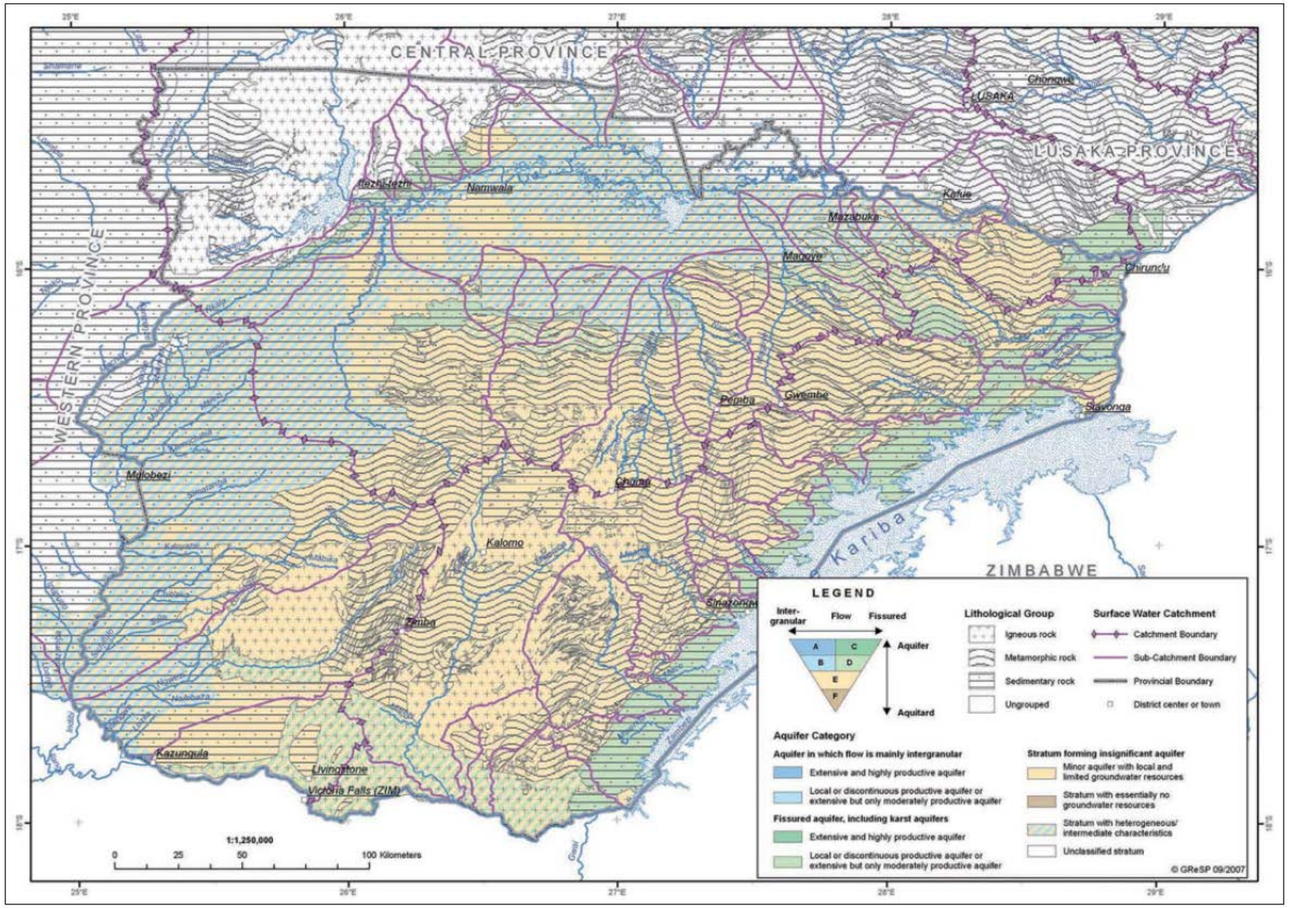


[30] Baumle, et al (2007), Groundwater Resources for Southern Province: A Brief Description of Physiography, Climate, Hydrology, Geology and Groundwater Systems of Southern Province

Figure 7-5 (below) details the lithology and anticipated groundwater potential of the region downstream of the dam. It can be seen that the region is considered likely to have some smaller aquifers present, which may be of local importance, but is unlikely to generate regionally significant aquifers. It is considered that these local aquifers may be sufficient to supplement surface water-based irrigation. Following the construction of the Itezhi-Tezhi dam, there is concern that reduced flooding extents / frequencies, will negatively affect aquifer recharge and formation for areas on the extent periphery of larger flood events. These areas are also further from the Kafue River, limiting the potential for irrigation to supplement this declining resource.

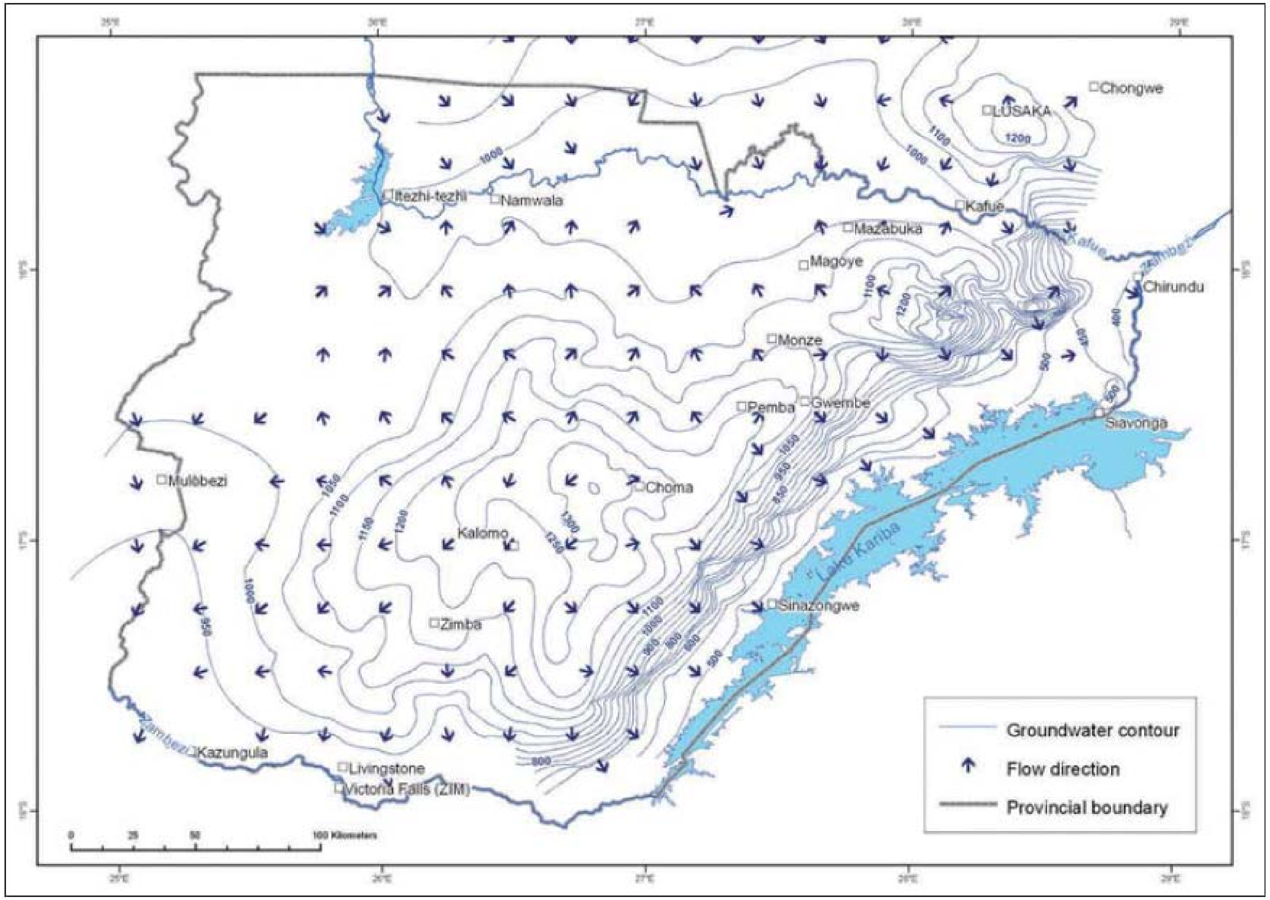
The inter-granular nature of the aquifer storage in the region and association with Kafue River also requires that the groundwater is generally shallow, and flow is typically directed back towards the River (**Figure 7-6**). The presence of local aquifers is well known to local settlements as evidenced by the presence of hot springs and semi-permanent dambos across Kafue Flats (**Figure 7-7**).

Figure 7-5: Lithology and Potential of Groundwater Systems in the Southern Province[31]



[31] Baumle, et al (2007), Groundwater Resources for Southern Province: A Brief Description of Physiography, Climate, Hydrology, Geology and Groundwater Systems of Southern Province

Figure 7-6: Groundwater Contour Map of Southern Province With Indication of Groundwater Flow Directions. Water Levels in MSL[32]



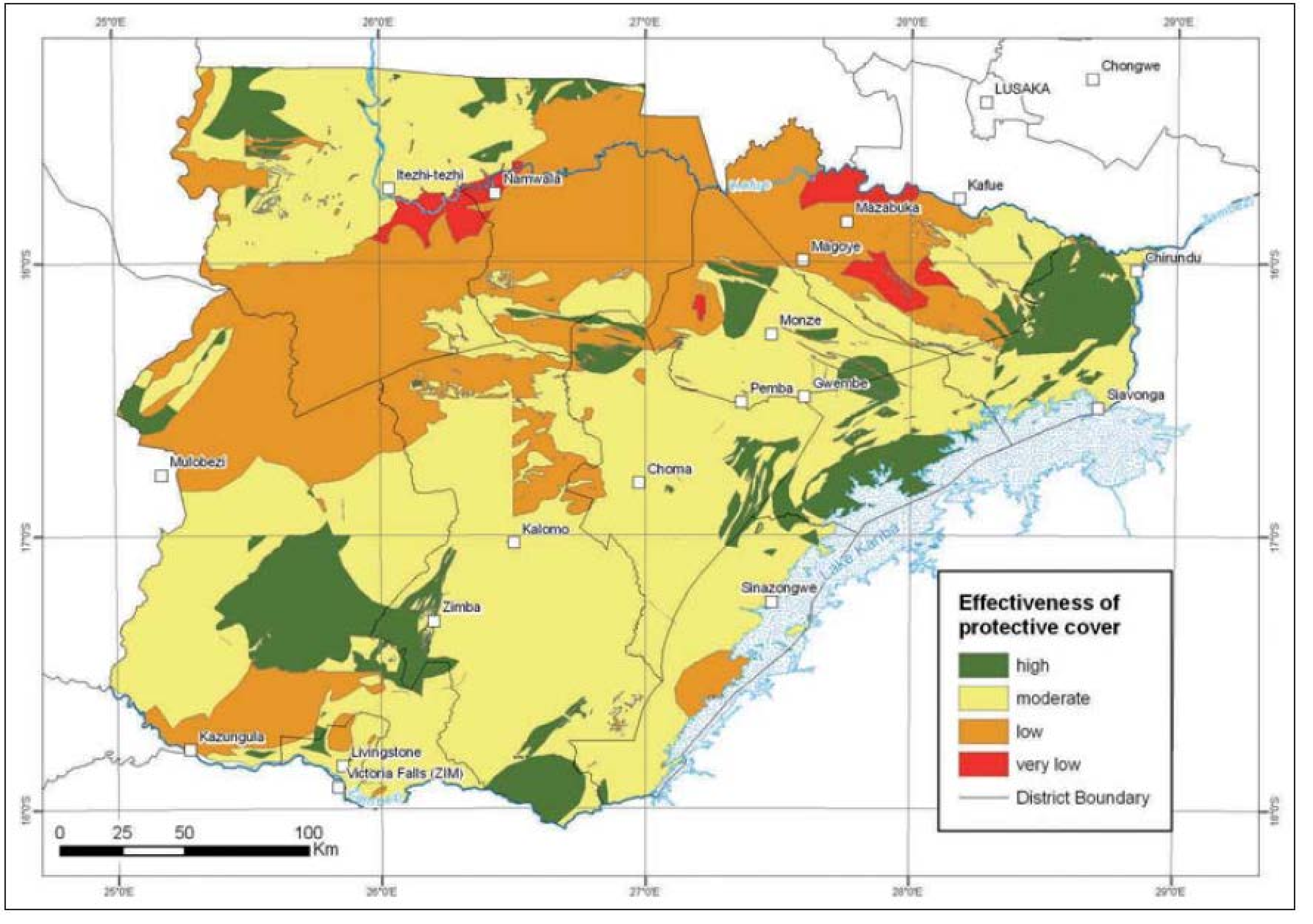
[32] Baumle, et al (2007), Groundwater Resources for Southern Province: A Brief Description of Physiography, Climate, Hydrology, Geology and Groundwater Systems of Southern Province

Figure 7-7: Hot Water Springs in the Kafue Flats.

The quality of groundwater within the region has not been characterised. However, in general, water quality in southern Zambia is considered to be typical of continental groundwater (Baumle et al. 2007). In the upper Kafue River catchment (e.g. in the Copperbelt) increased concentrations of toxic metals (e.g. copper, cobalt, nickel, chromium and cadmium) have been observed in the surface and ground water (Norrgren *et al*., 2000). However, the potential impact of tailings from upstream mines has not been significantly observed near Itezhi-Tezhi as yet and the dam/reservoir is considered likely to have aided in minimising the risk of any contaminants passing onto the flats. Given the local and disparate nature of aquifers downstream of the dam, most contamination is considered to be associated with poor bore hole / aquifer management from local settlements (e.g. poor sanitary practices or use of chemicals/pesticides).

Although, groundwater downstream of the dam is not currently considered to be of poor quality, the local groundwater are considered to be highly vulnerable to contamination in the event of significant pollution events (**Figure 7-8**). This is due to the very shallow groundwater tables, porous nature of the soils, and frequency of flooding. In particular, any changes to the riparian water quality which help supply aquifers in times of flood, may have long lasting effects on the viability of local aquifers and sources of drinking water and irrigation. The demand for irrigation in the area is growing rapidly as agriculture expands. However, there are readily enforceable management systems in place to control where farmers may choose to extract or irrigate.

Figure 7-8: The General Effectiveness of Protective Cover to Prevent Groundwater Contamination[33]



[33] Baumle, et al., 2007. Groundwater Resources for Southern Province: A Brief Description of Physiography, Climate, Hydrology, Geology and Groundwater Systems of Southern Province

7.3.2 Potential Impacts

Potential impacts upon the existing groundwater systems are likely to be associated with either:

- potential contamination of groundwater as a result of contamination or operation of the Project; or
- changes in groundwater levels either through abstraction or altered flow regimes as a result of construction or operation activities.

During construction it is not anticipated that any boreholes will be utilised to access water for use by project staff or activities (e.g. dust suppression, cleaning etc.). Potable water for Project employees will be procured from the existing water treatment plant which is being upgraded as part of the project works. Abstraction directly from the reservoir will be undertaken to meet non-potable water requirements. It is considered unlikely that construction associated activities will affect flow regimes or groundwater levels. It is not anticipated that any dewatering will be required as part of construction activities.

There is potential for construction activities to result in localised contamination of groundwater. This may occur through:

- accidental spillage of contaminants (e.g, hydrocarbons, chemicals, etc.) to land or water;
- contamination associated with poor hygiene practices of construction workers; or
- disturbance of contaminated lands.

The nature of construction works is such that potential contaminants are largely associated with fuels stored on site and the operation and re-fuelling of vehicles, plant and equipment. The risk of groundwater impacts arising from worker hygiene practices is considered to be low due to the provision of both treated potable water from the reservoir and a formal sewerage treatment plant. As such, the need for construction staff to utilise or interact with groundwater bore holes and aquifer is minimal. There is potential for incorrect waste disposal during construction to affect groundwater systems.

No contaminated lands are known to occur within the Project construction footprint (**Section 6.5**). The risk of contaminants (inorganic or organic in nature) migrating off-site as result of construction disturbance is considered to be very low.

In operation, there is potential for the Project to result in contamination of the disparate local aquifers downstream through:

- Contamination associated with poor hygiene practices of operational staff;
- Operation of the hydropower plant leading to alteration in downstream flooding patterns; or
- Operation of the hydropower plant leading to discharge of contaminated waters, resulting in the contamination of intergranular groundwater systems.

The contamination risk associated with hygiene practices of operational staff, as with construction employees, is considered to be low due to the provision of non-aquifer based potable water and sewage systems. There is a risk that failure of the sewerage treatment plant (e.g. under high rainfall events) may lead to downstream contamination. Water quality sampling at the downstream discharge site of the sewerage treatment plant indicates that in normal operating conditions, the plant is unlikely to lead to eutrophication or contamination events and is unlikely to affect groundwater systems. It is also noted that, by improving the supply of potable water to the town of Itezhi-Tezhi as part of the Project , there will be a

reduction in the local reliance on boreholes (or untreated reservoir abstraction) to provide water. This is considered likely to improve local health levels and lessen the demand on any local aquifers.

It is understood that the hydropower plant will be operated and managed in conjunction with the dam (and the existing reservoir gates) to ensure that the discharges associated with the Project will not significantly alter the existing flow and flooding patterns (**Section 6.4**). As such, it is considered unlikely that the project will impact downstream aquifers through flow attenuation.

The potential for the power plant to lead to the discharge of contaminated waters is discussed in detail in **Section 6.3**. It is considered unlikely that discharges will significantly alter downstream water quality. As such, the potential for impacts to groundwater to occur as a result of contaminated discharge is also considered to be low.

7.3.3 Mitigation Measures

The nature of the groundwater systems in the vicinity of the Project is such that there are no regionally or nationally significant aquifers that are likely to be impacted. The local aquifers tend to be relatively isolated and separated from each other, and as such, any impacts upon one aquifer are not necessarily carried over to another, minimising the potential extent of local impacts. The downstream aquifer systems are, however, linked through the Kafue River, as they both ultimately drain to the river and can be recharged by the river under flood events. As such management of Project impacts upon the Kafue River hydrology and water quality is seen as key to the mitigation of potential groundwater impacts.

Local groundwater impacts through construction and operation activities and worker practices are considered amenable to management by application of appropriate action management measures and procedures. Mitigation measures to address all the potential groundwater impacts identified are provided in **Table 7-4**.

Table 7-4: Mitigation Measures for Reducing Impact on Ground Water

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
46	Potential contamination of local groundwater as a result of accidental spillages on site	Construction / Operation	Medium	Functioning “spill kits” will be kept on site at all time during construction and operation (**Section 6.3**). Plant and equipment will be checked daily, prior to commencement of works for fuel, oil and hydraulic leaks and will not be used if there are any signs of leaks. If leaks arise during the course of the works, the leaks will be repaired immediately or the equipment will be removed from site (**Section 7.4**). Refuelling of vehicles and machinery will only be undertaken in bunded, hard-standing areas (**Section 7.4**). All employees will be receiving training as to the procedures to be adopted in the event of accidental spillage or pollution (**Section 7.4**).	Low
47	Potential contamination of local groundwater as a result of mobilisation of contaminated soils	Construction	Very Low	In the event that contaminated soils are discovered on-site, works will halt until the contamination is able to be assessed, and removed in an appropriate manner (**Section 7.4**).	Negligible
48	Potential disturbance of sub-surface groundwater as a result of construction	Construction	Medium	It is not anticipated that dewatering will be required as part of construction. However, any sub-surface or groundwater generated during construction shall be collected using a suitable pit or basin system and retained onsite until the suspended sediment component has settled. Once the sediment content has settled to an adequate level (e.g. when the water is clear), the water shall be discharged to the Kafue River in a manner that does not result in soil erosion, scouring or sedimentation of waterways, or significant changes in flow to downstream. It is not considered likely that the potential	Low

				disturbance of groundwater would be of sufficient magnitude to alter the flows/operation of the broader intergranular groundwater systems	
49	Potential contamination of local groundwater as a result of poor worker hygiene or waste disposal practices	Construction / Operation	Medium	Employees will be provided with potable water from the Water Treatment Plant and functioning sewer infrastructure linked to the Sewerage Treatment plant. Employees will receive training as to the required waste management procedures as part of the the Project's Waste Management Plan (**Section 11.2**).	Low
50	Altered flow and flooding regime leading to altered inundation and recharge patterns for downstream aquifers	Operation	Medium	Co-ordination with existing dam management teams and procedures will occur, to ensure operational discharges are consistent with historic discharges since the development of the dam (**Section 6.4**).	Very Low
51	Altered Kafue River water quality as a result of operational discharges leading to contamination of associated groundwater systems	Operation	High	A Water Quality Management plan will be established capturing water quality in the dam (along its depth profile), at the discharge point, and down-stream locations (**Section 11.2**). In the event that water quality monitoring results exceed agreed metal/nutrient concentration levels (**Section 6.3**), operations will halt until the source of contamination, and potential treatment options can be implemented.	Medium

7.3.4 Residual Impacts

Following the application of the identified mitigation measures it is considered that the residual risk to groundwater associated with the Project is low. The water quality impacts associated with the operation of the project will be potentially most significant downstream. Initial sediment testing within the dam indicates that this is unlikely to currently occur (**Section 6.3**). However, given the extent of mining operations occurring in the upper Kafue River catchment, on-going monitoring is considered vital to ensure that any changes in water quality do not penetrate down into the Kafue Flat aquifers as a result of the operation of the Project.

Local impacts upon groundwater quality are difficult to quantify. However, by implementing waste management practices and providing potable water and sanitation facilities these risks can be effectively mitigated. In particular, the provision of potable water to Itezhi-Tezhi town is considered likely to help local aquifer systems by reducing local abstraction rates. This will allow more bore-water to be used for agriculture and may improve local health and sanitation.

7.4 Land Contamination

This section addresses the potential impacts associated with land contamination in the Project area. Impacts associated with contamination of sediments and water quality is discussed in **Section 6.3**.

7.4.1 Baseline Conditions

The Itezhi-Tezhi District is predominantly undeveloped, with approximately 95% of the District area (visually estimated from aerial photography) comprised of vegetation, most of which is associated with the Kafue Flats. The lack of development within the district reduces the probability of significant contamination events having occurred. However, it is noted that increasing commercial agriculture on the flats (e.g. maize, sugar cane) is leading to deforestation of native forests, and increasing application of fertilizers and agro-chemicals. This contamination is considered highly likely to increasingly accumulate within both the soils and waterways of the Kafue Flats (Scott Wilson Piesold, 2003).

The significant developments that have occurred in the Project area include:

- the construction of the northern and southern diversion tunnels prior to the construction of the Itezhi-Tezhi dam;
- the construction of the Itezhi-Tezhi dam in 1978;
- the development of the granite quarry to the north-west of the dam (**Figure 3-4**). This quarry was used to source material for the dam's construction and has since been flooded; om Itezhi-Tezhi to Livingstone;
- the development of the New Kalala, Musungwa Lodge and Chibala Camp tourist facilities; and
- the gradual growth and expansion of Itezhi-Tezhi (residential and agricultural areas) towards the Power house site and off-site ancillary facilities.

Of these activities, none are considered to present a high level of contamination risk in terms of the nature of the activities undertaken and materials used. However, it is acknowledged that all development activities inherently present contamination risks, particularly in regards to hydrocarbon pollution and concrete production.

None of the commercial operations undertaken within Itezhi-Tezhi town are considered likely to be associated with high land contamination risks. A regional survey undertaken of soil contamination (Ikenaka et al. 2010) assessed a soil sample taken from adjacent to the main

road within Itezhi-Tezhi town and identified the levels of heavy metals (Pb, Zn, Cu) to be relatively low.

There are currently no known sites of contamination at the Project site.

7.4.2 Potential Impacts

The construction of the Project has the potential to lead to contamination through:

- accidental spills and leakages associated with the operation of construction vehicles, plant and equipment; and
- contamination associated with storage of construction associated wastes on-site or inadequate site clean-up.

None of the proposed construction activities (**Section 3**) are considered to lead directly to land contamination. Rock blasting does utilise chemicals potentially capable of contaminating local soils. However, the nature of blasting and the volume of chemicals utilised in the scope of works is minimal. Concrete batching can utilise chemicals capable of contaminating both ground and water quality, and will require appropriate management. The proposed works are not considered to utilise significant volumes of dangerous or hazardous materials likely to lead to contamination events.

Spill of hydrocarbons associated with leakage, accidents and refuelling of vehicles and equipment is considered to be the greatest contamination risk. Any such contamination is likely to be localised in nature and minimal in extent due to the typically low volume of liquids involved in construction associated spillage events.

Wastes produced during construction will be required to be stored temporarily on site prior to removal and disposal. Incorrect storage, particularly of liquid wastes may lead to contamination of soils. Similarly, inadequate clean-up following construction activities may lead to minor localised contamination.

Based on the nature of the development area, it is considered unlikely that construction works will identify previously unknown areas of contamination.

Under normal operating conditions none of the Project's major or ancillary facilities are considered likely to lead to contamination of local soils and land. The potential for operation of the hydropower plant to transfer heavy metals downstream is discussed in **Sections 6.3** and **6.4**. System failure at the sewerage treatment plant may lead to contamination of the surrounding area and potential health risks. Such contamination would be short-term in its impact. As with construction, accidental spillage or leakages associated with plant, vehicles and equipment may occur. Associated contamination events are likely to be constrained in their area of impact.

Switching stations and power stations often utilise polychlorinated biphenyls (PCBs) in their transformers. PCBs are persistent chemical substances which bioaccumulate and potentially cause significant harm to the environment and human health. Potential leakages or inappropriate disposal of such oils may cause significant contamination.

7.4.3 Mitigation Measures

The identified potential impacts associated with Land Contamination are seen to be primarily associated with local impacts arising from on-site accidents or failure of infrastructure and equipment and of typically low magnitude and consequence. A range of management measures to minimise the risk of such events occurring and minimise contamination impacts are provided in **Table 7-5**.

Table 7-5: Mitigation Measures to reduce Land Contamination

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
52	Potential contamination of land and soils as a result of accidental spillages or plant/equipment failure on site	Construction / Operation	Low	Functioning “spill kits” will be kept on site at all time during construction and operation (**Section 6.3**). Plant and equipment will be checked daily, prior to commencement of works for fuel, oil and hydraulic leaks and will not be used if there are any signs of leaks. If leaks arise during the course of the works, the leaks will be repaired immediately or the equipment will be removed from site (**Section 7.3**). Refuelling of vehicles and machinery will only be undertaken in bunded, hard-standing areas (**Section 7.3**). All employees will receive training as to the procedures to be adopted in the event of accidental spillage or pollution (**Section 7.3**). The sewerage treatment plant will be regular inspected as to operating condition, and suitable cut-off drains, bunding and fencing installed around the site.	Very Low
53	Discovery of previously unknown land contamination during construction (e.g. through odour, colour, texture of exposed soils)	Construction	Very Low	Upon discovery, all works within 50m of the identified contamination will cease. No further works shall occur within the area until a contamination assessment has been undertaken by a suitably qualified person and appropriate remediation/removal processes are completed.	Negligible
54	Land contamination through improper storage and disposal of waste contaminants	Construction / Operation	Very Low	All wastes will be disposed of in accordance with the developed Waste Management Plan (**Section 7.13** and **12.2**). In particular, any liquid wastes swill be stored in appropriate sealed containers in bunded hard-standing areas prior to removal from the site.	Negligible

55	Potential release of highly toxic chemicals (e.g. PCBs) as a result of site operations	Operation	Very Low	Where possible, equipment and infrastructure present on-site will not utilize PCBs and instead utilize alternative oils/greases. Disposal of operating components containing PCBs and other contaminants will be done in accordance with a Dangerous and Hazardous Goods Management Plan to be developed as required (**Section 7.13**).	Negligible

7.4.4 Residual Impacts

Following the application of the identified mitigation measures, it is considered that the overall residual risk in regards to land contamination issues, from Project activities, is very low. Due to the nature of both construction and operation activities the likelihood and consequence of potential land contamination events associated with the project are small. The low risks that are posed by the Project's activities are considered to be readily mitigated through on-going management of waste management procedures and plant and equipment maintenance.

7.5 Landscape and Visual Impacts

This Section presents the baseline conditions and methodology used to assess the potential impacts on the landscape character and visual amenity resulting from the development of the Project. In addition, mitigation measures which aim to avoid, reduce or restore / compensate or offset these potential impacts and thereby minimise residual impacts are also provided.

Landscape impacts refer to any changes to the physical structure and elements of the landscape surrounding the project site and any possible effects on the wider character of the landscape. In contrast, visual impact is a more subjective category, which attempts to capture the effects of the Project on the visual amenity of sensitive receivers (e.g. local community).

In the absence of Zambian guidelines, the format and content of this assessment was undertaken based on guidance from the Countryside Agency/Scottish Natural Heritage and the Landscape Institute and Institute of Environmental Management and Assessment given in:

- Guidelines for Landscape and Visual Impact Assessment (GLVIA), Second Edition, (IEMA and LI, 2002) (*currently under revision*); and
- Landscape Character Assessment, (Guidance for England & Scotland) 2002 (Swanwick et al., 2002).

These publications form the standard reference for undertaking landscape character and visual assessment in accordance with European standards but are applicable to projects elsewhere. This process involved the review of existing desktop and database information, followed by confirmation through site visits undertaken on 14-18 June 2012.

7.5.1 Baseline Conditions

Landscape

The Itezhi-Tezhi dam is located within the Kafue Basin. The area of the basin, upstream and to the north of the dam is characterised by intersecting mountain ranges, with light to dense forest cover of savannah and hill woodland. Downstream of the dam, to the east of the site, the basin is characterised by undulating flats and swampy plains, which tend to be lightly vegetated and utilised as prime grazing areas (**Figure 7-9**). Areas of development and infrastructure within the basin are minimal in comparison to the expanse of vegetated areas.

Figure 7-9 Landscape Viewed from the Power House Site, Facing Northeast.

On a local scale, the construction of the dam in 1978 has significantly altered the immediate upstream landscape, forming a 390 sq km^2[34] reservoir, and altering the nature of the surrounding woodlands (**Figure 7-10**). Downstream of the dam, the landscape is typical of most of the Kafue Flats and has no distinctive or unique features. Although artificial, the formation of the dam has sufficiently altered the local environment, creating a distinctive landscape within the region. As such, the landscape context is considered to be of moderate quality.

Figure 7-10: View looking south towards the power house site. The Itezhi-Tezhi dam is observed on the RHS of the photo

[34] http://en.wikipedia.org/wiki/Itezhi-Tezhi_Dam, accessed on July 11, 2012

The sensitivity of the landscape to change (i.e. to what extent would the landscape change following a given impact) in the immediate vicinity of the dam is considered to be low. This is due to the visual dominance of the 65m high dam wall (**Figure 7-10**). Any infrastructure of lesser magnitude will not generate a significant change in landscape character. In contrast, any developments along the reservoir edge or on the flats further downstream, may significantly alter the character of the area.

Visuals

The Guidelines for Landscape and Visual Impact Assessment (IEMA/LI, 2002) note that sensitivity of receptors depends on a number of factors. Visual impacts result from change to the appearance of the landscape as a result of the proposed development either intruding into, or obstructing existing views, or by their overall impact on visual amenity and character. The sensitivity of receptors relates principally to three factors:

- Receptor's function whilst exposed to view;
- Degree of exposure to view; and
- Period of exposure to view.

The criteria used to assess the magnitude of visual impacts are as follows:

- Value of existing views;
- Degree of change to existing views;
- The availability and amenity of the alternative views; and
- Distance to receptor.

Impacts may be considered as beneficial (i.e. positive) as well as adverse. The magnitude of a visual impact in this assessment may be described as very high, high, medium, low or very low.

Professional judgement is inherent in determining the category of impact. The assessment of visual impacts is based upon views obtained at the time of assessment. The sensitivity of a receptor and the level of impact upon it can be combined to assess the significance of the resultant effects. Representative photographs of the context of the power house site were captured at a number of viewpoints in 14-18 June 2012 **(Table 7-6** and **Figure 7-11**)

Table 7-6: Details of Landscape and Visual Context Photos

Location	Easting	Northing	Figure	Direction
1	8256161	0395112	Figure 5.3-1	Northeast
2	8257291	0395089	Figure 5.3-2	South
3	8257687	0395985	Figure 5.3-4	South
4	8256198	0395262	Figure 5.3-5	North

Figure 7-11: Locations of Landscape and Visual Context Photos

(Aerial image © 2012 Google; Image © 2012 Cnes/Spot Image;Data SIO, NOAA, U.S. Navy, N.G.A, GBECO)

The photos captured are presented in **Figures 7-9** and **7-10** (above), and **Figures 7-12** and **7-13** (below).

Figure 7-12: View From Power house Farm Looking South Towards the Powsr House Site

Figure 7-13: View From the Power House Site Looking Northest Towards Itezhi-Tezhi Town.

The dam and proposed construction site of the power plant, is seen from very few public vantage points. To the south and south west, the dam wall is shielded by hills and vegetation. To the north of the proposed power plant site, a further hill and vegetation shields the site from the town? of Itezhi-Tezhi (**Figure 3-3**). The only permanent residences with a direct line of site towards the dam and proposed power plant are Power house and Melissa farms which are located 1.6km and 1.8km to the northeast respectively (**Figure 3-3**). To the east, the rolling plains of the Kafue valley extend. Due to the flat nature of this region, the top of the hill (100 m high), into which the power plant is to be built, is likely to be visible from some areas of the

eastern side of Itezhi-Tezhi town. However, due to the flat nature of the land, local vegetation acts as a significant visual barrier, limiting the observable horizon for communities within the plains (**Figure 7-13**).

The shielding provided by Itezhi-Tezhi dam, surrounding topography and proposed power house construction site is such that the list of receptors capable of viewing it is limited to:

- farmers identified on adjacent lands;
- fishermen and water users (including tourists) on both upstream and downstream river locations; and
- road users using roads adjacent to the site (such as the D769 Road).

Given the nature of the identified receptors and the distance of the receptors from the site, it is considered that the existing dam site has a low visual sensitivity. The locations of the associated water treatment plant, sewerage treatment plant, and worker accommodation, are in closer proximity to residential areas and are likely to be more readily observed by nearby sensitive receivers. **Figure 3-3** demonstrates the location of all off-site ancillary facilities, key sensitive receivers and landscape characteristics. However, the density of vegetation around these sites, will limit the impacts of any facilities that do not extend above the tree line.

7.5.2 Potential Impacts

Due to the relatively remote location of the Project, topographic and vegetative shielding of the site and the nature of the proposed construction and operation activities, impacts upon the landscape and visual amenity of the area are unlikely to be significant during the construction and operational phases of the proposed works.

Construction

During the construction phase of the proposed road upgrade and extension elements of the work that may temporarily detract from the visual landscape include:

- heavy vehicles, construction worker vehicles, and equipment located on site;
- stockpiles of construction materials located on site;
- construction waste located on site;
- site fencing;
- site compounds; and
- loss of vegetation.

Of these, the loss of vegetation represents the primary change to existing landscape components, as the construction associated impacts are likely to be temporary in nature and not directly associated with existing landscape character or features. Approximately 50 ha of vegetation at the power house site is required to be cleared as part of the proposed construction works. This vegetation extends down the north face a small hill towards the Kafue River. The area to be removed is part of a much larger patch of Miombo woodland that is at least 6,000 ha in size. This impact upon the vegetative landscape of the area is considered to be minor.

The existing surrounding vegetative screening at the water treatment site will significantly limit the extent of visual impacts. It is considered that the construction impacts upon landscape and visual amenity are likely to be minor. **Table 7-7** summarises the ancillary facilities and the amount of vegetation clearance required and the resulting extent of visual impacts. The existing surrounding vegetative screening at these sites will significantly limit the extent of visual impacts. It is considered that the construction impacts upon landscape and visual amenity are likely to be minor.

Table 7-7: Extent of Vegetation Removal and Visual Impacts.

Facility	Amount of Vegetation Removal (ha)	Extent of visual impacts
Accommodation camp	9.0	Site located on the crest of a hill. Screening is provided by adjacent vegetation on the northern side which limits visual impacts to residents that may occur on this site. The closest nearby residences are located to the north some 100 m from the site. Limited vegetation screening occurs on the side of the hill that is exposed to the reservoir. All buildings will be single story residences. As such, impacts are considered to be low.
Water treatment plant	1.0	Site is excavated into the side of a hill. Screening is provided on all sides by adjacent vegetation (excluding the road side). As such, impacts are considered to be negligible.
Sewage treatment plant	0.6	Site is located adjacent to the emergency spillway. All facilities are generally low to the ground and some screening is provided by adjacent vegetation and surrounding topography. As such, impacts are considered to be negligible.

Operation

In operation, the permanent structures associated with the Project will potentially alter the landscape character and the visual amenity of the power house site. In particular, the power house and switching yard will provide new structures within a formerly vegetated area. The height of power house is anticipated to be no more than 1020.23 m ASML (**Section 3**), therefore it is estimated that the power house will rise approximately 21 m high above ground level. The highest structures of the switchyard will rise approximately 18 m high above ground level. As such, the power house and switchyard are unlikely to be readily noticeable following revegetation. The power plant itself will be built into the side of the existing hill, and will not protrude over its peak. The top of the surge shaft will not rise above the surface, however a control room, fence and gate will protrude approximately 5 m above the surface. The concrete batching plant will be below 15 m high.

Similarly, the structures associated with off-site ancillary facilities are all anticipated to be less than 15 m in height and unlikely to be observable from surrounding residential areas and sensitive receivers. In particular, the majority of the ancillary structures are of similar form to residential housing and are considered to be keeping in with the semi-urbanised character of Itezhi-Tezhi town.

In operation, none of the Project elements will produce visual side effects, with the exception of:

- limited internal and external lighting (**Section 7.6**); and
- traffic and transport associated with the movements of the 47 operational staff.

The extent of these impacts is considered to be minimal and in keeping with the character of the area.

Mitigation Measures

Due to the limited number of sensitive receptors, the low sensitivity of existing landscape, and the nature and location of the proposed works, the extent of impacts upon the existing landscape and visual amenity is likely to be low. However, a range of mitigation measures are recommended to ensure the long term amelioration of visual and landscape impacts. These mitigation measures are shown in **Table 7-8**.

Table 7-8: Mitigation Measures to Contain Long Term Visual Impacts

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
56	Elements of the work that will temporarily detract from the visual landscape, include: • Heavy vehicles, construction worker vehicles, and equipment located on site; • Stockpiles of construction materials located on site; • Construction waste located on site; • Site fencing; • Site compounds; and	Construction	Low	Any construction waste resulting from the works will be removed from site / burnt on a regular basis (**Section 7.13**). After completion of works, all machinery, fencing, and unnecessary signage is expected will be removed from the site as soon as practicable. All perimeter areas which have been disturbed by the works will be restored via revegetation with species native to the area as soon as practicable (**Section 6.1**). The duration of construction activities will be minimised as much as possible. A tidy work site will be maintained at all times during construction, with all materials confined and stockpiled within the work site boundaries. The spread of stockpiles, waste and vehicle parking would be minimised.	Very Low
57	Elements of the work that will permanently detract from the visual landscape, include: • Loss of vegetation; • Site buildings and facilities; and • Traffic associated with site operation	Construction and Operation	Very Low	Following installation of the road, landscaping with native tree species alongside the road verge is required. If complaints are received regarding visual impacts the potential for implementation of vegetative screening will be assessed.	Negligible

7.5.3 Residual Impact

Providing the mitigation measures listed in **Table 7-8** are appropriately applied it is considered that the residual impact risk of the Project on the landscape and existing visual amenity will not be significant. The minor visual impacts associated with the power plant will be primarily limited to Melissa farm and the currently abandoned Cho'onga farm which are located 1.8 km and 1.6 km northeast of the power house site respectively (**Table 3-1**).

7.6 Lighting

Light sources at the Project site are limited to a small number of fluorescent streetlights which line the road which runs across the top of the existing dam wall (**Figure 7-14**). Due to its location, with the closest sensitive receivers located 1.6 km and 1.8 km northeast away, these lights are not considered to be a significant source of light pollution and are unlikely to annoy residents at night. For most residences, light pollution at night-time is limited to the neighbouring internal light sources or occasional security/external lights on the exterior of structures. Within the town of Itezhi-Tezhi, street lighting is also minimal, with the majority of streets unlit.

Figure 7-14: Light sources around the dam and the project site[35]

The proposed development will include the following additional light sources:

- internal lights within Project buildings for both construction and operational phases;
- additional street lighting around the power plant site and dam;
- security lighting around the power plant, switch yards and permanent facilities;
- light pollution associated with operation of construction/operational vehicles at night-time (i.e. headlights); and
- construction lighting to facilitate working during night-time hours.

[35] Source: ZESCO, 2008. Environmental Impact Assessment Addemndum for Itezhi-Tezhi Hydroelectric Project (Surface Power House). ZESCO, Zambia.

The power plant site is located such that, with the exception of the Melissa Farm and the abandoned Cho'onga farm, it is not considered to be readily visible to any residences due to its topographic and vegetative shielding by hills to the north and south and east, and the dam to the west. As such, any lighting installed will have a limited affect on sensitive receivers. The greatest potential impacts would be during construction for any works undertaken at night. Any such nuisance from lighting received by residents would be short-term in nature.

Lighting associated with the off-site ancillary facilities may lead to larger impacts due to their proximity to additional sensitive receivers. The worker accommodation camp has external street and security lighting which may intrude into neighbouring properties, however screening is provided by adjacent vegetation on the northern side of the site and the closest nearby residences occur to the northeast of the site and are more than 100 m away. The extent of impact associated with these light sources is considered to be minimal.

The volume of vehicles proposed to be used in both the construction (a workforce of 500 people) and operational (a workforce of 47 people) phases (**Section 6.9**) is such that it is unlikely to alter existing traffic volumes at night. As such, light intrusion associated with turning and passing vehicles is likely to be minimal.

It is noted that the establishment of the power plant will substantially improve the provision of electricity to Itezhi-Tezhi and surrounding villages. Currently, Itezhi-Tezhi recieves electricity through a 1.0MVA transformer. Following the completion of the power house and switchyard, this supply will occur via a 10MVA transformer. This increased capacity will allow for the development of more extensive internal and external lighting throughout the town and roadways.

It is not anticipated that site specific mitigation measures will be needed to minimise lighting impacts upon any sensitive receivers. However, standard light impact mitigation measures should be applied to both construction and operational phases of the proposed works to ensure impacts are minimised. These measures are described in **Table 7-9**.

Table 7-9: Mitigation Measures for Impacts of Lighting

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
58	Increased luminance for the Melissa farm and Cho'onga farm, and other sensitive receivers due to construction works.	Construction	Low	Where possible, schedule works within the vicinity of sensitive receivers to be conducted during the day. Ensure all night time construction lighting maintains appropriate directional shielding and arrange work sites such that light sources do not directly face sensitive receivers.	Negligible
59	Increased luminance for sensitive receivers due to internal and external light fittings on Project infrastructure.	Operation and Construction	Low	Ensure all light fittings are appropriately aligned / directed / shielded to prevent unnecessary light scatter. Ongoing maintenance of light fittings is required. If complaints are received, consult with individuals as to the need for protective screening (e.g. vegetative screening, curtains).	Negligible
60	Increased luminance for sensitive receivers due to increased vehicle traffic at night.	Operation and Construction	Low	If complaints are received, consult with individuals as to the need for protective screening adjacent to roadways.	Negligible

7.6.1 Residual Impact

Following the application of standard light impact mitigation measures listed in **Table 7-9** the residual impacts are considered to be negligible and are not considered to be of concern. The construction and operation of the proposed road upgrade and extension will alter the existing lighting environment. However, the lack of sensitive receivers within the impacted area means that potential impacts are not considered to be of significance.

7.7 Project Hazards and Risks

The following hazards and risks caused by natural phenomena are considered to be a potential risk to the project:

- extreme climatic events;
- bushfire; and
- seismicity

Extreme climatic events

Potential flood risks are discussed in **Section 6.4**. In summary, due to the location of the power house site at the Itezhi-Tezhi dam, the presence and operation of the dam will mitigate the risk of riparian flooding except under dam-break scenarios, therefore flooding risks will be limited to local catchment areas. Additionally, the Project's off-site ancillary facilities are elevated above the level of the dam's main spillway and not located next to waterways or within local catchments likely to generate significant flood risks. Suitable storm water management measures will need to be applied to ensure potential impacts are mitigated.

Additionally, the operation of the currently sealed SDT will provide an additional flood control mechanism for the dam as a whole.

The Kafue River Basin extends into the south west region of Zambia which is considered to be the most drought-prone region within Zambia (Buamle et al, 2007). Decreased water inflows into Itezhi-Tezhi as a result of drought events are a likely risk that will impact on the power generation of the Project. In the event of drought, the Project will continue to be operated to coincide with existing conditions, and will meet the conditions relating to the operational flows of the dam as issued by the Zambian Government (**Section 6.4**).

Bushfire

Due to the Projects close proximity to the Kafue National Park and the Nkala GMA bushfires present both an operational risk and a safety risk to the Projects work force. These risks are particularly present during the dry season (August to October).

As presented in **Section 6.1**, the Projects workforce will be prohibited from lighting fires.

Seismicity

The Project lies approximately 200 km west of the seismically active region of the East African Rift system. The East African Rift System extends from the Red Sea south to Mozambique. The system also splits into several branches. The south-western branch runs through Luangwa and Kariba in Zambia.

The Project is considered to be located within an area that experiences frequent low intensity seismic activity and occasional larger intensity events (ZESCO, 2006). A review of the Worldwide Seismic Database was carried out in October 2012 for the period 1900 to 2012 (USGS, 2012). The results demonstrated that nine earthquakes measuring greater than M_L 5.0 were recorded within 300 m of Itezhi-Tezhi dam (**Table 7-10**) and six earthquakes greater than M_L 3 occurred within 22 km from Itezhi-Tezhi dam (**Table 7-11**).

Table 7-10: Greater Than M_L 5 Earthquakes Recorded Within 300 km of Itezhi-Tezhi Dam for the Period January 1900 to October 2012.

Year	Magnitude (M_L)	Distance from Itezhi-Tezhi Dam (km)
1973	5.0	275
1973	5.0	228
1973	5.1	229
1973	5.2	235
1974	5.5	233
1984	5.4	293
1986	5.5	273
1991	5.0	205
2011	5.2	22

Table 7-11: Greater Than M_L 3 Earthquakes Recorded Within 100 km of Itezhi-Tezhi Dam for the Period January 1900 to October 2012.

Year	Magnitude (M_L)	Distance from Itezhi-Tezhi Dam (km)
1980	4.1	22
1980	4.2	35
1982	4.4	4
1982	4.5	15
1999	3.9	16
2011	5.2	22

ZESCO (2006) reports that between the early 1900s to 1978, five seismic events above M_L 5 were recorded within 305 km from the site. The results of their findings are included in **Table 7-12.**

Table 7-12: Greater Than M_L 5 Earthquakes Recorded Within 100 km of Itezhi-Tezhi Dam for the Period January 1900 to October 2012.

Year	Magnitude (M_L)	Distance from Itezhi-Tezhi Dam (km)
1963	5.8	305
1963	5.8	298
1968	5.6	20
1968	6.0	328
1969	5.2	80

Reservoir induced seismicity has been observed to occur during the filling of impounded water reservoirs (Gupta, 2010). Monitoring of seismic activity has occurred since the filling of the Itezhi-Tezhi reservoir (1978 to 1991). This monitoring demonstrated that increased seismic activity occurred within the proximity of the reservoir in 1978, shortly after filling commenced, and was determined to be potentially due to reservoir induced seismicity (ZESCO, 2006). Additionally, in 1982 several earthquakes ranging from M_L 3.0 to 4.0 were also attributed to reservoir induced seismicity and were associated with a decline in aquifer pressure (ZESCO, 2006). Following 1982, reservoir induced seismicity decreased to baseline levels (ZESCO, 2006).

Itezhi-Tezhi dam was constructed to withstand an earthquake of M_L 6.5. The baseline levels of seismic activity demonstrate that the no seismic events greater than M_L 6.0 have been recorded within 300 km of the Project site. The largest earthquakes recorded within 100 km of the Project area were 5.6 (1968), 5.2 (1969) and 5.2 (2011). As such, it is considered that any damage to the structure and/or function is unlikely from natural or reservoir induced seismicity. In the unlikely event that the power house will be damaged due to seismic events, water flow to the power house can be restricted via the radial gates or completed stopped via the bulkhead gates, therefore any resulting impacts from the operation of a structurally or functionally compromised power plant are unlikely. As such this impact is considered to be low.

The operation of the dam will follow previous release patterns, therefore no changes to the water stored within the reservoir will occur from existing levels (**Section 6.4**). As such, the Project is unlikely to result in reservoir induced seismicity above the existing levels.

7.8 Solar Access

Solar access is an important factor for primary production as well landscape amenity for sensitive receivers. It also plays a significant role in reservoir and wetland systems, affecting rates of evaporation. The Kafue Flats receive approximately 3000 sunshine hours per year, an average of 8.2 sunshine hours per day (Chabwela & Kalyocho, 2003). However, the majority of these hours occur in the seven dry months of the year (April to October). This moderately high level of sunshine, coupled with the temperature, wind and topographic conditions, is seen to result in mean annual evaporation levels of around 2,000 mm per year (approximately 160 mm per month) (Beilfuss & dos Santos, 2001). In comparison to monthly rainfall (**Section 6.2**), there typically is a net loss of water through evaporation. This highlights the importance of the Kafue River, and operational flows from the dam in maintaining the Kafue Flats

ecosystem. It is anticipated that the project will not affect received regional solar radiation levels or alter evaporation rates

Locally, the previous construction of the dam (51 m high) on an approximate north-south alignment, is considered to have marginally decreased the extent of solar radiation received immediately downstream in the afternoons. This shadow falls primarily upon the river. However, in general, this local environment is naturally shielded from afternoon radiation due to the low hills on both the northern and southern sides of the Kafue River that ties in with the dam wall.

The Project will not significantly impact upon solar radiation within the vicinity of the works. None of the anticipated construction activities will be of sufficient scale to alter local radiation levels. Construction associated dust does have the potential to affect received sunlight. However, the likely magnitude of dust production (considered to be greatest during rock blasting) is relatively low and any such effects would be extremely short-term and localised in nature. Application of the dust and wind-erosion control measures would further ensure that any such impacts are negligible (**Section 7.11**).

The nature of the Project buildings and infrastructure is such that any associated shadows cast are unlikely to significantly extend past site boundaries. The largest proposed building is the power house (approximately –21 m above ground level). However, this structure is proposed to be built into the side of the hill on the southern side of the Kafue River (**Figure 7-15**) and will not exceed existing hill elevations. Other on-site and off-site facilities are single storey or below 18 m and therefore will have limited potential to cast shadows.

Figure 7-15: Approximate Location of the Power House

It is considered that the Project will not significantly impact upon the existing solar access within the Project area. No specific mitigation measures are considered necessary.

7.9 Traffic and Transport

7.9.1 Baseline Conditions

Roads

Road vehicle and pedestrian transport are the primary modes of travel within Itezhi-Tezhi District. The road network within Itezhi-Tezhi District links in with broader Zambian road network. The main road through the town of the Itezhi-Tezhi is the D769 (**Figure 1-2**). This road runs through the centre of the town, connecting with Ngoma (and Ngoma Airport) 30 km to the south, and ultimately the larger regional centre of Livingstone (250 km to the south). To the north, the D769 connects with the M9, which connects with Lusaka to the east (250 km) (**Figure 7-1**). The D180 Road is also a significant road within Itezhi-Tezhi District. The road commences from the D769 Road (to the north of Itezhi-Tezhi town) and runs along the northern floodplain of the Kafue River for much of its length (**Figure 1-2**). The road provides a more direct route to the M9 and Lusaka. However, it is noted that while the M9 is a sealed and in reasonable condition, both the D769 and D180 roads are un-sealed roads in variable condition, and frequently badly pot-holed. Both roads, although not formally marked, are wide enough to permit a single lane of traffic in each direction.

Locally, a network of unsealed local roads connects to these larger roads (**Figure 1-2**). Local roads are of unsealed gravel and in variable condition. No formal pedestrian pavements or guttering are present. The only portion of sealed road in the vicinity of the town is a 3km section of the D769 road between Itezhi-Tezhi town and the power house site. This section of sealed road was built as part of the dam construction works, and has continued to be maintained by ZESCO.

Road usage is considered to be primarily associated with transport of individuals either within the District or the transport of goods and produce towards Lusaka. Many local farms and villages along the Kafue River, supply both Itezhi-Tezhi and Lusaka with food produce. Most vehicles observed on the roads during site inspections were seen

to be either 4-wheel-drives or small trucks, capable of carrying multiple people and produce while also coping with the variable conditions of the roads.

A detailed road user survey was not undertaken as part of this study. However, observations made by URS staff while on site, indicated that vehicle passage across the Itezhi-Tezhi dam was in the order of 1 – 2 cars per hour, heading in both a north and southerly direction, with no noticeable peak hour flux. While passage of vehicles is relatively low, the number of pedestrians observed utilising roads was high. With no formal pavements, pedestrians utilise the existing roads to carry goods and produce.

Itezhi-Tezhi and the surrounding area hosts 1 high school, 191 permanent class rooms and a new boarding high school that is currently under construction (**Section 8**). At both the start and end of the school day there is a noticeable increase in the number of pedestrians using the roads. The Musungwa Lodge Compound Community School (approximately 50 pupils) is the closest school to the proposed Itezhi-Tezhi hydropower plant (**Figure 3-3**).

There is limited public transport within the Itezhi-Tezhi District. Two buses provide a one way service between Itezhi-Tezhi town and Lusaka. Each bus alternates to provide a one way journey per day. Local transport is provided by approximately five taxis and two mini-buses that provide daily transit from Itezhi-Tezhi to nearby towns. Car ownership within Itezhi-Tezhi District is relatively low (**Section 8**).

Rail

Rail transport within Zambia is provided by two companies: TAZARA Railway and Zambia Railways Limited. Most of the rail network is associated with the Copperbelt District and connections with Lusaka. There is no rail-related infrastructure within the Itezhi-Tezhi District.

Air Transport

There are a number of landing strips capable of receiving small air-craft in the Itezhi-Tezhi District?, including:

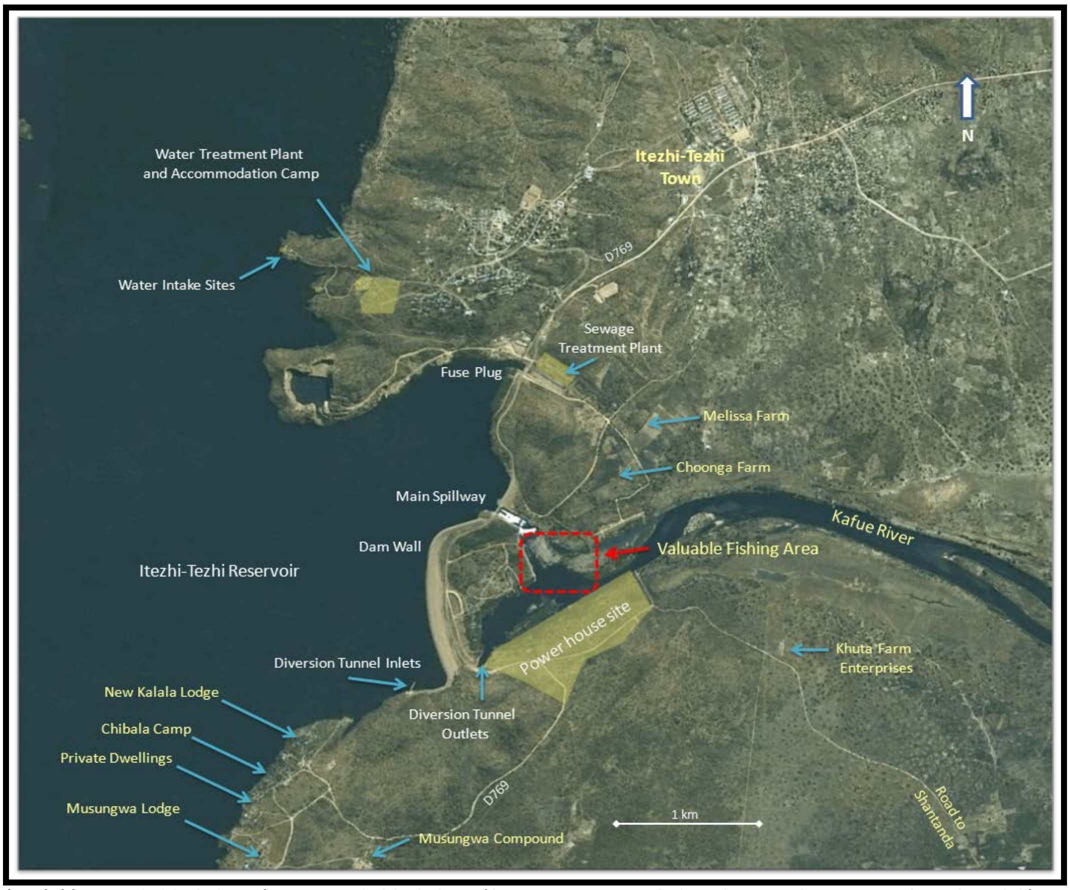
- Ngoma Airport;
- Namwala Air-strip; and
- Puku Pan Air-strip

Ngoma Airport is the closest, located approximately 30km south of Itezhi-Tezhi on the D769 road. This small airport has a refuelling station, air-strip lighting and windsocks. It is most frequently utilised by small charter planes for individuals (tourist and business) wishing to access the Kafue National Park, or Itezhi-Tezhi. The closest large airports are at Livingstone and Lusaka.

Water-craft

Both the Itezhi-Tezhi reservoir and the Kafue River downstream are utilised for transport. Local fishermen, use small, privately owned, boats on the river and reservoir to catch fish. In particular, the section of river immediately below the gates of the dam (**Figure 7-16** and **Figure 7-17**) is recognised as a valuable fishing site, as the discharged waters stir-up sediment, nutrients and invertebrates, attracting fish to the area. Vessels associated with tourism also utilise the reservoir and river, with many tourist lodges offering cruises to observe local wildlife species.

Figure 7-16: Location of local valuable fishing area.



(Aerial image © 2012 Google; Image © 2012 Cnes/Spot Image;Data SIO, NOAA, U.S. Navy, N.G.A, GBECO)

Figure 7-17: Fishermen boarding boats near the valuable fishing area

Transport of goods for sale by boat is not considered to be widely practiced due to the extremely meandering nature of the river along the Kafue Flats. Vehicle transport is a more efficient option, with most major market being located away from the Kafue River. However, some riparian communities may provide goods to other local riparian communities by boat.

A pontoon is in operation at Namwala, approximately 65 km downstream of the Project site to transfer cars from one side of the river to another (**Section 8**).

A water-craft transport survey was not undertaken as part of this study. However, the number of vessels observable from the near-shore Project sites was estimated to be in the order of 3 – 5 per day.

7.9.2 Potential Impacts

Vehicles will be required to access the site both during the construction and operational phases of the project, affecting the existing traffic and transport conditions. The Project is not anticipated to impact upon any existing air or water-based transport systems.

Construction Phase

During the construction phase a combination of goods and materials transfer will need to be brought to site to aid development. Materials will be transported via road, primarily from Lusaka. It is not anticipated that any goods would be flown in to local airports or that employees would come to the site via aeroplane.

The range of construction vehicles required across the various project sites includes:

- bulldozers;
- graders;
- loaders;
- compactors;
- excavators;
- fuel Tankers;
- cranes (number of sizes);
- forklift trucks (number of sizes);
- water tankers;
- trucks/trailers (including Heavy Goods Vehicles);
- cars; and
- buses.

The larger heavy-construction associated vehicles are likely to be limited to use at the power plant / switching yard site. Smaller construction sites (e.g. the upgrade of the water treatment plant) are likely to require use of lighter construction vehicles (e.g. trucks, cars). The majority of these vehicles (particularly heavy construction vehicles), once present on the construction site, will be securely stored on-site until the end of the construction phase, and are unlikely to significantly impact local traffic levels.

In contrast, transport of construction goods and materials on-site and off-site (e.g. disposal of excess rock material following rock breaking) will be on-going throughout construction, as will the daily transportation of workers. Transport of goods and materials (e.g. concrete, steel, piping) is likely to be done by Heavy Goods Vehicles (HGVs). Peak weekly transport levels of heavy vehicles from Luska to Itezhi-Tezhi is anticipated to be a two vehicle trips per week, over the 3.5 years proposed construction

timeframe. Most trips will cover the entire distance from Lusaka to the Project site, travelling along the M9 and the D769 Road. This peak volume is considered to be relatively low and is unlikely to significantly affect traffic flow conditions and rates. However, given the condition of the local roads, and the number of pedestrians utilising the roads, any traffic of HGVs is considered to pose a risk to communities that live adjacent to these roads.

Construction works will require daily ingress of workers to and from the construction sites. Unskilled workers employed from the surrounding local communities (approximately 420 employees) will be picked-up and dropped off by bus. This will require at most six bus trips per day. Semi-skilled/skilled and project management staff (approximately 80 employees) will reside either in ITPC / ZESCO owned properties within Itezhi-Tezhi town or within the proposed operational workers camps once its construction is complete. These employees will access the site via bus or car. The number of construction workers required will vary over the 3.5 year construction timeframe. At its peak, it is expect that the number of workers present on site will be 500 individuals. Transportation of these individuals will be undertaken by bus and car. It is anticipated that 4 – 6 trips will be made per day over a short approximately 5 km journey (**Figure 3-3**). This number of trips may have a low impact upon the local road network, minor road-associated impacts (e.g. noise) on residences adjacent to roads, as well as posing a risk to pedestrian road users. With all Project associated vehicle movements there is a risk of accidents occuring, and subsequent environmental and social impacts (e.g. pollution, injury, delays etc.).

The number of trips (via bus or car) to transport workers to and from Lusaka is anticipated to be less than two per week over the construction phase of the Project. This is unanticipated to have a significant impact upon the existing transport network.

During construction, the D769 oad will require diversion to permit safe passage of vehicles during the blasting and power construction works. An alternative route shall be provided that turns off the D769 Road at the end of the diversion tunnel crossing, before looping around the power plant and switching yard construction sites and rejoining the D769 Road approximately 400 m east from the diversion point (**Figure 3-9**). The additional 10 m will not alter travel times or costs for passing vehicles.

It is understood that the current length of D769 Road that has previously been sealed in associated with construction of the dam is to be maintained. Impacts associated with the future extension of this road section are not considered within this ESIA.

Operation Phase

During operation, Project vehicles movements will be limited to:

- daily employee access to the power plant from the worker camp in Itezhi-Tezhi town;
- occasional maintenance trips to ancillary facilities; and
- transport to and from Lusaka as required.

The operational workforce is anticipated to be 47 individuals. Workers shall be housed within the designated worker camp. The number of small vehicle trips required to transport workers is estimated to be 10 – 20 per day. This level of vehicle movement is unlikely to significantly impact the local road network, although it will provide additional road hazards to pedestrians. Some individuals accessing the site (e.g. project management, cleaning staff) may not reside within the worker camp, but within private residences in surrounding communities. Such individuals may require alternative/additional vehicle movements to enable them to access the site. Any such additional trips are unlikely to have a significant impact upon the local road network.

Vehicle movements as part of maintenance trips to service ancillary facilities (e.g. water treatment plant, sewerage treatment plant) will be scheduled at regular intervals (e.g. once a month). Associated traffic impacts are likely to be negligible. Similarly, the number of vehicles trips to transport workers to and from Lusaka, is considered to be insufficient to significantly impact local or regional transport systems.

7.9.3 Mitigation Measures

The traffic and transport impacts associated with the project are considered to be relatively minor, as the scale of both construction and operations are insufficient to significantly alter existing road traffic volumes, travel times, or vehicle operation costs. However, due to the nature of the existing road network, it is acknowledged that the additional vehicles will pose additional safety hazards and risks to the existing road users. A range of mitigation measures will be applied to ensure that the risk to both other road users, surrounding sensitive receivers, and the operation of the local road network is minimised.

The recommended mitigation measures are shown in **Table 7-13**.

Table 7-13: Mitigation Measures for Impacts of Traffic and Transport

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
61	Increased traffic volumes from Project associated vehicles resulting in altered traffic flows and travel times on local and regional roads.	Construction / Operation	Low	A Traffic Management Plan will be developed detailing appropriate vehicle movement procedures and driver training. Drivers shall follow approved haulage routes and not deviate except in the case of emergency. Controlled movements will be provided where construction vehicles exit/enter public roads. Attempts will be made to minimise off-site traffic movements, particularly during peak traffic periods (i.e. around school times). Buses will be provided to transport works to and from construction sites/worker camps/villages. A complaints register will be established. All construction vehicles shall be maintained in good working order (e.g. brakes, tyres and indicators).	Very Low
62	Increased accident risks as a result of Project vehicles movements	Construction / Operation	High	All drivers of construction vehicles will be required to be fully trained and qualified to operate and maintain the vehicles they drive and ensure safe driving practice. Alcohol/drug use by workers will be prohibited. An Emergency Response Plan will be developed detailing the roles and responsibilities of individuals in the event of an accident.	Low

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
				The local community will be informed about anticipated increased traffic levels and the duration of works. Local schools will be provided with information on road and site safety. Drivers will follow approved haulage routes and not deviate unless in the case of emergency. Vehicles will adhere to agreed speed limits both on-site (40km/hr) and off-site (as marked) (**Section 6.1**).	
63	Increase noise, vibration and disturbance associated with increased traffic levels	Construction / Operation	Low	Environmental impacts associated with Project vehicle movements are addressed in the relevant environmental aspect sections of this Report. Traffic specific measures include: • All drivers of construction vehicles will be required to be fully trained and qualified to operate and maintain the vehicles they drive and ensure safe driving practice. • The local community shall be informed about anticipated increased traffic levels and the duration of works. • Where possible, workers shall be encouraged to uses buses or car pool to travel to and from work sites.	Very Low
64	Alteration to existing road networks or temporary diversions leading to increased risk of accident or delays.	Operation	Low	Provision of sufficient road warnings, speed limits, and detour signage on public roads in close proximity to construction works. Adequate road side signage / safety markers shall be provided warning drivers of speed limits, detours	Very Low

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
				and the presence of road works. Controlled movements shall be provided where construction vehicles exit/enter public roads.	

7.9.4 Residual Impacts

Due to the inherent risks associated with the movement of Project vehicles within the Public domain, there are unavoidable risks associated with the potential for accidents and indirect environmental impacts (e.g. noise, air quality etc.). In particular, given the high pedestrian utilisation of local roads in the vicinity of the project, the risk to life associated with Project related accidents is recognised as the key concern. Following adoption of the recommended mitigation measures the residual impact associated with Project traffic and transport is considered to be low at most. The relatively small scale of the construction works, defined work locations, low predicted traffic volumes and utilisation of collective transport measures (e.g. buses) will ensure that impacts on the operation of the existing local network are effectively mitigated.

The temporary diversion of route D769 is considered unlikely to significantly impact the current operation of the road.

7.10 Trans-boundary Issues

7.10.1 Baseline Conditions

The approximate distance of Itezhi-Tezhi to the Zambian borders with the closest neighbouring countries[36] are provided in **Table 7-14**. Due to the location of the Project in the southern part of Zambia, the closest neighbouring countries are Namibia, Zimbabwe and Angola.

Table 7-14: Distance of the Project to the Neigbouring Countries

Neighbouring country	Distance	Direction	Distance by Road
Namibia	225 km	Southwest	280 km
Zimbabwe	230 km	South and East	330 km
Angola	345 km	Southwest	325 km

The Zambian Electricity Grid originates from the main hydropower generating Projects at Kafue Gorge, Kariba north and Victoria Falls. The Grid connects to Zimbabwe (330 kV line), the Democratic Republic of Congo (220kV line), Namibia (132 kv line), Tanzania (66 kV line) and Malawi (66 kV line) (ZESCO, 2008). The Southern African Power Pool estimated that a regional total power shortfall 1,166 MW would occur as of 2010, however it is not understood whether this has occurred (ADBG and NTF, 2012). The estimated Zambian deficit of 568 MW accounts for almost half of the total (ADBG and NTF, 2012).

Watershed

The Kafue River lies within the Zambezi River Basin. The Basin covers an area of 1.3 million km^2 and is fed by tributaries from eight countries (Mukosa and Mwiinga, 2008). Approximately 75% of the basin occurs within the borders of Zambia and tributaries within the country provide 42% of the Zambezi River water. The Zambezi River commences in the Northwestern Province of Zambia, then runs in a south east direction through or along the borders of Namibia, Bostwana, Zimbabwe and Mozambique and drains into the Indian Ocean (Mukosa and Mwiinga, 2008). The Kafue River drains into the Zambezi approximately 450 km downstream of the Power house site and 60km from Kariba Dam[37].

[36] Distance less than 400 km
[37] The location where the Zambezi River drains Kariba Lake.

By 2007, more than 30 large dams had been built in the Zambezi basin (Fox and Sneddon, 2007). The construction and operation of dams within Zambia has been reported to have had transboundary impacts to a range of wetlands within the basin. More specifically, Fox and Sneddon (2007) report that the construction of dams within Zambia has resulted in environmental and socio-economic impacts to the Zambezi Delta within Mozambique which are largely due to altered hydrological regimes including a decrease in annual flooding.

Water issues associated with the developments within the Zambezi basin are regognised as significant within the political agenda of riparian countries. Several intergrated water management agreements, plans and initiatives have been developed and implemented by riparian countries, including the Zambezi Protocol on Shared Watercourses[38], the Zambian Watercourse Commision, and the Zambezi Action Plan Project 6, Phase 2 (World Bank, 2010). The development, signing and ratification, and implementation of these initiatives between the riparian countries (including Zambia), have been ongoing for decades and are reported to have faced many challenges and varying successes (Fox and Sneddon, 2007).

The Zambezi River holds the largest installed and potential hydropower capacity in Southern Africa (World Bank, 2010). The estimated hydropower potential is approximately 20,000MW of which about 5,000MW has been developed (Densconsult, 1998; as cited in Tumbare, 2004). The development of hydroelectric Projects to meet this potential may lead to further hydrological issues from altered flow regimes of the Zambezi River (including its tributaries) and the important wetlands.

7.10.2 Potential Impacts

The Project is not likely to generate transboundary impacts related to in-migration (including illegal in-migration) into Zambia from neighbouring countries due to its location (i.e. far from borders and other large centres such as Livingstone), relatively small workforce and the ITPC's commitment to a locally sourced workforce. As such no negative impacts are envisaged.

The development of the Project will assist in providing a source of low cabon emitting power to the Southern African Power Pool to meet the growing energy requirements of the South African Development Community. No negative impacts in terms of electrical supply are envisaged.

The Project is located upstream of wetlands such as the Zambezi Delta in Mozambique. The operation of the project not envisaged to contribute to altered hydrological regimes as the operation of the project will follow previous discharge releases and therefore will not result in changes to downstream hydrology under this release pattern. This is discussed in greater to details in **Section 6.4.**

Potential impacts to water and sediment quality identified in **Section 6.3** are considered to be a more significant issue to the Kafue River and Kafue Flats rather than the wider Zambezi River Basin. The wetlands of the Kafue flats are likely to act as a buffer to contaminatied water or sediment that may be released due to the dams operation.I If wetlands do not adequately buffer any nutrient or metal contamination, this may be transferred into the wider Zambezi Basin and across country borders such as the downstream reaches of the Zambezi River and Zambezi Delta in Mozambique.

Overall the impact to the Zambezi River is considered to be low, the recommended mitigation measures for transboundary impacts are provided in **Table 7-15**.

[38] Established in 2000 by the Souther African Develoment Community's water division. Which includes Zambian representation.

Table 7-15: Mitigation Measures to Reduce Transboundary Impacts

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
65	Changes to the hydrology of downstream rivers and wetlands within the Zambezi Basin beyond the Zambian border	Operation	Low	Carry out hydrology mitigation measures outlined in **Section 6.5**). Operation of the hydropower station to be consistent with the dams existing operating rule curve.	Negligible
66	Changes to the water quality of downstream rivers and wetlands within the Zambezi Basin beyond the Zambian border	Operation	Low	Carry out water and sediment quality mitigation measures outlined in **Section 6.3**).	Negligible

7.10.3 Residual Impacts

The Project's residual impact on transboundary impacts are 'neglibible'. The implementation of mitigation measures to reduce potential impacts to the Kafue River and Kafue Flats (**Section 6.3 and 6.4**), are considered to be be sufficient to mitigate impacts to the wider Zambezi basin.

7.11 Topography, Geology and Soils

7.11.1 Baseline

Topography

The Kafue basin lies on a 1000 m desert peneplain on the Central African Plateau (ZESCO, 2006). The average altitude of the Kafue River Basin is between 800 and 1200 m AMSL (Buamle et al., 2007). The upper basin is largely mountainous and forested. Further downstream the topography is gently undulating on a vast plateau, interrupted by ranges of hills and mountains of moderate height (ZESCO, 2006).

The Itezhi-Tezhi power house site is of relatively flat topography, with the exception of an approximately 100m hill that borders that south west boundary of the site. The power house will be located at the foot of the hill and the surge shaft will be construced on the northern side of the hill. (**Figure 3-9)**). North of the Power house site, the topography is generally flat exluding some approximately 100 m high hills that occur north of the site (**Figure 3-3**). Downstream of the Power house site, topography is generally flat with occasional rocky outcrops.

Geology

Eastern Zambia consists of Precambrian crystalline rocks whilst the west consists of successively younger rocks that are sedimentary formations (Petersson and Ingri, 2001). The geology between Mazabuka and Kafue town consists of calcium rich carbonate rocks (Alsterhag and Petersson, 2004). The Itezhi-Tezhi dam is located in the down-faulted valley (graben) in a relatively inactive segment of the East African Rift System (ZESCO, 2006). The underlying geology of the abutments of the dam and most of the reservoir is characterised as granitic basement rock (ZESCO, 2006). The central part of the valley, beneath the main section of the dam is underlain by 30 to 100 m of flat-lying mudstone which forms part of the Karoo System (ZESCO, 2006). Granitic basement rock, including some foliated metamorphic rock, underlies the mudstone sequence (ZESCO, 2006).

The power house site appears to lie on the border of two geological types (**Figure 7-4** and **Section 7.3**). The lithologies upstream of Itezhi-Tezhi dam are typically consolidated, typified by granites and metamorphic rocks of the Hook and Basement Complex (**Section 7.3**). The Hook Igneous Complex occurs across the northwestern part of the Southern Province and consists mainly of granitoids with some metamorphic rocks such as gneiss and migmatite (Buamle et al., 2007). A small outcrop of rhyolite represents the extrusive character of the magmatism occurring during the Lufilian Orogenesis along the Mwembeshi Shear Zone, which is part of a large-scale shear zone transecting southern Africa (Buamle et al., 2007; **Figure 7-4**). The lithology downstream of the Project power house site is classified as Cenozoic deposits, they consist of unconsolidated alluvial sediment, resulting from sediment transport, flooding, and erosion associated with the Kafue River (Buamle et al., 2007). As a consequence of its complex hydrological history, the region is characterised by variable and inter-bedded layers of clay, silt, sand and gravel (Buamle et al., 2007).

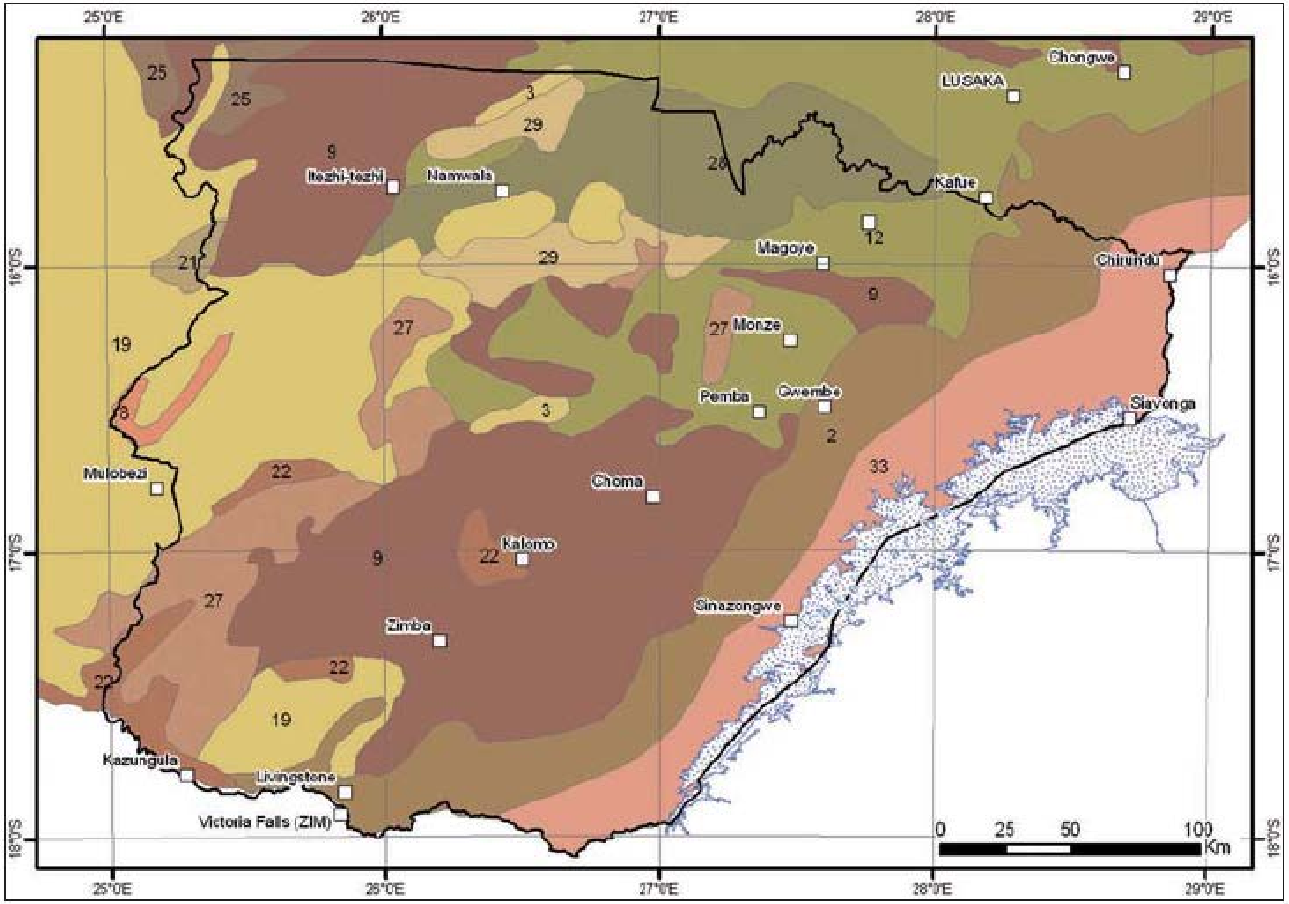
The geology at the power house site is generally rocky. The bedrock is granitic basement rock with some foliated metamorphic rock, underlying the mudstone sequence. Away from the

power house site, the overburden is a sandy/silty residual soil (laterite) from the in-situ weathering of the granitic bedrock.

Soils

Soils upstream of the Project site are classified as Ferric Acrisol/ Ferric Luvisol (Buamle et al., 2007). This soil type is characterised as moderately leached reddish to brownish clayey to loamy soils, derived from acid rocks (Miombo), and are common soils on mag-matic and metamorphic rocks of the Hook Igneous and Basement Complex (Buamle et al., 2007). Downstream of the Project site Pellic/chromic Vertisol soils are more common as these comprise the Kafue Flats Clay Soils and correspond to the Alluvium, colluvium and laterite geological composition of the Kafue Flats (Buamle et al., 2007). **Figure 7-18** demonstrates the soil types of the Southern Province.

Fig 7-18: Soils Map of the Southern Province[39]



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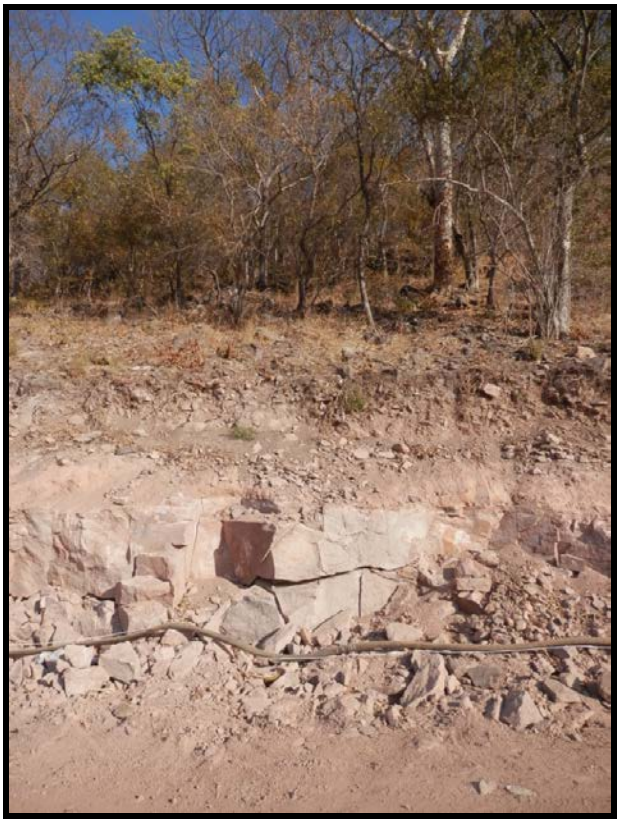
[39] Baumle, et al (2007), Groundwater Resources for Southern Province: A Brief Description of Physiography, Climate, Hydrology, Geology and Groundwater Systems of Southern Province

At the Project site surface soils are generally two to five meters thick, and are likely to have been formed by weathering of the granitic substrate (**Figure 7-19**). The alluvium of the floodplain is mostly sandy in composition and ranges to a maximum thickness of approximately 10 to 12 m (AfDB, 2011).

Figure 7-19: Soils Profile at the Power House Site.



7.11.2 Potential Impacts

Construction Phase

<u>Topography</u>

The northern face of the hill that borders the south-western perimeter of the power house site will be excavated to accommodate the surge shaft and the power house. Blasting will be carried out to re-shape an approximately 1.2 ha area of the northern face of the hill to create a platform installation for the surge shaft (near the top of the hill for the) and to provide for the power house (at the toe of the hill). Earthworks will include slope stabilisation along the northern face of the hill. While these impacts will be localised, they will result in a permanent change to the topography of the site.

The sites of ancilliary facilities (such as the water treatment plant) will also be excavated to create stable foundations, however these will result in minimal impacts to the overall topography.

<u>Geology</u>

- tunnel excavations to occur as part of the project include the following:

- a horizontal headrace tunnel from the existing SDT to the inlet of the power station; and
- a vertical tunnel from the surge shaft to the headrace.

Blasting will be carried out as a major method of rock excavation during construction to assist with both surface and underground rock excavations. As discussed in Section 3, approximately 140,000 m^2 of rock will be removed, of which approximately 30% will be crushed at the on-site rock crusher and used for concrete aggregation during construction and 70% will be disposed of as waste rock at the decommissioned quarry (**Figure 3-4**). No potential impacts to geology are perceived from the construction of these tunnels. Effects of blasting on noise and vibration are discussed in **Section 6.2**.

Soils

During construction, vegetation will be removed and areas for project facilities and roads will be graded to provide a suitable foundation for construction works. Soils will subsequently be exposed and will increase the potential for soil erosion. The gradient of the Power house site slope towards the Kafue River, therefore the potential for high rainfall during December to February (**Figure 7-2**) may lead to sediment transfer into the Kafue River and decreased water quality, this impact is discussed in **Section 6.2**.

A range of vehicles will be operational at the site to assist with transportation of construction materials, and installation of infrastructure and facilities. Details of these vehicles and their movements are discussed in **Section 7.9**. The increased movement of vehicles is likely to lead to compaction of soil, however given that this impact will be temporary the impact is perceived to be very low.

Operation Phase

Topography

Earthworks will not form part of the operational phase of the Project, therefore no potential impacts to topography are perceived during the operation phase of the project.

Geology

No potential impacts to geology are perceived during the operation of the Project

Soils

Earthworks will not form part of the operational phase of the Project, therefore no potential impacts to soils are perceived during this phase. Soils disturbed during the construction will be stabilised following re-vegetation (as described in **Section 6.1**). Soil compaction is likely to occur due to vehicle movements during operation. This impact is perceived to be negligible as the original route of the D769 Road will be re-instated following construction, and the number of project related vehicles during the operations phase (**Section 7.9.2**) will be significantly lower than vehicles from local or regional transport.

7.11.3 Mitigation Measures

The topography, geology and soils impacts associated with the project are considered to be relatively minor with the exception of soil loss and disturbance and ground vibration and air blast overpressures.

The topography of the power house site and the potential for high rainfall events, are conducive to soil erosion. To prevent soil erosion a range of mitigation measure have been developed to limit soil disturbance and removal, and act where soil erosion is evident.

The recommended mitigation measures for topography, geology and soils are shown in **Table 7-16**.

Table7-16: Mitigation Measures to reduce Topography, Geology, and Soils Impacts

No.	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Impact Risk
67	Altered hill slope resulting from excavation, blasting and slope stabilisation	Construction	Low	Excavation, blasting and slope stabilisation to be kept to the minimum required for the development of the project including health and safety requirements. Re-grading of areas to blend with the existing topography of the site.	Very Low
68	Loss and disturbance of soils as a result of water or air-borne erosion or as waste	Construction	Low	Define and demarcate areas of land disturbance to minimise areas of land that are disturbed.	Negligible
69	Loss of soil stability and increased erosion of soils.	Construction	High	Install soil traps where practicable to capture mobilised soil. Grade and shape roads, and incorporate drains and culverts to minimize soil erosion. Carry out progressive remedial action to reinstate areas of erosion e.g. soil traps, planting vegetation, etc. Slope stabilisation to be carried where vegetation has been removed on hill slopes (i.e., using Gabions) Reduce stockpiling spoil and soil materials close to the Kafue River (i.e., maintain a minimum of 10 m distance from the river), where practicable.	Low
70	Compaction of soil due to vehicle movements.	Construction and Operation	Very Low	Use designated roads, tracks and parking areas around the Project site. Carry out soil remediation where required as part of	Negligible

				progressive re-vegetation e.g. deep ripping prior to planting vegetations.	

7.11.4 Residual Risks

Following the application of the specified mitigation measures listed in **Table 7-16** the residual impact risks in terms of topography and soil will be between low and negligible. There will be a degree of unavoidable impact due to excavation of the hill that borders that power house site to accommodate the surge shaft and power house, however this will have minimal impact when regarding the topography of the wider region. Provided that the mitigation measures pertaining to soil erosion are carried out, the residual impact is considered to be low.

7.12 Cultural Heritage

This section details the baseline conditions of archeologically significant resources, their number, character, and location with respect to the Project. It also discusses the possible impacts the project could have on these resources and the possible mitigation measures for the preservation, management and conservation of heritage resources which may occur in the project area.

A desktop study was carried out by a suitable qualitified cultural heritage specialist to determine the baseline conditions of archaeological and cultural heritage and the likelihood of cultural heritage sensitivities occurring within the Project site (**Appendix E**).

A series of studies were undertaken in the 1960s and later on in the 1970s to document the archaeological and cultural heritage of the Itezhi-Tezhi region:

- Studies by E. W. Smith and A. M. Dale, Dr. M. Bisson, B.M. Fagan, van Noten, Phillipson amongst other archaeologists and historians to detail the history and archaeology of the area in relation to the development of mankind, tool making cultures such as the Wilton culture, agriculture, diet and settlement patterns, political and socio-economic dynamics.
- Detailed studies were undertaken during 1973-77, before the construction of the Itezhi-Tezhi dam by the then National Monuments Commission (now National Heritage Conservation Commission). Archaeological excavations were carried out during this period in the upstream area of the Itezhi-Tezhi dam.

Additional to the desktop study, the site visit carried out by URS in 14-18 June 2012 considered the presence of cultural heritage sensitivities during visits to the Project sites, however this didn't include a detailed site survey.

7.12.1 Baseline Conditions

The previous studies revealed the presence of archaeologically significant sites in the wider area of the Project. These locations are provided in **Table 7-17** and **Figure 7-20**, and demonstrate their proximity of these sites in relation to the project site.

Archaeological research near the Project area commenced in the 1960s and intensified during the construction of Itezhi-Tezhi dam Hydro-electric Scheme between 1973 - 1977. A total of 153 Late Stone Age, Middle Iron Age and Recent Iron Age archaeological sites were documented. The GPS recording did not include the seconds value (the sites were only recorded to degrees and minutes). As a result the locations of the previously recorde cultural heritage sites may be inaccurate by 1.8 km. At a maximum inaccuracy of 1.8 km, the recorded sites will still remain outside of any project boundaries.

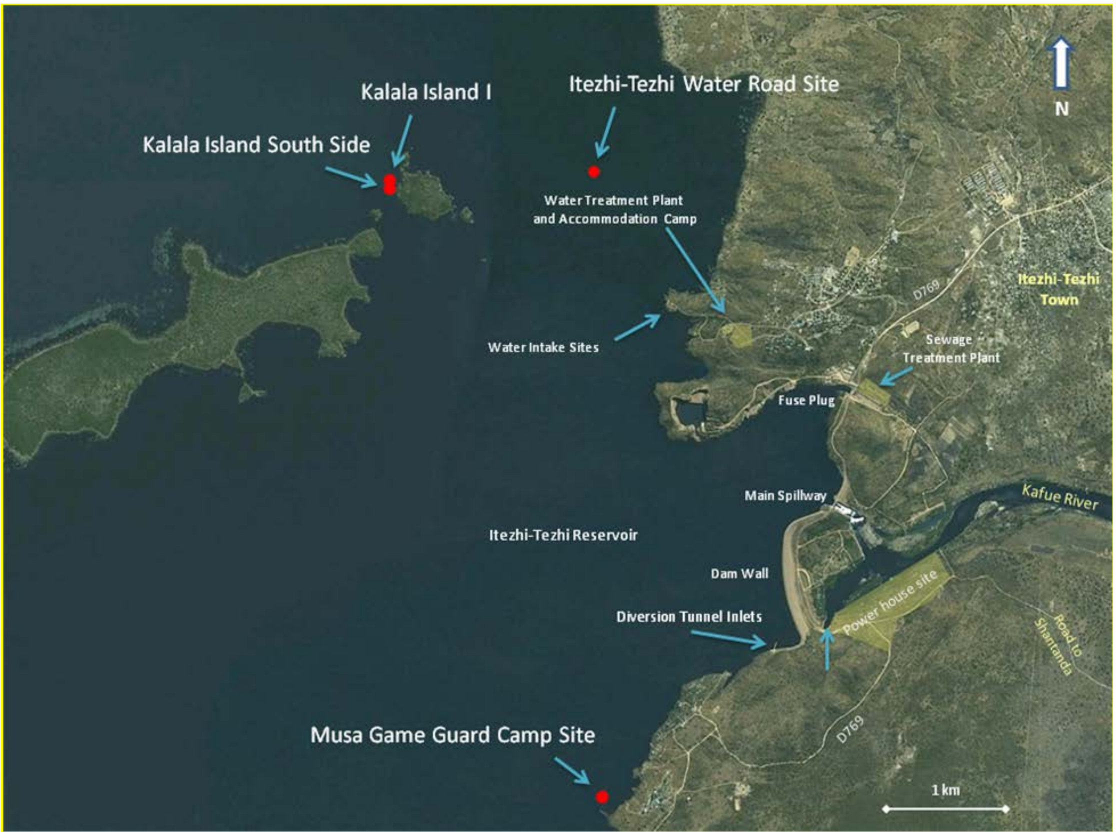
Table 7-17: Location of Previsiously Recorded Archaeologically Significant Sites

NAME	LOCATION[1]	DESCRIPTION/ SIGNIFICANCE
Kalala Island I	15°44'S	Presence of archaeologically significant artefacts from Stone

	25°59'E	Age up to the Iron Age. These include pitted stone tools burial sites (human bones), cowrie shells, copper items, decorated and undecorated potsherds, Glass beads, iron wires, cones, strip, spear binders, cylinders and bracelets. Clay objects found are decorated and undecorated potsherds The site also possessed Slag, Blom, Ironstones and Tuye're pieces pointing to Iron metallurgy industry.
Kalala Island South Site	15°44'S 25°59'E	Pottery, animal and human bones and stones flakes dating 1280 to 1630 AD. Iron fragments were also found
Itezhi-Tezhi Water Road Site	15°44'S 26°00'E	Bones, potsherds, slag, blade, disc beads and Iron Objects from 1050AD
Musa Game Guard Camp Site	15°47`S 26°00'E	Human bones, pottery pieces, ochre, grindstones, smoke pipes from the iron age dating back to 1680 to 1770 AD
Gwisho Hotsprings	15°55'S 27°15'E	Late Stone Age site belonging to the Wilton era

1 GPS co-ordinates were recorded to degrees and minutes only.

Figure 7-20: Location of Previously Recorded Archaeologically Significant sites



(Aerial image © 2012 Google; Image © 2012 Cnes/Spot Image;Data SIO, NOAA, U.S. Navy, N.G.A, GBECO)

Limited information exists on the region downstream of the Itezhi-Tezhi dam, however studies carried out by Fagan and Van Noten in 1971 identified two archaeological sites within the Kafue Flats. The sites were from the Late Stone Age with tools assemblage resembling the 'Wilton culture' and were known as 'Sebanzi' and 'Gwisho'. Based on the studies carried out

Fagan and Van Noten in 1971, and Smith, Dale and other historians and archaeologists in the Kafue Flats, it can be concluded that there was no significant find in the area between the Itezhi-Tezhi dam and Namwala Pontoon.

Significance of Previous Finds

The sites identified surrounding the Project area (**Table 7-20**) are considered to be of regional and national importance and are protected by Cap 173, of the Laws of Zambia under the National Heritage Conservation Commission (NHCC). These sites are significant sources for the historical analysis of development, chronology and migration of mankind in the prehistoric ages. The stone tools and iron tools are important assemblages in the reconstruction of history of a people, their linguistics as well as their survival skills. The artifacts also help to determine possible contacts with foreigners, trade activities and may therefore be used to explain present lifestyles of individual communities and ethnic groups.

Additionally, archaeological sites, if well developed, can add interest for tourists that visit the Kafue National Park and the Itezhi-Tezhi Reservoir.

7.12.2 Potential Impacts

As highlighted and shown in **Figure 7-20** all the significant archaeological sites are located outside of the boundaries of the Project site and beyond the area of impact. The nearest site is 2 km away from the power house site. As such it is anticipated there will be no significant impact on these heritage resources either during the construction or the operation stage of the project.

The previous studies that informed the desktop study are considered to be in-depth archaeological surveys, therefore it is anticipated that all relevant details of archaeologically significant resources have been captured. As such, the probability of encountering any cultural heritage sensitivies within the boundaries of the power house site and off-site facilites is considered to be low.

The Project is not expected to change the flow and the discharge of Kafue River, and thus it is anticipated that it will not impact any of the downstream archaeological sites.

If any archaeological site is identified during the construction phase, the measures to be taken are detailed in the mitigation section.

7.12.3 Mitigation Measures

The expected impact on archaeological sites is very low, if however some sites are identified during construction of the Project, the management of risks will be carried out in accordance with **Table 7-18**.

Table 7-18: Mitigation Measures to Reduce Cultural Heritage Impacts

No	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual impact risk
71	The proposed works may expose, unearth or remove of unknown archaeological remains	Construction	Low	Prior to the initiation of construction and excavation the project owners and the site project supervisors will be sensitized about the possibility of unearthing or 'stumbling' over fossil, ancient or prehistoric archaeological materials. The project owners will be in contact with National Heritage Conservation Commission (NHCC) for professional advice and rescue excavations.	Low
72	The proposed works may cause the destruction or disturbance of possible burial site(s), specifically if construction sand is mined within immediate impact zone	Construction	Low	Care will be taken to control excavation of construction sand in the immediate project site and project owners will be sensitized to the implications of uncontrolled sand mining	Low

7.12.4 Residual Impact

With the application of the identified mitigation measures, it is considered that sites or objects of archaeological significance, if any are identified will be dealt with in the appropriate manner without causing any damage to them.

7.13 Waste and Waste Management

7.13.1 Baseline Conditions

The existing environment surrounding the Project area is largely free of waste and pollution. Some evidence of minor roadside debris was observed along D769 during site inspections (14-18 June 2012); increasing in frequency with proximity to the centre of Itezhi-Tezhi town. The existing surrounding land-use is such that there are no significant waste producing activities in close proximity to the Project area.

The potential for contaminated wastes to be present on site is discussed in **Section 7.4**.

7.13.2 Potential Impacts

National legislation, namely the Waste Management (Licensing of Transporters of Waste and Waste Disposal Sites) Regulations, 1993 (SI No. 71 of 1993) requires that waste from all sources must be collected, gathered and treated in order to eliminate or reduce their adverse effects on health, natural resources and environmental quality.

At the international level, the Bamako and Basel Conventions aim to protect human health and the environment against adverse effects resulting from the generation, management, transboundary movement and disposal of hazardous and other wastes.

The potential impacts of uncontrolled waste generation as associated with the hydroelectric shceme include the following:

- impacts on human health and the environment from releases to air, water or land;
- nuisance, including litter, odour, dust and vermin; and
- impacts on the global environment from carbon emissions.

Impacts can arise throughout the waste management supply chain and therefore the generation, storage, collection/transport, reuse, recycling, recovery, treatment and disposal all require appropriate consideration. Wherever possible, wastes should be managed within the closest proximity to the site of production.

The “waste hierarchy” describes an approach to sustainable waste management that is internationally recognised and which is enshrined in various national and international regulations (including the European Union Waste Framework Directive). The waste hierarchy ranks waste management options according to what is best for the environment. It gives top priority to preventing waste in the first place. When waste is created, it gives priority to preparing it for re-use, then recycling, then recovery, and last of all disposal (e.g. landfill).

Waste can be categorised into three main types:

- inert waste – e.g. surplus excavated soil and rock, rubble and bricks;
- non-inert waste – e.g. food waste, packaging waste and other general wastes from construction, businesses, industry and households; and
- hazardous waste – e.g. oils, certain types of healthcare waste, batteries and other waste exhibiting hazardous properties.

The main types of waste expected to arise from the construction and operation of the proposed hydroelectric scheme are described below.

Construction

The main construction works to be undertaken as part of the project will comprise:

- construction of above-ground infrastructure including tailrace, construction workshop, power house etc.;
- construction of permanent accommodation camp and associated potable water supply system and sewage treatment plant;
- tunnelling to form the new head race and surge shaft;
- dredging of sediments from an area adjacent to the SDT intake.

The main waste generating activities will be those associated with excavation of rock for the foundation of the new power house, and dredging of sediments.

General Construction Waste

The construction activities will require the use of a range of plant and equipment that will require maintenance, refuelling and storage when not in use. Typical waste streams are likely to include general wastes, discarded equipment, batteries, oily wastes, oil contaminated wastes, fuel and spill response waste. Such activities will generate relatively small quantities of wastes although some streams may require specialist handling.

The construction activities will generate waste in the form construction material packaging; damaged, surplus or off-specification materials; and general waste from site offices and workforce amenity areas.

During construction, 500 workers are expected to be on site during the construction phase of the project. Although it is anticipated that the workers will not live on site, site office, rest room and welfare facilities are expected to be provided. Domestic waste will be produced by the on-site workers, comprising food waste and miscellaneous waste from welfare facilities, offices etc. This is assumed to be around 1 kg per person per day, which equates to 0.5 tonnes per day across the site. Small quantities of hazardous wastes and clinical wastes are also expected, which will require special handling arrangements.

Waste generated from any accommodation camp will be dealt with in the same manner as the on-site waste.

Waste from Dredging

The dredging of sediment from the lakebed is likely to give rise to significant quantities of waste requiring disposal.

The area of dredging is not known at present, but if it is assumed that an area of 200 m x 50 m is dredged to a depth of 1m below current level, this will give rise to 200 x 50 = 10,000 m^3 of dredgings. Depending on the concentrations of contaminants in the dredgings, this material may require confined disposal and special measures may be required to control run-off from sediment dewatering, if they are disposed of to land.

Excavation Waste

Excavation in rock will be necessary for the new headrace tunnel, surge shaft, penstocks and power house foundation.

The quantity of excavated rock is anticipated to be approximately 140,000 m^3.

Table 7-17 summarises the main types of waste that will be generated by the Project activities during the construction phase

Table 7-17: Waste Types and Quantities that will be Generated by the Project

Project Component	Waste Types	Quantity
Dredging	Dredged sediment, possibly with elevated concentrations of contaminants.	Not known. Likely to be large or very large (> 1,000 tpa). Level of contamination may require special measures for contained disposal.
Excavation	Inert waste, predominantly hard material (rock from blasting)	Very large (> 100,000 tpa)
On-site construction worker's facilities	Domestic and office wastes	Likely to be medium (100 – 1000 tpa), mainly non-inert non-hazardous.
General construction activities	Wastes associated with maintenance of construction plant (e.g. used oils, filters etc.)	Likely to be small (< 100 tpa) and will comprise hazardous waste.
	General construction waste, predominantly surplus materials and packaging	Potentially large (>1,000 tpa) and will comprise mainly inert waste, with small quantities of non-inert waste.

Operation

Impacts during operation are likely to be limited to:

- waste generated from routine maintenance of the power house and associated generation and transmission plant;
- trash removed from inlet screens;
- domestic waste from the accommodation camp; and
- sewage sludge from the STP.

Tabel 7-18 summarises the main types of waste that will be generated by the project activities during the operation phase.

Table 7-18: Main Waste Types that will be Generated by the Project

Project Component	Waste Types	Quantity
Maintenance of powerhouse and generation/transmission plant	Oils, solvents, chemicals; surplus components and packaging	Likely to be small (< 100 tpa) and will comprise potentially hazardous waste.

Cleaning of inlet screens	Organic debris	Likely to be small (< 100 tpa) and will comprise non-inert waste.
Operation of accommodation camp	Domestic waste	Likely to be small (< 100 tpa) and will comprise mainly non-inert waste
	Sewage sludge	Likely to be small (< 100 tpa) and will comprise non-inert

The amount of domestic waste generated by the construction camp is estimated based on a per capita waste generation rate of 500kg per person per annum, giving an annual total of 25 tonnes.

7.13.3 Mitigation Measures

The general approach to mitigating solid waste management impacts will be through the preparation and implementation of a Project Waste Management Plan (WMP). The Project WMP will include guidance on:

- waste minimisation/prevention;
- identification and segregation of waste materials at source;
- recycling/reuse of suitable materials; and
- treatment and disposal of specific waste streams.

All wastes should be managed in accordance with applicable local regulations and should be consistent with the waste characteristics. The Project WMP should reflect the waste hierarchy, placing priority on waste minimisation, followed by recycling or reuse if economically practicable, then by environmentally sound methods of treatment and/or disposal.

The structure of the waste management plan will follow the outline as per **Table 7-19**:

Table 7-19: Waste Management Plan Structure

Section	Contents
Introduction	Background
	Plan Objectives
	Limitations of the WMP
	Layout of the WMP
Project Description	Project Details
	Nature of Project
	Location
Management Arrangements	Roles and Responsibilities
	WMP Distribution
	Instruction and Training
	Performance Indicators
Waste Management Arrangements	Forecast Waste Arisings
	Record of Decisions Taken Regarding Waste Management
	Opportunities for Increasing Recycled Content
	Opportunities for Waste Minimisation
	Waste Storage and Segregation Arrangements
	Waste Management Arrangements
	Monitoring Arrangements

The general approach to managing both hazardous and non-hazardous wastes is to use existing facilities in and around Itezhi-Tezhi town where possible. It is not clear the extent to which such facilities are available, or whether they meet good international industry practice. In particular, it is not clear whether there are any facilities for managing hazardous waste.

It is anticipated that many of the waste streams to be generated during the construction phase will be able to be reused or recycled. Examples include:

- recycling of inert wastes, excavated materials and surplus concrete and concrete products into aggregates for use within the development, such as in the parking areas;
- recycling of metal off-cuts, surplus and damaged parts, including pipework, re-bar, cabling etc; and
- reuse, recycling or recovery of packaging wastes including wood, cardboard, paper and some plastics.

Where possible contractors should be encouraged to reduce waste arisings and identify opportunities for reuse and recycling.

A significant proportion (30%) of excavation waste will be used as aggregate for concrete. The remainder will be disposed of in the decommissioned quarry (**Figure 3-4**) or will be offered as construction aggregate to the users in the vicinity of the site.

The impacts associated with sediment disposal can be mitigated by identifying a suitable disposal location, where local populations and soil quality will not be adversely impacted and where the run-off from dewatering of the dredged material will not impact on water courses. The quality of dredged sediment should be assessed by regular analysis, and the potential for beneficial reuse of dewatered sediment should be assessed by comparison with local or international soil quality guidelines. The method of placement and final landform of the disposal location should be designed to avoid slope instability, which could potentially pose risks to nearby populations.

General construction wastes (including waste from site offices and workforce accommodation and amenity facilities) will be managed with a local waste management contractor as per the local waste management market. The waste management contractor will be approved to transport, reuse, recycle, treat and / or dispose of waste types that are generated. Appropriate skips, containers and storage areas will be provided including the separate storage of hazardous and non-hazardous wastes and for the segregation, where viable, of materials suitable for reuse or recycling such as metals, plastics and paper and card.

Hazardous materials, such as waste oils and oily wastes, will be contained in appropriate closed containers / drums. Liquid wastes will be stored in an area of secondary containment, designed to capture any waste that may leak from the containers, with a volume equal to at least 110% of the volume of the largest storage container. Hazardous wastes will be collected for treatment by a suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice.

The recommended mitigation measures for waste management are provided in **Table 7-20**.

Table 7-20: Mitigation Measures to Reduce Waste Impacts

No	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual impact risk
73	Wast spoil associated with dredging operations	Construction	High	All dredging waste sediments will need to be sampled for chemical properties to determine the appropriate method of disposal. Where possible, spoil should be re-used on site as part of landscaping.	Medium
74	Excavation wastes	Construction	Low	Waste will be stored at in a designated stockpile at the rock crusher (at a minimum distance of 100 m from the banks of the Kafue River) until used or disposed of at the decommissioned quarry.	Very Low
75	On-site construction worker's facilities wastes	Construction	Low	Waste minimisation and source segregation will be encouraged to enable onsite and off-site reuse, recycling and recovery. Wastes will be managed using a local management contractor. Hazardous wastes will be collected for treatment by a suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice	Very Low
76	General construction activities	Construction	Low	Waste minimisation and source segregation will be encouraged to enable onsite and off-site reuse, recycling and recovery. Wastes will be managed using a local management contractor. Hazardous wastes will be collected for treatment by a suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice	Low
77	Maintenance of power house and generation/transmission	Operation	Medium	Wastes will be managed using a local management contractor.	Medium

	plant			Hazardous wastes will be collected for treatment by a suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice	
78	Cleaning of inlet screens	Operation	Low	Wastes will be managed using a local management contractor. Hazardous wastes will be collected for treatment by a suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice	Very Low
79	Operation of accommodation camp	Operation	Low	Waste minimisation and source segregation will be encouraged to enable onsite and off-site reuse, recycling and recovery. Wastes will be managed using a local management contractor. Hazardous wastes will be collected for treatment by a suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice	Very Low

7.13.4 Residual Impact

Provision of adequate mitigation measures is likely to be effective in mitigating risks to a moderate to low level. However, there is considerable uncertainty regarding the availability of suitable local facilities to management any hazardous waste generated by maintenance activities.

The risks associated with construction-phase impacts of waste management are generally low, with the exception of disposal of dredged sediment. There is currently insufficient information to assess whether the planned disposal route adequately mitigates the risks associated with this material.

The risks associated with operation-phase impacts of waste management are medium to low. There are potentially significant residual risks associated with the management of hazardous waste generated by maintenance of the power generation and transmission plant, since there is insufficient information on the adequacy of local facilities or how the project proponent plans to manage this material.

8 SOCIO-ECONOMICS

8.1 Social Impact Assessment Methodology

This section details the approach used for the assessment of socio-economic impacts, risks and identification of mitigation options. In the methodology, in order to recognise and reflect the variable sensitivity that social receptors[40] can have in response to an impact, a more detailed assessment process has been adopted. In particular, given the recognised potential for negative impacts to more significantly affect vulnerable communities than other parts of society, it is considered that a more detailed approach is justified and in accordance with recently updated IFC Performance Standards.

As with all impacts, socio-economic impacts have the potential to affect existing baseline conditions as a result of Project development. Typical categories of socio-economic impacts include:

- Demographics and population;
- Livelihoods and employment;
- Local governance;
- Labour and Working Conditions;
- Land use, land tenure and Land Users;
- Gender;
- Education;
- Health;
- Housing and access to physical infrastructure;
- Water and sanitation; and
- Access to social infrastructure.

The range of specific impacts arising within these categories is vast, and varies significantly in relation to the social, economic, political, institutional and cultural context.

The risk of any specific socio-economic impact occurring is a function of both its impact significance and its impact probability. Evaluating an impact's risk (i.e. its Social Impact Risk) ultimately allows for the application of effective and appropriate decision-making in regards to the Project and adoption of appropriate and effective risk mitigation and management measures.

The following section describes the overall approach used for the assessment of impacts and the identification of mitigation options.

8.1.1 Assessing Impact Significance

An impact is significant when, in isolation or in combination with other impacts, it is considered necessary to be included in the decision-making process. This decision is based on the methodology outlined in this section and professional judgement by the ESIA team.

The criterion for assessing significance is based on:

[40] Social receptors are individuals, community groups, socio-economic groups and socio-cultural groups.

- **Sensitivity** of the impact receptor – for human receptors, the sensitivity of the household/community and resilience to change;
- **Magnitude** of impacts – as considered by those affected and taking into account the likely perceived importance, as understood through stakeholder engagement; and
- **Likelihood** – the possibility that the identified impact will occur, based on professional experience and evidence that an outcome has occurred previously.

The magnitude of an impact and the sensitivity of its receptors can be combined to form a matrix of impact significance.

8.1.2 Sensitivity

The degree of sensitivity of a receptor is based on an individual's abilities to adapt to changes and maintain their livelihood and health. Sensitivity is not uniform. Sensitivity can also be referred to as 'vulnerability': *'a Stakeholder's resilience or capacity to cope with sudden changes or economic shocks'*.

There are a range of variables that can determine a stakeholder's sensitivity and should be considered in impact assessment, for example: age, livelihood, education, health and level of marginalisation. **Table 8-1** outlines the criteria adopted for evaluating sensitivity.

Table 8-1 – Sensitivity Criteria

High	An already vulnerable receptor with very little capacity and means to adapt to change and maintain/improve quality of life
Medium	A receptor with some capacity and means to adapt to change and maintain/improve quality of life
Low	A receptor with plentiful capacity and means to adapt to change and maintain/improve quality of life

8.1.3 Magnitude

The magnitude of an impact is a measure of the degree of change in the baseline environment as a result of a development leading to positive or negative effects on socio-economic receptors. The baseline condition can include a diverse range of dimensions and the magnitude of an impact may vary, such as:

- Nature of the change - what resource/receptor is affected and how;
- Scale and spatial extent of the area impacted or proportion of the population/ community affected;
- Duration and temporal extent; and
- Type of impact, e.g. direct, indirect.

Table 8-2 outlines different dimensions of impacts that may determine the magnitude of an impact.

Table 8-2 – Definitions of Impacts

IMPACT	DEFINITION
Nature of Impact	Any change to a resource[41] or receptor brought about by the presence of a project component or by the execution of a project activity
	Negative – An impact that is considered to represent an adverse change from the baseline, or to introduce a new undesirable factor *Positive* – An impact that is considered to represent an improvement to the baseline or to introduce a new desirable factor
Scale of Impact	*Local* – Impacts that affect locally important resources or are restricted to a single (local) administrative area or local community *Regional* – Impacts that affect regionally important environmental resources or are experienced at a regional scale as determined by administrative boundaries *National* – Impacts that affect nationally important resources, affect an area that is national important/protected or macro-economic consequences *International* – Impacts that affect internationally important resources such as areas protected by International Conventions *Trans-boundary* – Impacts that are experienced in one country as a result of activities in another
Duration of Impact	*Temporary* – Impacts are predicted to be of short duration and intermittent/occasional in nature *Short-term* – Impacts that are predicted to last only for a limited period (e.g. during construction) but will cease on completion of an activity, or as a result of mitigation measures and natural recovery (e.g. non-local construction workforce-local community interactions) *Long-term* – Impacts that will occur over an extended period, but cease when the Project stops operating. This will include impacts that may be intermittent or repeated rather than continuous if they occur over an extended time period *Permanent* – Impacts that occur during the development of the project and cause a permanent change in the affected receptor or resource that endures substantially beyond the project lifetime
Type of Impact	*Direct (or primary)* – Impacts that result from the direct interaction between a planned project activity and the receiving environment (e.g. employment) *Secondary* – Impacts that result from the primary interaction between the project and its environment as a result of subsequent interactions within the environment *Indirect* – Impacts that result from other activities that are encouraged to happen as a consequence of the project

As such, the overall assessment of impact magnitude in socio-economic systems is highly complicated. Consequently, qualitative appraisals of impact magnitude are

[41] Resources are community assets, amenities and opportunities.

typically undertaken to collectively assess the perceived nature, scale, duration and type of an impact.

Table 8-3 outlines the adopted qualitative decision criteria used to assess impact magnitude.

Table 8-3 – Magnitude Criteria

Positive Impacts	Provides resources or receptors with positive benefits. Equity of distribution should be considered when assessing the positivity of impacts, for example, economic benefits such as employment opportunities
Low	Resource or receptor will not be affected in any way by a particular activity or the effect will be experienced but the impact magnitude is sufficiently small (with or without mitigation) and well within acceptable standards
Medium	Impact is within acceptable limits and standards. Medium impacts may cover a broad range, from impact as minor up to a level just short of the legal limit
High	An accepted limit or standard is exceeded, or large magnitude impacts occur. For some aspects there may be major residual impacts after all practicable mitigation options have been exhausted.

8.1.4 Weighted Impact Significance

Impact magnitude and sensitivity are, in practice, continuous criteria rather than discrete. Therefore, the evaluation of significance requires the application of professional judgement and experience. Each impact should be examined individually and a detailed explanation of the issues leading to the conclusion included.

Using **Table 8-2** to evaluate sensitivity and **Table 8-3** to evaluate magnitude, these can then be applied to the matrix in **Table 8-4** to evaluate the overall significance of social impacts. The following impact significance categories were established.

Table 8-4 – Overall Significance Matrix

Sensitivity of Receptor	Magnitude of Impact		
	Low	**Medium**	**High**
Low	Minimal	Minor	Moderate
Medium	Minor	Moderate	Major
High	Moderate	Major	Catastrophic

It should be recognised that these significance ratings are equivalent in function to the "Consequence" ratings adopted in the environmental impact assessment methodology.

8.1.5 Likelihood

Having described the potential significance of an impact, it is necessary to evaluate the likelihood of the impact occurring. Some impacts will be unavoidable as part of Project development, whereas others may arise as the result of an accident or unplanned event within the project, e.g. traffic accident, fire. As such, mitigation measures may be able to be applied to lower the probability of a particular impact arising.

Five 'Likelihood Categories' were established to capture the likelihood of specific impacts occurring. All identified impacts are assessed for likelihood. The five

categories are summarised in **Table 8-5**. Indicative percentile groups are also provided as practical guides to aid in decision making. They are not intended to be strict criteria.

Table 8-5 –Likelihood

Occurrence Likelihood Category	Description	Indicative Likelihood Percentiles
Improbable	The outcome is not expected to occur	0-5%
Unlikely	The outcome is only expected to occur in a few circumstances	6-35%
Possible	The outcome may occur	36-65%
Likely	The outcome is expected to occur in most circumstances	66-95%
Certain	The outcome is expected to occur	95-100%

8.1.6 Social Impact Risk

Social Impact Risk is both a function of impact probability and impact significance. As such, a corresponding risk matrix can be developed, reflecting the various potential combinations of probability (**Table 8-5**) and significance (**Table 8**-4). The outcome of the resultant risk matrix (**Table 8-6**) is the assigning of a unique 'social impact risk rating'.

Table 8-6 – Social Impact Risk Matrix

Likelihood	Significance				
	Minimal	**Minor**	**Moderate**	**Major**	**Catastrophic**
Improbable	Negligible	Negligible	Very Low	Low	Medium
Unlikely	Negligible	Very Low	Low	Medium	High
Possible	Very Low	Low	Medium	High	Very High
Likely	Low	Medium	High	Very High	Extreme
Certain	Medium	High	Very High	Extreme	Extreme

Using this matrix, impacts with a high likelihood (e.g. probable) and high significance (e.g. catastrophic) are considered to have an extreme impact rating and to pose considerable risk to the project. Seven impact categories are identified:

Negligible – Impacts are considered to be immaterial to the project and receptors are unaffected. Does not require response;

Very Low – Impacts are not considered to be significant and will not affect project outcomes and only affects receptors considered to have very low sensitivity. Unlikely to require response;

Low – Impacts are not considered to be of concern and affects receptors with low sensitivity. May require a project response;

Medium – Impacts are of concern and affects receptors with moderate sensitivity. Should be actively responded to and managed;

High – Impacts are significant and affects a range of sensitive receptors. May affect project outcomes unless mitigated;

Very High – Impacts are significant and are dangerous for receptors that are not resilient to change. Will affect project outcomes unless mitigated; and

Extreme – Impacts severely affect highly sensitive receptors (e.g. leading to death of individual or significantly altering individual's way of life). Likely to prevent the project from proceeding.

8.1.7 Mitigation Measures and Management

Ultimately, the SIA aims to prevent or mitigate as far as possible any negative impacts on the socio-economic environment. Mitigation and management measures are aimed at preventing or minimising potential negative impacts in the design of the Project, as opposed to remedying or providing compensation later in the Project lifecycle. These mitigation and management measures are also focused on maximising positive impacts throughout the Project lifecycle.

By applying mitigation measures, both the significance of impacts (e.g. by limiting impact magnitude, or sensitising receptors to the potential changes) and the probability of impacts (e.g. the risk of accidents can be lowered) can be reduced. This will effectively lower the risk profile of the Project. Some risks can be entirely removed such that there is a negligible risk of impact, whereas for others, mitigation measures may not be able to prevent all impacts from occurring.

8.1.8 Residual Impacts

A residual impact is the impact that remains after mitigation measures have been designed and implemented for Project activities. For some potential negative impacts, full mitigation might not be possible. As was undertaken for the original impacts identified, the residual impacts following mitigation can be assessed using the methodology outlined above. Social impact residual risk ratings can be identified using the matrix in **Table 8-6**.

If mitigation measures are deemed to be practicable in lowering Project risks, then it is recommended that they be applied as part of Project management plans. **Table 8-7** and **8-8** illustrate the mitigation hierarchy for planned and unplanned events to be adopted to ensure that the potential for social impacts are minimised at all times.

Table 8-7 – Mitigation Hierarchy for Planned Events

Mitigation	Definition
Avoid at source / Reduce at source	Avoiding or reducing at source through the design of the project (e.g. re-routing activity away from sensitive areas, restricting working area, changing time of activity)
Prevent on Site	Add something to the design to decrease the impact (e.g. pollution control)
Prevent at Receptor	If an impact cannot be controlled on site then control measures can be implemented off-site (e.g. traffic measures)

Repair or Remedy	If an impact involves unavoidable damage to a resource, these impacts require repair, restoration and remedy
Compensate in Kind / Compensate through Other Measures	When other mitigation measures are not possible or fully effective, then compensation for loss, damage and disturbance might be appropriate (e.g. financial compensation). Compensation for residual impacts to livelihood will generally be non-financial and focus on restoration of livelihood

Table 8-8 – Mitigation Hierarchy for Unplanned Events

Mitigation	Definition
Control	Prevent an incident from happening or reducing risk of it happening to as low as reasonably practicable (ALARP) by reducing the likelihood of the event (e.g. traffic calming and speed limits, community road safety awareness)
	Reducing the consequence
	Combination of both of these
Recovery / Remedy	Contingency plans and response, e.g. emergency response plans

8.2 Socio-economic Baseline

8.2.1 Introduction

This section provides an overview of the demographic and socio-economic characteristics at the provincial, district and community levels. Information utilised in the preparation of this report includes existing publicly available documentation, previous impact assessments undertaken for the Project, studies conducted by URS for the proposed Project, and site visits undertaken by URS and a qualified national social specialist.

The following section provides a description of the methodology for baseline data collection and a profile of the demographic and socio-economic features of the population living within 3km of the existing ITT dam, and habitations along the Kafue River for a distance of approximately 65km downstream from the Project site. The topics covered include governance, demographic profile, land ownership, economic profile and livelihoods, gender, education, infrastructure and services, health status and Project perceptions of local stakeholders.

8.2.2 Baseline Data Collection Methodology

This section details the methodology and activities carried out by URS to identify the existing baseline conditions. In order to understand the baseline conditions, qualitative and quantitative data has been collected from primary and secondary sources. Secondary data collection was obtained through review of existing literature and documentation on the Project and Project area. Primary data has been collected by directly engaging with the identified stakeholders. A site visit was undertaken by URS in June, 2012 to understand the social setting of the Project and identify potential social receptors. Social surveys and stakeholder consultations were carried out by a qualified national social specialist between June and August 2012.

Receptors are considered within an approximately 3km radius from the powerhouse site as this includes all immediate areas that may experience direct, measurable and

significant changes. Located within this radius are commercial vegetable and livestock farms that are dependent on the water from the Kafue River for irrigation and drinking water. Downstream of the dam, up to 60km, there are a number of settlements that are mostly temporary in nature. The inhabitants of these settlements are dependent on water for livelihoods such as fishing, livestock and agriculture, as well as for daily and personal use. It is anticipated that any change in water quality, and quantity and timing of water flows from the operation of the hydropower plant will have impacts on these water users. The socio-economic analysis, therefore, concentrates on these water users and on the nearest town, Itezhi-Tezhi.

The purpose of the socio-economic baseline data collection is to:

- Understand the socio-economic profile;
- Identify gaps in data and collect primary and secondary data from which potential impacts of the Project can be addressed;
- Meet with key stakeholders and groups to discuss the socio-economic context and potential impacts (positive and negative) of the Project;
- Develop a baseline from which monitoring and evaluation can take place; and
- Identify impacts and mitigation measures.

8.2.3 Secondary Data Collection

A desktop literature review was carried out for the available secondary data at the national (tertiary impact zone), regional (secondary impact zone), and local levels (direct impact zone).

Data was gathered on the following aspects:

- Governance
- Demographics including population
- Religious and ethnic profiles
- Population movements
- Economic and livelihoods profiles
- Gender and development
- Education
- Health
- Housing
- Roads and transport services
- Water and sanitation
- Waste management
- Land tenure and zoning

Secondary data was collected from the most recent reports available from government departments at the national, regional and local levels. The following organisations and departments were identified to be consulted as potential data sources. This list is not exhaustive. A full list of stakeholders consulted and the minutes of meetings are in Annex A of the Stakeholder Engagement Plan (SEP) (**Appendix B**).

<u>National:</u>

- University of Zambia;

- Ministry of Energy and Water Development;
- Ministry of Agriculture and Co-operatives;
- Department of Water Affairs (DWA);
- Department of Fisheries;
- Ministry of Labour and Social Security;
- Ministry of Health;
- Ministry of Tourism, Environment and Natural Resources; and
- Ministry of Home Affairs.

Regional and Local:

- Province-level local authorities and government departments;
- Local NGOs; and
- Local businesses.

The desktop study contributes to scoping the social assessment, as it supports identification of stakeholders, key informants, participants for focus group discussions, and final design of field tools.

Table 8-9 lists the data sources and topics on which information was collected:

Table 8-9 – Secondary Information Data Sources and Topics

DATA SOURCES	TOPICS
World Bank Country information	Population
UN Human Development Index (HDI)	Demography
UNDP Country information	Gender profile
UNEP Country information	Education
Census data and data from the government's Office of National Statistics	Health
	Economy
Studies conducted by government departments (such as Environment, Health, Gender and Women)	Labour and employment
	Land use and land tenure
National skills assessments and reports on economic activities	Infrastructure facilities: access to water, sanitation, waste management and electricity
Feasibility Study of the Itezhi-Tezhi Hydroelectric Project, Harza and Rankin, 1999	
ITT Feasibility Study, Final Report, TCE Consulting Engineers, Feb 2008	
ITT Environmental Impact Assessment report, ZESCO, September 2006	
Environmental Impact Assessment Study, Scott Wilson, January 2003	
State of the Environment Report, Integrated Kafue River Basin Environmental Impact Assessment Study, Scott Wilson, May 2003	
Strategic Environmental Impact Assessment Report, Integrated Kafue River Basin Environmental Impact Assessment Study, Scott Wilson, September 2003	

DATA SOURCES	TOPICS
Research articles	

During the EIAs carried out by ZESCO in 1999-2009, secondary and primary data was collected, in accordance with Zambian EIA regulatory requirements. This data was incorporated as secondary data for this ESIA, where suitable.

However, given that the data for the ZESCO EIA is more than six years old, and to meet international IFC performance standards, it was necessary to conduct a wider scope of secondary data collection.

8.2.4 Primary Data collection

Primary data collection was carried out through socio-economic surveys and engaging with identified stakeholders. The process of identification of stakeholders is further detailed in the Stakeholder Engagement Plan (SEP) that is found in **Appendix B**.

Initial stakeholder groups identified as being of primary concern include:

- Central government and agencies
- Regional government departments
- Local government
- Traditional leaders (Chiefs)
- Non-executive council's and bodies
- Research institutions
- NGOs
- CBOs
- Workers' Unions
- Fishermen
- Subsistence farmers
- Local businesses
- Vulnerable individuals / groups
- Other interested parties

Table 8-10 lists stakeholders consulted for primary data collection, the purpose of engagement and the tools that have been used to engage with them. Due to constraints and limitations in gathering primary data it was not possible to engage with the full list of stakeholder groups identified as important, for example, workers' unions and CBOs. These stakeholders will be engaged and consulted as part of the SEP.

Table 8-10 – Stakeholders identified for primary data collection

STAKEHOLDER GROUP	STAKEHOLDER	PURPOSE OF ENGAGEMENT	TOOLS OF ENGAGEMENT
Government Departments	Department of Agriculture	Agricultural activities undertaken in Itezhi-Tezhi district and in project impact zone	Semi-structured interview
	Department of Livestock Services	Livestock based activities undertaken in Itezhi-Tezhi district and in project impact zone	Semi-structured interview

STAKEHOLDER GROUP	STAKEHOLDER	PURPOSE OF ENGAGEMENT	TOOLS OF ENGAGEMENT
	Department Fisheries, Itezhi-Tezhi District	Details on fishing camps and fishery livelihoods in the project impact zone	Semi-structured interview
	Itezhi-Tezhi District Planning Department	Socio-economic profile of Itezhi-Tezhi district and project impact zone. Migration details	Semi-structured interview
	District Education Board	Education facilities in Itezhi-Tezhi District	Semi-structured interview
	District AIDS Office	Health/ HIV AIDS of Itezi-Tezhi district	Semi-structured interview
Government authorities	Ngoma Zambia Wildlife Authority	Activities of ZAWA and Kafue National Park and Game Management Areas	Semi-structured interview
Elected/ traditional representatives	District Commissioner Ward councillor Council Secretary District Assembly Member	Socio-economic status Social and Physical Infrastructure	Semi-structured interview
	Traditional Chief	Socio-economic profile of water users (potentially affected communities)	Semi-structured interview
Water users	Commercial establishments: Agriculture and Livestock	Type of establishment and the nature of water use Quantity and Seasonality of water use	Focus Group Discussions
	Commercial establishments: Lodge	Nature of the establishment and the number/ seasonality of visitors Quantity and Quality of water use Nature of dependence on River	Focus Group Discussions
	Fishing community: Villages and Camps	Demographic, Socio-economic profile Nature of dependence on River Livelihood assessment	Focus Group Discussions
NGO	NGOs	Relevant issues/ concerns of the local community Concerns with the project	Focus Group Discussions

8.2.5 Methods for Primary Data Collection

Community Profiling

Community profiling is an investigation of households, livelihood strategies and local institutions. By profiling a specific village/community, the context in which households and local institutions operate can be understood. Community profiling of specific communities relevant for the Project and potentially Project-affected persons was undertaken.

In the defined primary impact zone a number of farms were identified, along with the Itezhi-Tezhi town, and fishing and livestock dependent communities were observed at various locations downstream of the Project site. Data was collected from the Itezhi-Tezhi town, the farms near the Itezhi-Tezhi dam and downstream villages and habitations. Profiling of villages was carried out to determine population and demographic data, livelihood patterns and seasonality and access to infrastructure facilities.

Transect Walks

Transect walks involve walking through an area of interest and observing, asking, listening, looking, identifying different zones, and seeking problems and possible solutions. Through this direct observation and interaction with communities, potential issues and problems can be identified.

Transect walks were undertaken through farms within the primary impact zone and downstream habitations within the secondary impact zone in order to understand the nature of the settlements and conditions of communities and people living near the Project site.

Focus Group Discussions

A series of focus group discussions were carried out with fishermen, livestock herders, local government, women, elderly, youth groups and community/traditional leaders. Minutes of these focus groups can be found in the SEP.

Conducting focus group discussions with identified stakeholders builds upon primary and secondary data, looks more in-depth at socio-economic issues and potential impacts, and helps to identify vulnerable or sensitive receptors.

Focus groups discussions are commonly held with between 8-10 participants and usually last for 1.5-2 hours if not more.

Stakeholders who were engaged in focus group discussions in June-July, 2012 for this project include:

- Fishermen;
- Elderly;
- Livestock herders;
- Local government;
- Women;
- Civil society, i.e. NGOs;
- Community and traditional leaders, such as Chiefs; and
- Youth groups.

Key Informant Interviews

In-depth interviews were carried out with stakeholders to build understanding of Project affected communities and issues. Key informant interviews were semi-structured, allowing the participant to have more freedom to respond than in a structured interview, and therefore a more in-depth discussion of issues.

Key informant interviews were held with the following government department officials, elected and traditional representatives and interested parties:

- Chief Musungwa;
- District Commissioner;

- District Planning Officer;
- Council Secretary;
- District Education Board Secretary;
- District Health Management Board Planning Officer; and
- Department of Agriculture Officers and Fisheries Officers.

Livelihoods Assessment

Information on livelihoods and skills was collected during secondary data collection, community profiling, transect walks, focus group discussions and key informant interviews, as outlined above. This assessment considered essential information about key livelihood strategies, potential alternatives, and economic activities pursued by inhabitants in the Project area, in order to enable an assessment as to how these might be impacted by the Project.

Livelihood assessment details, data and minutes of primary data surveys and consultations are in **Appendix I**.

8.2.6 Constraints and Limitations

In carrying out community profiling and livelihood assessment, especially in fishing camps, a number of limitations were experienced. In some instances, the camps were either deserted or those present could not give the required information. In other instances, residents did not give their names when asked for their identification for record purposes. There were cases in some camps where people were intoxicated, which precluded meaningful interaction and interviews/discussion. In focus group discussions, it was not always possible to have both male and female representation. This was because in fishing camps women were often not present as they had gone back to their villages of origin. Additional engagement with women will be carried out through the SEP to ensure meaningful consultation with both men and women.

8.3 Definition of Impact Zone

8.3.1 Defining the Zone of Impact

From the nature of the development, it is anticipated the Project will have an impact on the immediate surroundings of the Project site and up to 60km further downstream of the dam. It is also anticipated to impact the socio-economic conditions of the Itezhi-Tezhi district and the Central Province. Based on this understanding three impact zones have been identified for this Project: the primary or direct impact zone, secondary impact zone and the tertiary impact zone.

8.3.2 Primary/ Direct Impact Zone

The Direct Impact Zone comprises the area that will experience direct, measurable and significant changes to the current socio-economic conditions and to the physical environment once the Project is implemented. For the Project the Direct Impact Zone is defined as lying within a radius of 3 km around the Project site and 60km downstream. The Direct Impact Zone will include the Itezhi-Tezhi town, the Melissa Farm, Khuta Farm, Choonga Farm, Musungwa Lodge and the New Kalala Lodge, which are located within 3km (**Figure 8-1**). Furthermore, the habitations and villages located up to 60km downstream of the Project site, up to the Namwala Pontoon are also considered within the direct impact zone due to potential impacts on fisheries, livelihoods, and resources (**Figure 8-2**). While this could be also classified as a secondary impact due to the offsite and indirect nature of the impacts (the livelihoods impacts are from environmental outcomes of the Project), it has been classified as direct due to the importance of fisheries for livelihoods and the potential for community concern.

Figure 8-1 – The Project primary zone of impact

(Aerial image © 2012 Google; Image © 2012 Cnes/Spot Image;Data SIO, NOAA, U.S. Navy, N.G.A, GBECO)

8.3.3 Secondary Impact Zone (Wider Area of Influence)

The Secondary Impact Zone is the area that will experience indirect but noticeable changes to the physical, social and economic conditions once the Project is implemented. For this Project, the Secondary Impact Zone is identified as the broader district, with considerations relating to social infrastructure within the district, the Kafue Flats, with consideration of the social impacts due to changes to the downstream ecology within the Kafue Flats and associated livelihood resources, and communities along the Itezhi-Tezhi – Mumbwa Road.

8.3.4 Tertiary Impact Zone

The Tertiary Impact Zone comprises the wider geographical area impacted by the Project – in this case it is expected to include the Central Province and the national level.

8.4 Baseline Conditions

8.4.1 Tertiary Impact Zone

National Level Governance

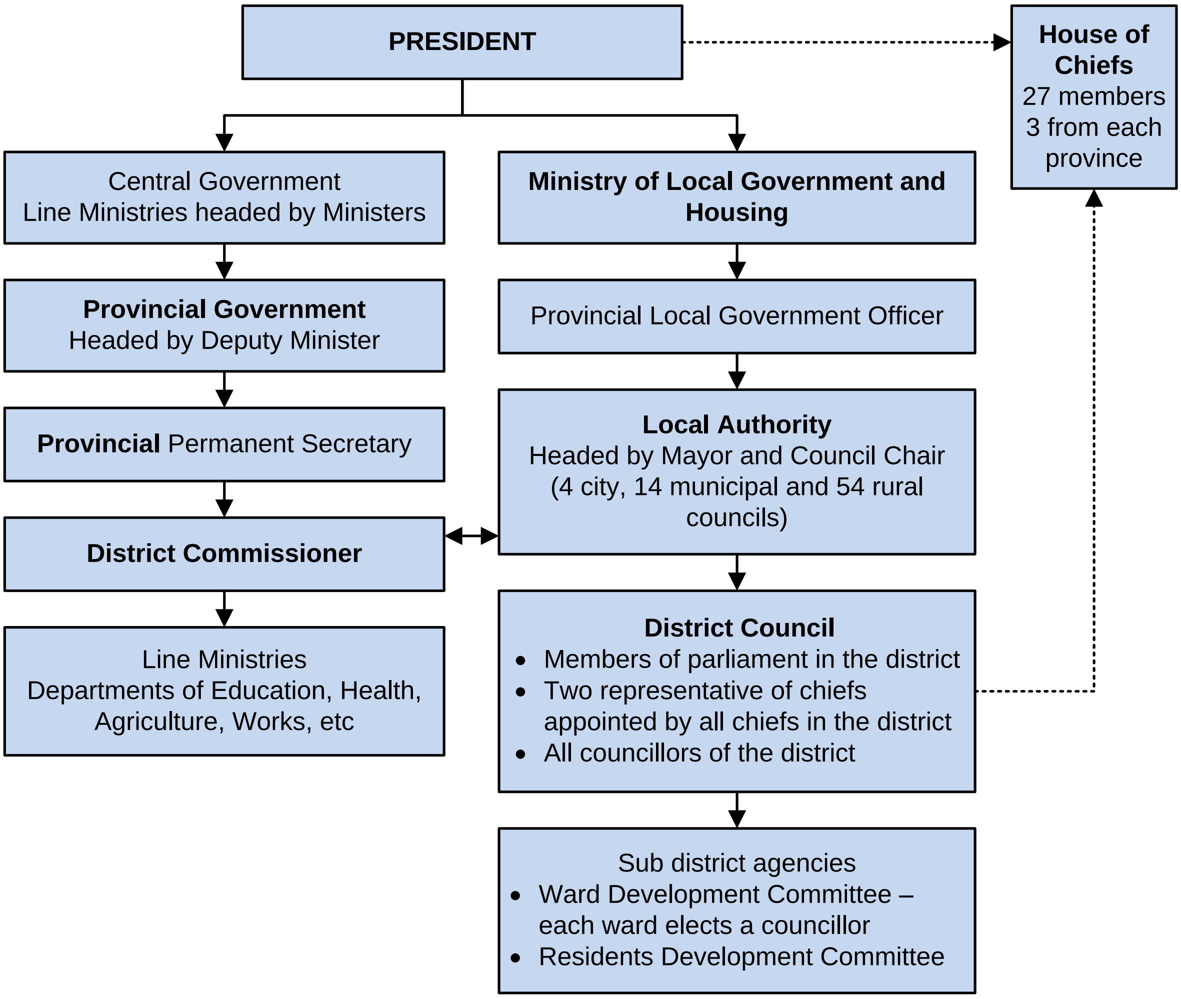
Zambia is a unitary state with the president as the Head of State and the Head of Government, elected through universal suffrage for a period of five years. The parliament is known as the national assembly and has a single house consisting of 150

members. In addition to this, the president can appoint ten members to the national assembly.

Apart from the national assembly, Zambia also has a House of Chiefs comprising 27 chiefs; three each from the nine provinces which acts as an advisory body on traditional and customary matters.

Zambia is divided into nine provinces and further into 72 districts. Administratively at the national level the president is the supreme authority assisted in discharging his functions by a Council of Ministers. As per the Local Government Act (Cap 281 of 1991) the Ministry of Local Government and Housing is responsible for provincial and district administration. For the provincial administration the president nominates a Deputy Minister (a political head) who is assisted in his functions by the Provincial Permanent Secretary. At the district level the administration is headed by the Mayor/Council Chairperson. There is also a District Commissioner who oversees the field administration and reports to the President.

Figure 8-3 – Administrative structure at the Provincial and District Level in Zambia[42]



[42] Source: The local government of Zambia, www.clgf.org.uk; UCLG Country Profile- Zambia Accessed at http://www.cities-localgovernments.org/gold/Upload/country_profile/Zambia.pdf; Republic of Zambia- Public Administration Country Profile, Department of Public Administration and Development

Demographics

Zambia has a population of approximately 13.47 million with an annual average population growth rate of 3%. The majority of the population lives in rural areas. According to the 2010 Census (CSO, 2010) 60.5% (7,919,216) are located within rural areas, while 39.5% (5,173,450) are urban inhabitants. The population in Zambia is characteristically youthful. The proportion of the population below 15 years accounts for 45.4% of the total population.

Table 8-12 below outlines the key socio-economic indicators for Zambia.

Table 8-12 – Key Socio-economic Indicators of Zambia, based on 2011 UNDP International Human Development Indicators[43]

INDICATOR	VALUE
Population	13,475 million
Population Growth rate	3%
Population, female (% of total)	49.9%
Life Expectancy at birth, Total (in years)	49
HDI Index Value Rank (*UNDP, 2011*[44])	164 (out of 187)
Gender Inequality Index (0 – men and women fare equally; 1 – one gender fares as worse as possible in all dimensions: reproductive health, empowerment and labour market)	0.627
GDP Per Capita (PPP$)	1,430
GDP growth (annual %)	5.9%
Unemployment, total (% of total labour force)	15.9
School enrolment rate, Primary (% net)	92.6
Adult Literacy Rate (% ages 15 and older)	70.9%
Hospital beds (per 1,000 people)	2
Access to electricity (% of population)	18.8
Improved water source (% of population with access)	61
Improved Sanitation Facilities (% of population with access)	48
Ores and metals exports (% of merchandise exports)	86
Prevalence of HIV (% of population ages 15-24)	Men: 4.2% Women: 8.9%
Births attended by skilled health personnel (%)	47%

[43] Source: All data from UN Human Development Indicators (2011) and World Bank Development Indicators (accessed on August 14, 2012)
[44] http://hdrstats.undp.org/en/countries/profiles/ZMB.html

INDICATOR	VALUE
Population below Income Poverty Line (PPP $1.25 a day)	64.3%
Seats in national parliament (% Female)	14%

National Economic and Livelihood Profile

The Zambian economy is one of the fastest growing economies in sub-Saharan Africa. In 2011, the country's per capita GDP was USD1,600 and the annual growth rate was 6.7%. This growth is premised largely on the industrial growth, at 8.8% (2011), fuelled mainly by its growing copper and cobalt mining industry concentrated in the copper belt in the north-central province in Zambia. The mineral industries power requirements are met by Copperbelt Energy Corporation Plc which purchases the majority of its power from ZESCO.

The mineral sector contributes between 8-20% to the GDP, employs approximately 15% of the wage earning work force and accounts for approximately 86% of Zambia's export earnings.

The agriculture sector is largely rainfall dependent and contributes an average 18% to the GDP (Republic of Zambia, 2000. It fluctuates with seasonality and suffers from reduced investment and stagnation. The Central Statistics Office (CSO) 2000 Survey (Republic of Zambia, 2000[45]) recorded 1,305,783 households dependent on agriculture with the highest proportion, 16.8%, of households engaged in agriculture in the Northern Province. The main food crops in Zambia are cassava, maize, millet, groundnuts and sugar cane. Cash crops for export are sugarcane, cotton, tobacco and green coffee.

The 2000 Census recorded 454,629 agricultural households involved in raising livestock consisting of cattle, goats, pigs, sheep and donkey. Of these the Southern Province has the highest percentage, 24.4% of households, raising cattle.

The fisheries sector contributes to about 1.24% of the GDP and supports about 300,000 people directly as fishers and fish farmers or indirectly as traders, processors and other service providers (World Bank, 2009). Fishing is dominated by artisanal fishers with traditional boats, the major fishing centres being located in the two river basins - Congo Basin (Bangweulu, Mweru-Luapula, Mweru-Wantipa and Tanganyika), and the Zambezi Basin (Kafue, Kariba, Lukanga, Upper Zambezi, Lower Zambezi, Itezhi-Tezhi and Lusiwashi). The Kafue River is one of the most important river systems in Zambia. The river forms an important fishery with fish production from the Kafue River forming 11% of overall fish production for the country.

Zambia is divided into 9 provinces: Central, Copperbelt, Eastern, Luapula, Lusaka, Northern, North-Western, Southern and Western. The Central Province, where Itezhi-Tezhi is located, has a population of 1,012,257, having a gender make-up of 50.4% male and 49.6% female.

The 2011 Zambia Human Development Report notes that the positive economic growth of the recent past is evidently still insufficient to fully redress the decline in the standard of living and in human development originating from the "two lost decades[46]" (ZHDR, 2011).

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[45] A census was conducted in 2010; the results are pending for information relating to income, livelihoods employment. Preliminary population and housing statistics based on the 2010 census were released in February 2011.

[46] The lost two decades refers to a period of economic stagnation and contraction that was experienced in the 1970s-1980s.

In Zambia, poverty levels are still very high. For individuals, this poverty is often multi-dimensional covering aspects of health, education and standard of living. Overall extreme poverty in Zambia was estimated at 51% in 2006. In urban areas extreme poverty declined from 32% in 1991 to 20% in 2006, while extreme poverty in rural areas stood at 67% percent in 2006 (ZHDR, 2011). It is estimated that approximately 64.3% of the population lives below the poverty line (PPP $1.25 per day). Poverty is concentrated in rural areas, affecting 81% of the population. The CSO 2000 Survey estimates that the Western, Luapula, Northern, Eastern and North-western are the poorest provinces. Poverty and food insecurity is generally due to unfavourable climatic conditions, undiversified economy, poor infrastructure and low incomes.

The 2011, the Zambia Human Development Report observes that while the urban provinces have seen improved economic activities, conditions in rural areas have not changed much, with poverty levels remaining high and accompanying low HDI indicators. This is attributed to the fact that the rural economy is dominated by the agricultural sector. Most employment in the sector is informal and not well paid and hence mirrors the high poverty levels in rural areas. Many rural households depend on some of the least resilient livelihood activities, such as fishing and livestock, which have been adversely affected by the depletion of natural resources and animal diseases.

Gender and Development

The National Gender Policy, approved in March 2000, reflects the national vision on gender equality and equity. The institutional structure that addresses women's and gender issues is the Gender in Development Division at Cabinet Office, under the Office of the President. Zambia, and is a party to the United Nations Convention on The Elimination of All Forms of Discrimination Against Women (CEDAW).

A Zambia Strategic Gender Assessment Report (2004) identifies culture, especially patriarchy, and socialization as key elements of gender relations in Zambia. The Report examined gender profiles in education, health, HIV/AIDS and decision-making and found that in all cases, women were disadvantaged in relation to men. The Report further notes that although the Constitution provides for freedoms for women, these are often overridden by customary laws and cultural factors. In particular, the dual legal system limits women's rights of access to and control over productive resources.

Education

In Zambia, formal education is based on a three-tier system, namely primary education consisting of seven years, junior secondary school consisting of two years, and senior secondary school consisting of three years. Attending tertiary education either at a college, vocational or technical training institute or university follows completion of secondary school education by pupils.

Inequality in access and quality of education between rural and urban areas in Zambia is quite evident. The distance to primary or secondary schools is one of the measures of accessibility to education. Invariably, school attendance by residence was lower in rural areas than urban areas for all school age-groups (CSO, 2011). The dropout rate was 2.1% in 2010 compared to 2.6% in 2006.

Adult literacy has had slight increases over the last 20 years. From a rate of 66% in 1990 it increased to 67.2% in 2000. As indicated in **Table 8.2** above, adult literacy has increased to 70.9% as at 2011.

Health

The delivery of health facilities and services is still very poor in Zambia. For example, Zambia had 1 doctor per 10,000 people between 2000 and 2009 with a per capita expenditure on health of USD79 in 2007. When compared to another African country,

such as Mauritius, this is very low. Mauritius is chosen as a comparison as this is generally considered to be the most developed in terms of democracy and service delivery in Africa (as well as Botswana) and is an upper middle income country. Mauritius has a higher human development index (rank 77), and in 2007 had 11 doctors per 10,000 people and spent US$502 per person (ZHDR, 2010).

Life expectancy in Zambia at birth is 47.3 years, as of 2011. This is a low life expectancy compared with middle and high-income countries. This can be attributed to poor access to health service facilities. Additionally, poor reproductive health services contribute to high maternal and infant mortality rates. For instance, between 2003-2008 the maternal mortality ratio was 830 per 1,000 live births; the mortality rate for children under the age of five years was 148 per 1,000 in 2008; and adult mortality rate (15-49 year) was 361 per 1000 people in 2008 (ZHDR, 2010).

Malaria continues to be the foremost cause of death in Zambia. It is endemic throughout the country and continues to be a major public health problem especially among pregnant women and children below the age of five years. For people living with HIV and AIDS, tuberculosis is a leading cause of morbidity and mortality (National Aids Council, 2010).

Like in other sub-Saharan countries, HIV/AIDS in Zambia has been a major health and development challenge. Although it has been declining since 2006, its prevalence is still high. For example, again using the comparison of the higher human development index country - Mauritius, the HIV/AIDS prevalence rate for adults between 15-49 years is 14.3% compared with only 1.7 % prevalence rate for the same age category in Mauritius. The prevalence rate declined from 16.9% to 14.3% between 2006 and 2010. It is estimated that females have a 16.1% likelihood of being HIV positive and males a 12% chance. Urban areas experience a higher HIV/AIDS prevalence rate (20%) than rural areas (10%). An estimated 10% of transmission is through mother-to-child. There has been a rapid scale-up of HIV care and treatment allowing many patients to continue active, productive lives. This has also resulted in a decrease of HIV-related illnesses that needs in-patient care. About 68% of adults and children with advanced HIV were accessing antiretroviral treatment (ART) in December 2009 (National Aids Council, 2010).

<u>Land Tenure and Zoning</u>
The Lands Act No. 27 of 1995 governs the land tenure system in Zambia. There are two categories of land in Zambia: state land and customary land. Traditional rulers are custodians of customary law and rights of land under their jurisdiction. This land is usually allocated on the basis of use rights to a parcel of land. Land outside the traditional authority is state land, which is held in trust by the President for the Zambian people and is administered by town or district councils.

Land ownership under leasehold is applied to the Commissioner of Lands, through the Local Authorities.

8.4.2 Secondary Impact Zone - Itezhi-Tezhi District

<u>Background</u>

The Itezhi-Tezhi District is a former sub-centre of Namwala District Council. Due to increased social and economic activities in the area, the government elevated its status to a District in September 1997, under Statutory Instrument No. 127 of 1997. This paved the way for establishing it as a District Council. Itezhi-Tezhi, which was until recently part of Southern Province, was realigned to Central Province under a presidential pronouncement in February 2012.

Itezhi-Tezhi District is one of the seven districts of the Central Province. It is located in the South-Eastern part of the province, at a distance of 330km from the capital, Lusaka.

It shares borders with Mumbwa in the north, Kaoma in the west, Kazungula and Kalomo in south-west, Choma in the south, Namwala in the south-east and Mazabuka District in the east. The Kafue River crosses the district from West to East and the rich ecological and agricultural areas of the Kafue Flats adjacent to the river are of importance to the district economy and livelihoods. During the last 30 years, however, these areas have come under increasing pressure due to over-exploitation (Chabwela, 2010). Itezhi-Tezhi district has a total surface area of about 13,000 km^2.

Governance

Itezhi-Tezhi district is divided into 13 wards and one parliamentary council. Each ward elects a Councillor, who along with the Member of Parliament constitutes the district council, which plays an important role in the implementing local development policies and programmes in the district. The Council is headed by the Council Chairperson.

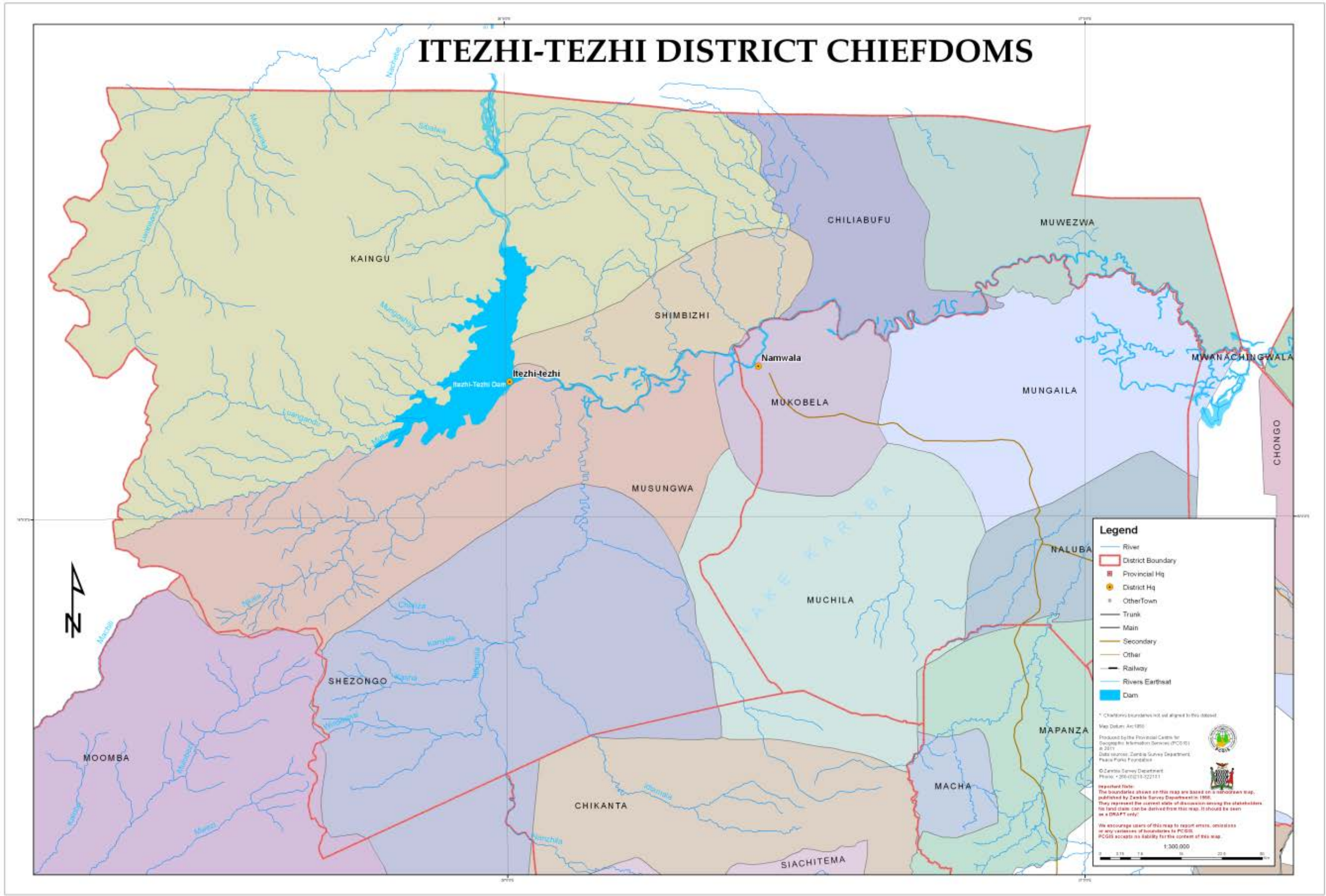
The Administrative Council headed by the Council Secretary consists of the Deputy Secretary (Administration), Treasurer (Finance), Director of Works (Engineering) and the District Planning Officer (Planning) is responsible for performing civic duties and implementing the planning decisions of the Political Council. **Figure 8-3** shows the traditional and administrative structure of the country as well as the district.

Traditional leadership in rural parts of Zambia is entrusted to Chiefs who are custodians of local customs and practices. At the national level, Chiefs are represented in the House of Chiefs, which is an advisory body to government concerning issues involving the welfare of their respective ethnic groups.

The traditional leadership system comprises chiefs, village headmen, and groups of elders or Councilors. Authority is passed on to the chiefs through ancestries or lineages. Depending on the ethnic group, it follows either a patrilineal or matrilineal line. In Zambia, there are an estimated 72 diverse ethnic groups. Traditional rulers govern their subjects according to their own set of rules, laws, and customs.

Itezhi-Tezhi District has 6 Chiefdoms governed by Chief Shimbizhi, Chief Kaingu, Chief Chilyabufu, Chief Muwezwa, Chief Shezongo and Chief Musungwa. The delineation of the various chiefdoms is shown in **Figure 8-4** below. The Chiefs play an important role in mobilising their subjects in developmental activities in their respective areas (Itezhi-Tezhi District Council, 2009).

Figure 8-4 – Itezhi-Tezhi District Chiefdoms



Demographics

Itezhi-Tezhi district has a population of 64,593 and recorded an annual growth rate of 4.1 percent between 2000 and 2010. This is higher than the average annual growth rate of 1.6% for the rest of the country (CSO, 2010). The higher population growth rate of Itezhi-Tezhi District can be attributed to in-migration on account of the economic and labour opportunities (direct and indirect) surrounding the Itezhi-Tezhi and Kafue Gorge dams.

The population density of Itezhi-Tezhi District is four persons per square kilometer. With a total population of 64,593 people, the district has 12,777 households andan average household size of five persons.

Table 8-13 shows the ward level population of Itezhi-Tezhi District.

Table 8-13 – Ward level population of Itezhi-Tezhi District

WARD	HOUSEHOLDS	MALES	FEMALES	TOTAL	POPULATION 18 YEARS+
Itezhi-Tezhi	**1,644**	**4,028**	**4,074**	**8,102**	**4,101**
Itumbi	1,156	2,824	2,899	5,723	2,396
Kaanzwa	989	2,821	2,887	5,708	2,180
Banamwaze	501	1,344	1,351	2,695	1,130
Makunku	654	1,678	1,757	3,435	1,407
Nyambo	433	1,216	1,120	2,336	1,067
Kabulungwe	385	865	799	1,664	826
Lubanda	1,274	3,138	3,114	6,252	2,860
Masemu	2,016	4,456	4,723	9,179	4,183
Luubwe	645	1,619	1,559	3,178	1,399
Basanga	1,389	3,239	3,506	6,745	2,914
Luchena	406	972	1,030	2,002	785
Mbila	1,285	3,614	3,960	7,574	2,910
Itezhi-Tezhi District Total	12,777	31,814	32,779	64,593	28,158

Religious Composition

Over 90% of the district population is Christian, of various denominations. Prominent denominations include the Roman Catholic Church, New Apostolic Church, Evangelical Church in Zambia, United Church of Zambia, Jehovah's Witnesses and Seventh Day Adventist Church.

Ethnic and Language Profile

The main ethnic group in the district is Ila. They are traditionally subsistence herders and fishermen. The Ila are polygamous and have an extended family system in their kinship. While the Ila tribe is a dominant tribe of the Itezhi-Tezhi District, there are other tribes present like the Nkoya, Mbunda, Lozi (from western Zambia), Bemba (from the north and Copperbelt), Luvale, Soli, and Tonga.

English is the official language and is predominantly spoken by people in the educated classes. Ila is the main language spoken in the district. Other languages spoken include Tonga and Lozi.

The Project area is primarily populated with indigenous groups from the Southern Province (as noted above, until recently Itezhi-Tezhi District was part of Southern Province).

Population Movements

There has been considerable in-migration from the neighbouring Western, Northern and Southern districts; evident from the presence of the Lozi, Soli, Bemba and Tonga tribes alongside the Ila tribe.

In-migration from these districts, mostly in search of employment options, notably took place around 1973 when the Itezhi-Tezhi dam was built. In recent years, migrants from Southern Province towns of Kalomo, Kazungula, Choma and Monze have come into Itezhi-Tezhi.

Clashes with local residents were reported in 2010. These clashes were between ethnic groups who had migrated into the area searching for farm land and local residents. There was conflict as in-migrants tried to settle in the Game Management Areas.

The population around the reservoir is made up of Mbunda, Lozi, Bemba, and Luvale ethno-linguistic groups who come from fisheries in western, northern, north western, Luapula, and central, provinces.

Livelihoods and Employment within the District

The main livelihood activities within Itezhi-Tezhi District are fishing and animal husbandry. The sale of both commodities is seasonal.

Fishing is the main source of livelihood and main economic activity in the Itezhi-Tezhi District. The livelihood pattern of the district is dictated by its topography and resource availability. The majority of the district’s population settled alongside the Itezhi-Tezhi dam and the Kafue River to engage in fisheries. Men are commonly issued with permits to fish in the Kafue River and its lagoons. Fishing camps downstream of the Itezhi-Tezhi dam are seasonal and shift depending on river water levels and the fishing season. There is no permanent infrastructure in these areas. As well as fishing and trading of fish, some households also keep livestock. There is also subsistence farming of maize, cassava and vegetables. This allows for livelihoods diversification during a fishing ban that occurs during December through to March, as during this time fishermen will engage in subsistence farming.

The extended Kafue Flats provide adequate grazing grounds to support livestock, making animal husbandry the second most important occupation in the district. As per the 2011 livestock census, there were 85,000 cattle and 13,000 goats in Itezhi-Tezhi District (Republic of Zambia, 2011). Beef and milk are main products from livestock husbandry; however, there is a shortage of milk collection facilities and slaughter houses meaning that value chains may not be realised to full potential. The district has a high potential for producing beef and milk at an estimated 10,000 litres of milk/day

due to abundant water and grazing land in the Kafue Flats. Prices for cattle can be between 1.2 to 2 million ZMK.

Common animal health diseases in the district are anthrax, bovine tuberculosis, Contagious Bovine Pleuro-Pneumonia (CBPP) and rabies, with outbreaks in the past wiping out large herds of cattle. Outbreaks of corridor and foot and mouth disease have also been reported in rural areas and are associated with traditional communal grazing practices. The occurrence of drought also impacts upon the productivity of the livestock sector by depleting animal grazing areas and drinking water.

As the main livelihood activity of the Ila people is livestock rearing, cattle ownership is a sign of an individual's wealth and the pride of households. People can own herds as large as 3,000 cattle. Cattle Kraals[47] allow for seasonal movements for livestock grazing to the highlands when the Kafue flats are flooded (around December to March) and along the banks of the Kafue River when waters recede.

Two cattle Kraals were surveyed in June-August 2012 and socio-economic data collected. For limitations experienced when collecting data see **Section Error! Reference source not found.** and the sub-consultant's report.

- Lutanga Cattle Kraal

Lubwe Village is a permanent settlement and the cattle village is seasonal. Over 50% of the village are engaged in livestock farming as its primary source of income. The main ethnic group is Ila. Cattle are the main livestock reared, and goats and chickens. The size of grazing areas are >25 ha. Milk is sold regularly for cash income in households. The most active months are between June and December. All livestock is sold locally in Itezhi-Tezhi, but cattle are rarely sold. Men and children are involved in milking and selling milk. The population has access to government veterinary services and flood warning advice from the Fisheries Department.

- Chisenga Cattle Kraal

The population is from Kasamu Village which came to Chisenga Cattle Kraal to rear livestock. The population is 4 and live in a grass house. There are no education facilities but there is a health post in Lubwe.

Agriculture is primarily undertaken for subsistence rather than trade, though trade does occur. On the Kafue Flats, the average crop land is up to 5 ha per household. Maize is the dominant crop, and is grown as both a consumption and commercial crop. The farming of maize is undertaken between September and March. Bags of maize are sold (150 bags) to the Food Reserve Agency for ZMK 65,000 for an average monthly income of ZMK 812,500. The Zambian Government provides subsidised fertiliser to farmers through the Farmer Input Support Programme to encourage increased maize production. Production of Maize for the 2010/2011 season was 405,530 metric tonnes. Production for 2011/2012 is expected to reduce to 399,730 metric tonnes, due to lack of rain during the growing season. Other crops grown are groundnuts, cowpeas, tobacco, cotton, soya beans and sorghum.

The cultivation of maize, cassava, groundnuts, tobacco, cowpeas and vegetables is commonly carried out alongside rearing of cattle, goats and chickens. Tobacco and cotton are generally grown as part of the out-grower schemes offered by tobacco and cotton companies.

An estimated 2% of the population are in formal employment which is restricted to government organisations and departments, and government owned corporations such as ZESCO.

[47] Enclosures for cattle generally within or near village settlements

Gender

Customary succession and inheritance practices usually limit women's rights of access to and control over productive resources such as land and property. It is not uncommon for male relatives to take property from the woman upon the demise of the man. Furthermore, women's lack of access to market support services limits the cash income they can earn for themselves and their families.

Within villages men commonly herd animals while women tend the fields. Selling fish to traders is primarily undertaken by men in the fishing camps.

There are challenges in the provision of education to girls, which is most prominent in rural parts of the district. However, in some livestock communities boys commonly leave school at similar levels of education to partake in cattle herding.

The gender and health nexus is exemplified by problems associated with maternal health. The number of women dying due to complications in pregnancy and childbirth in Zambia currently stands at 591 deaths per 100,000 live births in 2007 (CSO, 2011). This is attributable to poor access of women to health facilities and unsafe birthing conditions, especially in rural areas (UNDP, 2011). In comparison, Mauritius' childbirth mortality rate is 36 women per 100,000 live births, in 2008.

Education

The District Education Board Secretary's office is responsible for the administration of education provision in the district, staff placements and welfare. In 2012, the total number of enrolled pupils is 20,452 (**Table 8-14**). In Itezhi-Tezhi District in 2011, there were 75 schools, 52 basic school, 22 community schools and one high school (one boarding high school under construction) and 375 teachers. The District Situational Analysis (2005) notes that most of these education facilities are located in urban areas, and that literacy rates amongst the adult rural population are low. Pupils progressing to High School attend school in other districts such as Monze (Lusangu High School), Mapanza (St. Marks High School), Choma (Njase Secondary School) or Namwala (Namwala High School) (**Figure 8-5**).

Figure 8-5 – Mulilabanyama Basic School and Kaingu Community School

Table 8-14 – Institutions and associations in Itezhi-Tezhi[48]

S/N	School Facilities	Number of Facilities	Girls enrolled	Boys enrolled	Total enrollments
1.	High School	1	231	358	589
2.	Basic School	52	7,962	8,212	16174
3.	Community Schools	22	1,567	1,756	3323
4.	Interactive Radio Centres	5	184	182	366
	Total Number	**80**	**9944**	**10,508**	**20,452**

There are no tertiary institutions in Itezhi-Tezhi District. The closest are located in Lusaka (Univeristy of Zambia, Cavendish University) or Monze (Rusangu University), in Southern Province.

Health Profile

Within the district, there is one hospital and ten rural health centres providing curative and preventive health care services. A District AIDS Control Task Force is also active.

Predominant diseases include malaria, diarrhoea, cryptococcal meningitis and skin infections which indicates a lack of adequate water and sanitation facilities in the district. Diarrhoea is a main cause of morbidity in children under five years of age.

It has been noted in a study of fishers on the Kafue Flats[49] that these populations may be at a high risk for HIV/AIDS, reasons for this include: *high levels of mobility and migration, access to cash incomes within a broader context of poverty, long periods of time spent away from home, demographic profiles of fisher folk, availability of commercial and transactional sex in fishing ports and lakes, and high levels of drug and alcohol abuse. Women may be at particular risk due to social and economic vulnerability* (Lungu, A. and Husken, S.M.C, 2008).

Housing

The urban area of the district is limited to Itezhi-Tezhi town. It has permanent houses such as bungalows. The majority of permanent houses and concrete buildings were built by ZESCO during the 1970s.

Fishing camps are temporary or semi-permanent in nature and made of burnt clay, compacted earth and a grass roof. During field studies in June-August 2012, there were 20 fishing camps along the Itezhi-Tezhi River, though not all were occupied - further detail on this is included in **Section 8.4** below.

Road, Water and Sanitation

Public transport from Itezhi-Tezhi to Lusaka is provided two buses. Each bus alternates to provide a one way journey per day. Local transport is provided by approximately five taxis and two mini-buses that provide daily transit from Itezhi-Tezhi Town to towns such as Kataba and Masemu. Privately owned cars, motorbikes and bicycles provide personal transport in some cases.

[48] District Education Board Secretary, 2012
[49] Note: this represents an area broader than the Itezhi-Tezi district considered here.

Residents of Itezhi-Tezhi have access to piped and potable water. Communities living around the dam access water directly from the reservoir. In urban areas of the district, water is sourced from the Itezhi-Tezhi dam by ZESCO, is treated and then stored in overhead reservoirs from which it is supplied to the town. In the peri-urban areas water is supplied through 21 public water taps connected to ZESCO water reservoirs. In rural areas the only source of potable water sources are protected wells and boreholes and in many cases from unprotected shallow wells, streams and rivers, such as the Kafue River. Within the district there are approximately 200 hand pumps and 100 communal and unprotected wells.

In urban areas, the sewage network is managed by ZESCO, which services existing corporate compounds. At present there are three stabilisation ponds and seven septic tanks with a combined capacity of 200 m^3 /day. Households in the peri-urban and rural areas of the district use pit latrines and open bushes for sanitation.

Waste Disposal

There is no organised solid waste collection facility or managed landfill within Itezhi-Tezhi District at present. Four potential landfill sites have been identified by the District council: Makalachambwe I and II, Kachenjela and Makina on the Itezhi-Tezhi-Mumbwa Road; however, no formal site selection has been made.

Land Tenure and Zoning

The pattern of land acquisition and lease allocation at district level mirrors that at national level.

The Itezhi-Tezhi District situation analysis (2005) identifies the following categories of land use:

- State land – covering urban and peri-urban settlements of Itezhi-Tezhi
- Customary land – covering traditional land under Chiefs Chilyabufu, Kaingu, Musungwa, Muwezwa, Shezongo and Shimbizhi
- Forest Reserves – comprising the Ila National Forest No. 40 (377 km^2) and Sikaleta Forest (11.4 km^2)
- Protected Areas – The Kafue National Park No. 11
- Game Management Area (GMA) – The Namwala Game Management Area No. 13 (3,600 km^2) and Nkala Gamae Management Area No. 32
- Kafue Flats – The plains along the Kafue River used as grazing land for animals.
- Mining area – land used for small-scale mining activities in Chief Kaingu area.

A large proportion of the land in the district falls under traditional authority. The main land use in these areas is subsistence agriculture and cattle grazing, particularly in the Kafue Flats. The Kafue National Park and the GMAs constitute an important land use in the district. These provide livelihood activities related to consumptive and non-consumptive tourism[50], such as safari hunting, game viewing and wildlife photography.

8.4.3 Direct Impact Zone

The following section details the Direct Impact Zone of the Project and potential Project affected persons.

The social receptors that would be directly impacted by the proposed Project have been identified as Itezhi-Tezhi town, the commercial agriculture and livestock farms and

[50] Consumptive tourism involves the removal of tangible products or materials from the environment, such as artefact collecting, hunting and fishing; also known as extractive tourism. Non-consumptive tourism involves visitor experiences, such as bird watching, whale watching and wildlife safari; also known as non-extractive tourism.

the residential lodges. Downstream from the dam towards the Namwala Pontoon, the Kafue River passes through the Kafue Flats. The wetland ecosystem and its regular flooding regime supports a large fishing based livelihoods and livestock sector. Information for this area has been detailed given the importance of fishing to livelihoods and the potential impacts on the downstream stakeholders.

These receptors are shown in **Figure 8-1**.

<u>Itezhi-Tezhi Town</u>

Itezhi-Tezhi shares borders with other districts, namely: Mumbwa in the north, Kaoma in the west, Kazungula and Kalomo in south-west, Choma in the south, Namwala in the south-east and Mazabuka in the east. Itezhi-Tezhi district has a total surface area of about 13000 km^2.

Itezhi-Tezhi District was created through Statutory Instrument No.127 (September 1997). The population of Itezhi-Tezhi is 64,593 with an annual growth rate of 4% (Central Statistical Office 2010). There are 12,777 households and approximately 13,000 men, 15,000 women and 36,435 children. Ethnic groups include the Ila, Nkoya, Mbunda, Lozis, Bemba, Luvale, Soli, and Tonga with the majority of the population being Christian. The past 5 years has witnessed an increased in-migration of the Tonga from Southern Province towns of Kalomo, Kazungula, Choma and Monze in search of farming land.

For livelihoods, 60% of the town's population are engaged in farming, 10% in fishing, and 20% as traders. Formal employment includes teaching, health workers, church workers, government employees and private company employees. Livestock in the district is primarily cattle (over 90,000) and also goats, pigs and chickens.

There is 1 high school and 191 permanent class rooms. A new boarding high school is under construction. There are 7,331 pupils in grades 1- 7, 805 pupils in grades 8-9 and 484 pupils in grades 10-12.

There are 13 health centres and 1 district hospital, and referrals are made to the University Teaching Hospital in Lusaka. Itezhi-Tezhi has 2 permanent markets with over 300 stalls. Bigger items are found in Lusaka. Public transport is operated by approximately 5 taxis and 2 mini buses, operating locally on a daily basis between Uphill Township (Kataba) and Downhill (Masemu). The cost to go to Lusaka is ZMK 60,000. A number of residents also own personal vehicles, motorbikes and bicycles. The lodges operate boats that are used for fishing and river cruises.

The district has approximately 200 hand pumps and 100 communal and unprotected wells.

The town is connected to the national power grid through Choma and Namwala towns. Currently only about 30% of houses have electricity. Other fuel supplies include charcoal, wood and cow dung. About 35% of the town population is served by piped water that is a utility provided by ZESCO. Surface water is pumped from the Itezhi-Tezhi dam (upstream of the powerhouse site) and treated and stored at a ZESCO water treatment facility. The rest get potable water from the dam, river and shallow wells. Sanitation and waste disposal is through toilets, open pits and the river. There are designated disposal sites.

Within Itezhi-Tezhi Town houses are predominantly bungalows built in the 1970s as part of ZESCO housing units, during the construction of the Itezhi-Tezhi dam. There are a variety of house types, some of which are constructed of concrete blocks with corrugated iron sheets.

Itezhi-Tezhi has a police station to maintain law and order in the district, a fuel filling station that is owned by ZESCO, and a bank. A community radio station, ITT FM, also broadcasts from the town. The station was established in 2008 with financial support from the Danish International Development Agency.

Institutions and associations in the district are detailed in **Table 8-15**:

Table 8-15 – Institutions and associations in Itezhi-Tezhi

TYPE	NAME	NUMBER
District council	District Development Coordination Committee (DDCC)	1
District council	Community Resource Boards (CRBs) in all the 6 chiefdoms	6
District council	Area Development Committee (ADC) in all the 13 Wards	13
District council	District Women Association	1
Cooperatives	-	213
Associations	Village Action Groups (VAGs)	12
Association	ITT Fishermen Association	1
Local NGO	Catholic Relief Services Aids Relief, Foundation for a Democratic Process (FODEP)	1
Local CBO	Youth Coordinating Committee	1

<u>Commercial Agricultural and Livestock Farms</u>

There are three farms within the Direct Impact Zone:

- Melissa Farm;
- Choonga Farm; and
- Khuta Farm Enterprises.

Melissa Farm is the largest farm enterprise near the Project site and was surveyed as part of this socio-economic impact assessment in June-August 2012. Semi-structured interviews were held with owners of Choonga and Khuta Farm Enterprises.

<u>Melissa Farm</u> is located approximately 1.5km north of the power house site. The 99 hectare farm was part of large landholding originally belonging to ZESCO: however the land was surrendered to Itezhi-Tezhi Council, which subdivided it into two farms - Melissa Farm and Chonga Farm. The farm is a mixed enterprise growing crops and rearing livestock. Currently numbers of livestock include 362 beef cattle, 376 goats, 98 sheep, 3000 chicken broilers, 204 Chicken layers, 27 turkeys and 105 rabbits. Vegetables cultivated include cabbages, lettuce, carrots, baby marrows, eggplants, potatoes and rape. Spices cultivated include celery, parsley and coriander. A variety of fruit is cultivated and includes, among others, banana plantations, lime (205 trees) and orange (105 trees) orchards, and mangoes and guava trees. Most of the farm produce is sold in Lusaka. Some vegetables are supplied to Melissa Supermarket in Itezhi-Tezhi and the New Kalala Lodge. The farm employs 28 full-time employees, and during maize growing season 250 seasonal workers may be employed. Water is

pumped from the Kafue River for irrigation of crops and livestock, and for drinking water of employees.

Choonga Farm is located approximately 1.4km north of the power house site. There are mature mango, lemon and avocado trees on the on the farm, however there are no farming activities on the property, and there are no inhabitants. The structures, which include one bungalow, a house, caretaker's house, pigpens and workers' toilets, are in a state of disrepair.

Khuta Farm Enterprises is located approximately 1.8km east of the Project site. The Farm grows maize, tomatoes, cabbages, bananas and oranges. Blasting is heard from the Project site but no vibrations or 'ground–shaking' is experienced or felt.

Commercial Residential Lodges

There are three lodges within the primary impact area:

- New Kalala Lodge;
- Musungwa Lodge and Compound; and
- Chibala Camp.

New Kalala and Musungwa lodge and compound were surveyed during June – August 2012 for this socio-economic impact assessment.

New Kalala Lodge is located approximately 1.5km south west from the power house site. The Zambia Tourist Board constructed the lodge in 1978. It offers 13 chalets and game viewing drives, boat cruises, and fishing trips on Itezhi-Tezhi Lake and the Kafue River. Average room occupancy rates stand at 25%. This increases to 55% during peak season from July-December. Most of the vegetables consumed at the Lodge are sourced from the Melissa Farm. The poor road network in Itezhi-Tezhi is a hindrance for tourists to access the Lodge.

Musungwa Safari Lodge is located approximately 2.2km southwest of the powerhouse site. The lodge was constructed in 1976 and offers 24 rooms. During high season the lodge has an average of 20 clients per week; this drops to an average of 10 clients per week during low season. The Lodge offers game drives in the Kafue National Park, boat cruises and fishing. It currently employs 16 people who live in the associated Musungwa Lodge Compound. The Lodge supports the Musungwa Community School which is also located in compound.

Musungwa Lodge Compound is located approximately 1.9km south of the powerhouse site. It was established in 1987 as part of the Musungwa Lodge complex. The compound has 42 households with a population of 140 people. It has mixed ethnic groups such as Ila, Luvale, Chewa, Chokwe, Bemba, Tonga, and Ngoni. The settlement has no running water. Potable water is obtained from Musungwa Lodge approximately 500 metres away. Residents use pit latrines for sanitation. Many of the housing structures are in a dilapidated state, having very large cracks (**Figure 8-6**). There are two buildings, which are currently being used as school facilities (**Figure 8-7**). There are 25 pupils enrolled in Grade 1, and 8 in Grade 2. These attended two class sessions, one running from 07.15-11.00 for Grade 2; and another 11.15-15.00 for Grade 1. Pupils pay K15,000 as Parent Teachers Association (PTA) contributions to the School. The Government has recently employed the class teacher when the Community School was converted into a government school. The nursery school class runs from 08.00-11.00 every day. There are 11 children attending nursery school. Pupils in nursery pay K5,000/month. The teacher is paid a salary from the fees. There are no desks or learning materials at these school facilities. The class teachers have to improvise with the little learning resources they have. There are no ablution facilities for the children attending school. In the compound, there are 2 people employed as

teachers, 1 Church worker, 1 health worker, 8 employees of the Zambia Wildlife Authority, and others in the hospitality industry at New Kalala Lodge (4), Musungwa Lodge (16) and Chibala Camp Lodge (1). One person is employed at ITPC.

Chibala Camp is located adjacent to New Kalala Lodge and is owned by the Wildlife and Environmental Conservation Society of Zambia. The camp provides accommodation to research staff and tourists.

Figure 8-6 – Common house type within Musungwa Compound

Figure 8-7 – Classroom within Musungwa Lodge

8.4.4 Direct Impact Zone – Downstream Fisheries on Kafue River

Fisheries on Kafue River

20 fishing communities were identified along the length of the Kafue River up to Namwala Pontoon during the June-August 2012 data collection period. Some of these are small in size, comprising a few households and largely temporary in nature, and others relatively larger in size with a population of a few hundred people at a time and semi-permanent in nature. Fishing camps are abandoned between November and March when the water level is high and the camps are submerged, which also coincides with the Fisheries Department's fishing ban. The fishery sector is artisanal and seasonal; people from surrounding villages migrate into the region during the fishing season.

The CSO and DoF report of 2006 estimates that fisheries support over 1,262 fishermen harvesting over 7,000 tonnes of fish annually. The most important fish species of the area are Kafue Bream or mpende (*Orechromis andersonii* and different tilapia), "bubble fish" or barbel (such as the *mbuli* (*Clarias gariepinus*), and, especially in the tributaries, the small cisekele (Striped Robber, *Alestes lateralis*). The spawning and mobility pattern of these fish is linked to the flooding pattern of the river. In recent years a decrease in fish catches has been reported and is likely to be due to a combination of change in flood regime, and loss of habitats, increase in number of fishermen and over fishing, and unsound fishing techniques such as mosquito nets (Chabwela, 1986; Knight Pielsod, 2002; Muyanga and Chipungu, 1978).

The fish ecology of the Kafue Flats is strongly related to the flooding regime and the nature of the landscape. As the Kafue River meanders through the Kafue Flats, it creates ox-bow lakes, lagoons and swampy areas. During the rainy season the Kafue Flats are flooded, causing the river to join with lagoons and ox-bow lakes. During this time fish move out of the main river channel and into lagoons and oxbows for breeding and food. When water recedes, they migrate back into the river, however many continue to live in the ox-bow lakes, lagoon and ponds even after the water has receded and remain there until the next flooding event.

Table 8-16 below details demographic data collected during the June-August 2012 surveys of fishing camps along the Kafue River downstream of the powerhouse site. Full details from the primary data collection during this period are included in **Appendix I**.

Table 8-16 – Downstream Fishing Camps on Kafue River, from Itezhi-Tezhi Dam to Namwala Pontoon

NAME OF FISHING CAMP	TOTAL POP.	HOUSES	NATURE (TEMPORARY/ PERMANENT)	LIVELIHOODS
Nakemba	3	1	Temp	Diversified
Nawhi	2	1	Temp	Fishing
Kabeshabesha	1	1	Perm	Fishing
Kalala	30	5	Temp	Diversified
Namibale	30	9	Temp	Diversified
Mang'ongo	67	25	Temp	Fishing

NAME OF FISHING CAMP	TOTAL POP.	HOUSES	NATURE (TEMPORARY/ PERMANENT)	LIVELIHOODS
Chisenga		10	Temp	Diversified
Green	15		Temp	Fishing
Namacheka	120-150	20	Perm	Fishing
Salama	15	6	Temp	Fishing
Chanza	15		Temp	Fishing
Nuungu	80	20	Temp	Diversified
Lutongo	25	8	Perm	Fishing
Chilala	3	Unknown	Temp	Fishing
Zambwa	47	21	Unknown	Fishing
Kakuzu	200 at peak	13	Semi-Perm	Diversified
Kanyona	21	6	Unknown	Fishing
Shimwandu	8		Unknown	Fishing
Nakalongwe	18	4	Temp	Diversified
Chikoto	4		Temp	Fishing

The predominant ethnic distribution along the Kafue River is given in **Figure 8-8**. The camps surveyed demonstrated diversity in ethnic composition, and the social dynamics of these camps are largely influenced by this ethnic composition.

Fishing is almost entirely a male occupation; 100% of men in the camps are engaged in fishing. While women do carry out some fishing along river banks they are mainly engaged in related activities such as trading and processing.

The poorest and most marginalised rely to a large extent on fisheries-related activities such as processing and trading as a safety net to sustain their livelihoods and improve their food and nutrition security.

Fisheries have come under increasing pressures due to in-migration from the neighbouring areas. Fisheries in Kafue Flats attract a large number of in-migrants - fishermen, traders and transporters, some staying permanently and some migrating onwards or seasonally. The Ila tribe is native to the region and traditionally focuses on animal husbandry, while fishing and small scale farming is generally undertaken for subsistence. The predominant type of fishing in Kafue is artisanal and primarily single person operated or sometimes practiced in groups of 2-3 with profits shared in-between.

Figure 8-8 – Map showing the distribution of ethnic tribes along the Kafue Flats[51]

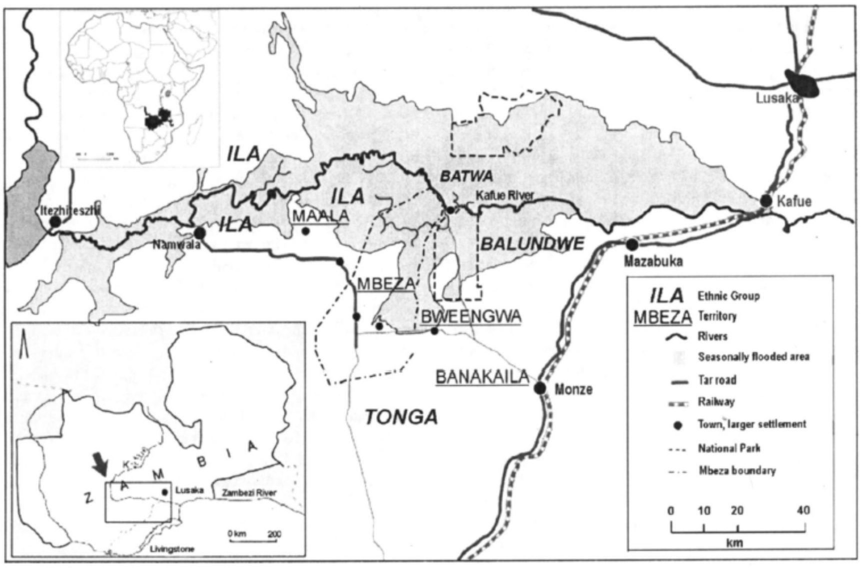


Fig. 1 The Kafue Flats and local ethnic groups (by C. Furrer based on map of S. Merten)

The fisheries in the Kafue Flats floodplains serve the neighbouring markets including Lusaka and are an important source of livelihood for people in the region. All households (100%) are engaged in fishing as a primary source of income.

During the November to March fishing season, fresh fish is sold to traders who come from Lusaka and the Copperbelt at ZMK 10,000/kg. Processed and salted fish, which fetches more than the fresh fish is transported by fishermen and sold at Kasumbalesa, border post on Copperbelt. Households that fish have the capacity to earn on average ZMK 400,000 to 1,000,000 a month from fishing, and fish are commonly sold in Lusaka, Mumbwa and the Copperbelt towns. Fishing gear comprises dugout canoes (**Figure 8-9**) and gill nets ranging from 2" to 4" mesh size. Fishermen buy fishing permits at ZMK 100,000 to fish for a 9-month period in designated areas.

Other livelihoods for fisheries include subsistence farming of maize, beans, groundnuts, between November and March. Cropping land is typically up to 5 ha. Maize is sold (15-300 bags) to the Food Reserve Agency for ZMK 65,000 per bag during the farming season. Land ownership is primarily customary ownership. From January to March there is flooding and inhabitants move to Lubanda for these months. The government provides food relief when there are severe floods.

[51] Source: Hallet,T and Merten, S (2008), "We Are Zambians—Don't Tell Us How to Fish!" Institutional Change, Power Relations and Conflicts in the Kafue Flats Fisheries in Zambia, in Human Ecology, Vol. 36, No. 5 (Oct., 2008), pp. 699-715

Figure 8-9 – Small scale fishing using dugout canoes

None of the camps surveyed had electricity. The main sources of cooking fuel included charcoal, wood and cow dung. Waste is disposed of in pits and there was limited sanitary infrastructure. There were no school or health facilities in any of the surveyed camps and residents are required to travel up to 7km away to access these facilities. Houses are constructed of grass materials (**Figure 8-10**). Water for drinking, cooking and washing is drawn from the Kafue River.

Figure 8-10 – Common house type within fishing camps

The most common health issues within the fishing camps reported by fishermen and their families included malaria and diarrhea. Hippopotamus attacks are also a serious safety concern, particularly when fishing is carried out in dugout canoes in open water.

8.4.5 Non-Governmental Organizations/Community-Based Organizations

<u>The Shelter Zambia Trust Fund (SZTF)</u>

This is a non-governmental organisation that has been working in the housing sector in Itezhi-Tezhi since 2009. The core business of the organisation is addressing housing supply needs in the community, especially amongst the low and mid-income households, through house construction.

SZTF is a local organization, which does not receive international funding, but raises its funds for construction of housing through loan financing from financial institutions. The organisation cites poor water reticulation and lack of affordable housing for low and middle incomes households as some of the challenges facing the district.

<u>Wildlife and Environmental Conservation Society of Zambia (WECSZ)</u>

This organisation, which was founded in 1953, is a charitable membership based non-governmental organization dedicated to environmental conservation. Its head office is located in Lusaka. It works in the environmental conservation sector. It also operates four Wildlife Camps in Zambia. It currently has no office in Itezhi-Tezhi but operates the Chibiya Wildlife Camp and has plans to open a resource centre in the town.

The Society participates in wildlife conservation and runs an Environmental Education Programme through the production of materials such as the Chongololo and Chipembele Environmental Magazines for school Conservation Clubs. In the Itezhi-Tezhi District WESCZ is involved through the Community Resource Boards in environmental education and awareness programme in 19 schools in the Kafue National Park area as well as the Elephant Orphanage at Ngoma.

WESCZ as part of its outreach programme is willing to engage with the community on environmental and social sector issues in relation to the Project.

<u>World Wide Fund for Nature (WWF)</u>

WWF has been working in the area through the Partners for Wetlands Project covering the Kafue Flats since 2001. Other WWF projects include the Wetlands and E-flows projects. The government of the Republic of Zambia, with the then Ministry of Energy and Water Development (MEWD), ZESCO, and WWF, had been working towards changing the operation rules of Itezhi-Tezhi and Kafue Gorge dams, to mimic as much as possible the natural flooding pattern of the Kafue River without affecting the water needed for electricity generation. This was in recognition of the fact that the dam distorted the natural flooding pattern in the Kafue Flats, disturbing breeding and feeding habits, cattle herding patterns, and indeed the livelihood activities of people living in the Kafue Flats. The partnership produced an Integrated Water Resources Management (IWRM) strategy and the implementation of a new water management system for the Kafue Flats.

WWF also has a Community-Based Natural Resource Management (CBRM) in Itezhi-Tezhi. It has been working with CRBs in, Kaingu and Shimbhizi on bee keeping and fish farming livelihood projects.

<u>Community Resource Boards (CRBs)</u>

The Zambia Wildlife Act of 1998 that makes specific provisions for the participation of local communities in wildlife management through local institutional structures known

as Community Resources Boards (CRBs). There are currently 35 Game Management Areas (GMAs) in Zambia. These GMAs were set aside primarily to serve as buffer zones around the National Parks. In Itezhi-Tezhi district there are two GMAs, namely the Namwala Game Management Area and Nkala Game Management Area.

There are 6 CRBs in Itezhi-Tezhi District, each found in their respective chiefdoms. These are Chilyabufu, Kaingu, Musungwa, Muwezwa Shezongo and Shimbizhi. There are 2 CRBs in the project area, namely Musungwa and Shimbizhi

8.4.6 Project Perceptions and Development Priorities

Community Level Project Perceptions

Community perceptions, concerns and attitudes towards the Project were gathered during focus group discussions carried out in June-July 2012.

The community perceives the Project as offering an opportunity for enhanced infrastructure development, improvement in trade and commerce, and social amenities. Most importantly it is anticipated that the Project will:

- Create employment;
- Provide increased capacity for power generation and reduce electricity power outages through load shedding in the town;
- Attract local tourism and contribute to improvement in the tourism sector in the district;
- Lead to improved infrastructure due to increased demand for existing services; and
- Provide an opportunity for the reconstruction of the D769 Itezhi-Tezhi - Mumbwa road.

However, the community perceives the negative effects of the Project to be due to an influx of employment migrants to the town resulting in:

- Induced greater demands on social infrastructure such as housing;
- Potential for increased social problems such as crime;
- Influx of workers from outside communities bringing the risk of spreading communicable diseases such as sexually transmitted infections (STIs); and
- Potential for growth of unplanned settlements.

These perceptions are summarised in **Table 8-17**.

Table 8-17 – Stakeholder Perceptions of the Project

STAKE-HOLDER CATEGORY	STAKEHOLDER	STAKEHOLDER NAME	KEY ISSUSES AND CONCERNS
Local government	Department of Fisheries Offices, Itezhi-Tezhi	Mr. Remmy LIshebo Mr. Victor Bwalinde	Key concerns: potential impact on livelihoods and fishing.
Local government	Itezhi-tezhi District Commissioners Office	Mr. Roy Nang'a'elwa	Fishing and agricultural sectors are important economic activities in the district. The ITPC Project is a welcome development in the district. It is anticipated that the Project will: e) Create employment f) Provide increased capacity for power

STAKE-HOLDER CATEGORY	STAKEHOLDER	STAKEHOLDER NAME	KEY ISSUSES AND CONCERNS
			generation and reduce electricity power outages through load shedding in the town g) Attract local tourism and contribute to improvement in the tourism sector in the district h) Lead to improved infrastructure due to increased demand on existing services However, there are anticipated negative effects of Project induced migration to the town. This will increase demands on existing infrastructure. Key concerns: potential impacts on water users, employment opportunities, livelihoods, in-migration, and infrastructure.
Local government	Itezhi-tezhi Council Offices	Hastings Chinyundu – District AIDS Coordination Advisor	Considers high poverty levels and unemployment as the most important problems facing the district. The influx of in-migrants to the district in search of employment is likely to increase HIV/AIDS and crime. The organisation is willing to engage with the community in HIV/AIDS issues in relation to the Project. Key concern: potential impact on rate of infection of HIV/AIDs.
Local government	Itezhi-tezhi Council Offices	Mr. Gaphine Walubita – District Planning Officer	Key concerns: potential impact on employment, infrastructure, livelihoods, health, and waste management.
Local government	Itezhi-tezhi, Department of Livestock Services	Shepard Phiri – Veterinary Assistant	Key concern: potential impacts on livelihoods, such as animal husbandry.
Local government	Department of Agriculture Offices	Ms. Petronella Lubasi – Senior Agricultural Officer	Key concerns: potential impact on livelihoods and agriculture from construction/operation and Project induced migration.
Local government	District Education Board Secretary’s office	Mr. John Moose, District Education Board Secretary	Key concern is education.
Local government	Council Secretary	Mr. Cheembo Mang’watu	It is expected that the ITPC Project will increase demands for water supply and sewerage facilities. Currently only about 30% of houses have electricity. The ITPC is a positive development in the district. It is expected to create employment which will contribute to increased personal levy payable to the council; the Project will increase prospects of more houses being built which will increase rateable property; the development will also enhance Itezhi-Tezhi’s

STAKE-HOLDER CATEGORY	STAKEHOLDER	STAKEHOLDER NAME	KEY ISSUSES AND CONCERNS
			status. The increased power generated is also expected to reduce the load shedding and will attract more industries to come to Itezhi-Tezhi. Key concerns: in-migration and competition for resources, employment, land, infrastructure, livelihoods, health, water and waste.
Local government	Itezhi-Tezhi Ward Area Development Committee (ADC)	Ms Getrude Sosopi	Although Ms Sosopi was not aware of all the details of the ITPC Project she expects the Project will benefit the community by providing electricity to their houses. She also expects more local people in the community to be employed, especially in unskilled jobs. Key concerns: employment, land, infrastructure, livelihoods, water and health and safety.
National government	Ngoma Zambia Wildlife Authority Headquarters Office	Mr. Kennedy Mweetwa –Park Ranger	Key concerns: potential impact on flora and fauna.
Local leader	Chief Musungwa	Chief Musungwa	Chief Musungwa noted that the ITPC Project is expected to create local employment and solve the problem of power outages in the district. He also expected the Project to give back to the community through its corporate social responsibility programme. Key concerns: employment, land, livelihoods, and cultural heritage.
NGO	Wildlife and Environmental Conservation Society of Zambia	Patrick Shawa National Coordinator	Key concerns: potential impact on flora and fauna, and wildlife conservation.
NGO	Shelter Zambia Trust Fund	Alfred Kalipa Project Liaison Officer Mukela Simunji – Community Liaison Officer	It believes that the Project will positively affect the provision of shelter in the district as more people are employed by the Project, and it will result in increased demand for more housing. Key concern: potential impact on existing infrastructure.
Fishermen	Nuungu Fishing Camp		Blasting from the ITPC Project site can be heard in the fishing camp. There have been low catches because of high waters, which drives the fish into the reeds. Key concerns: fishing, livelihoods, health, noise/vibration and water.
Fishermen	Namacheka Fishing Camp		Namacheka fishing camp is a temporary fishing camp, which is abandoned when the Kafue River overflows its banks. The camp is abandoned between November and March when the water level is high and the camp is submerged. This period also coincides with

STAKE-HOLDER CATEGORY	STAKEHOLDER	STAKEHOLDER NAME	KEY ISSUSES AND CONCERNS
			the Fishery Department's fish ban. Key concern: water, livelihood, fishing.
Fishermen	Mang'ongo Fishing Camp		Mang'ongo fishing camp is temporary camp occupied by fishermen and their families during the fishing season which runs from April to November. Key concern: water, livelihood, fishing.
Local business	New Kalala Lodge	Mr. Michael Mpundu – Manager – New Kalala Lodge	During the construction phase clients are affected by noise from blasting from the Project site. Key concern: potential impact on existing infrastructure and livelihoods.
Local business	Musungwa Safari Lodge	Mr. Luke Chirwa – Manager	ITPC Project is a welcome development in the area. It will improve electricity and reduce power outages. The Project has also employed young people from area, which has reduced petty crime, which was being experienced at the Lodge. Although the blasting noise can be heard from the Project site, there have been no effects from blasting. Key concerns: potential impact on existing infrastructure and livelihoods.
Local business	Musungwa Lodge Compound (business and settlement)	Community representatives: Frevios Mphanza – Chairman Mr. Charles Mabuwa – Musungwa Lodge Chairman Ms. Beatrice Pumulo – Class Teacher Mrs. Mercy Muyumba – Nursery Class Teacher Mrs. Precious Mabuwa	Key concerns: potential impact of noise/vibration and construction in progress and employment opportunities.
Local business	Melissa Farm	Mr. Victor Lungu – Manager Melissa Farm	Most of the farm produce is sold in Lusaka. Some vegetables are supplied to Melissa Supermarket in Itezhi-Tezhi and the New Kalala Lodge. The water used at the farm is abstracted from the Kafue River using two 7.5Hp pumps. Key concerns: potential impacts of noise/vibration, the construction in progress and on livelihoods.

The key development issues identified from the survey are:

- Poor water reticulation infrastructure in the district affecting a large proportion of the population;
- Poor road infrastructure (including the D769 Itezhi-Tezhi-Mumbwa Road);
- Low/inadequate housing stock for government workers;

- Inadequate social service infrastructure such as schools and health facilities; and
- Lack of qualified staff/manpower in government.

8.5 Assessing Socio-economic Impacts

This section details the socio-economic impacts that have been identified for this Project. These are potential socio-economic impacts that may result from Project activities. Using the Social Risk Impact Assessment methodology outlined above (**Section 8.1**) the identified potential socio-economic impacts of the Project were assessed to determine their risk rating.

The key impacts identified are:

- High community expectations;
- Construction-related employment tapering down in the operation phase;
- Community disturbance to health and well-being;
- Community disturbance due to increased noise, dust, vibration, light pollution and traffic; and
- Impact on livelihoods from reduced quality of water discharged from the dam.

These impacts are identified as being relevant for both construction and operation phases. .

8.5.1 Impact of High Community Expectations

Impact Description

High unemployment in the Project area along with the publicity of the Project (both by the developers and the government) creates high expectations from the local community (as well as nationally) that the Project will bring employment, opportunity and regeneration to the area. The relatively long Project lifecycle, from development and initial assessment through to approval and then construction, heightens community anticipation of the positive socio-economic benefits that Project may bring, including compensation. Raised community expectations can impact the Project negatively when those expectations are not met and can lead to frustration and resentment, particularly around hiring of local workers.

Based on consultation and focus group discussions, community expectations are considered to be highest on:

- Employment generation; and
- Improved infrastructure.

<u>Construction Phase</u>

The risk of high community expectations is considered to be relevant in the construction phase. During construction, community expectations are high in terms of local employment and the associated benefits. In addition, anticipated in-migration into the area is likely to further heighten local residents' expectations that the Project will primarily recruit from the local population.

Focus group discussions carried out in June-July 2012 found that local communities expected the Project to bring the following positive benefits:

- Creation of employment opportunities;
- Provision of increased capacity for power generation and reduction in electricity power outages through load shedding in the town;
- Attraction of local tourism and contribution to improvement in the district's tourism sector;
- Improved infrastructure due to increased demand for existing services for Project-related activities; and
- Opportunity for the reconstruction of the D769 Itezhi-Tezhi - Mumbwa road.

This shows that the communities' expectations are generally in-line with the proposed Project benefits.

During construction the *sensitivity* of social receptors is high. The Project has already begun construction without a Stakeholder Engagement Plan or significant engagement with the local community.

Impact *significance* is moderate, because high community expectations on employment and improved infrastructure may affect a wide range of receptors but will not significantly alter an individual's way of life.

Overall, the *social impact risk* of high community expectations over the Project in construction is assessed to be medium, prior to any mitigation.

<u>Operation Phase</u>

During the operation phase, high community expectations are expected to remain, with local communities continuing to anticipate increased development and investment in the area, and the on-going benefits of employment.

During operation the *sensitivity* of social receptors is medium. At this stage, the Project benefits should be meeting community expectations. Further, as indicated above, community expectations are currently in-line with proposed Project benefits.

Impact *significance* is minor, because community expectations during operation phase will not significantly impact on an individual's standard of living or way of life.

Overall, the *social impact risk* of high community expectations over the Project in operation is assessed to be low, prior to any mitigation.

Table 8-18 outlines the potential impact of high community expectations for construction and operation phases, and identifies the corresponding social impact risk.

Table 8-18 – Potential social impact risk of high community expectations

IMPACT	SUMMARY OF IMPACT	STAGE OF WORK	SENSITIVITY	IMPACT SIGNIFICANCE	LIKELIHOOD	SOCIAL IMPACT RISK
Increased community expectations	Project unable to meet community	Construction	High	Moderate	Possible	Medium

	expectations for employment, indirect economic benefits and improved infrastructure	Operation	Medium	Minor	Possible	Low

Mitigation Measures

The following mitigation measures are recommended to be applied to mitigate the identified impact:

- Stakeholder Engagement Plan: information disclosure and stakeholder engagement to inform local communities on the Project and manage expectations. Also, focused on transparent implementation of local employment and procurement policies to reduce any community dissatisfaction on preferential treatment/exclusion.
- Local Benefit Plan or Worker Management Plan: a comprehensive Local Benefit Plan will take advantage of creation of job opportunities (largely unskilled and semi-skilled) in construction and operation phases for local labour.
- HR should ensure all sub-contractors adopt Local Benefit Plans Or Worker Management Plan and adequate employment policies.
- Strategic Community Investment Plans: Encourage investment and development in the area.

Residual Impacts

With implementation of the above mitigation and enhancement measures, it is anticipated that impacts associated with high community expectations will be low during the construction phase and very low during the operational phase.

8.5.2 Impact of construction-related employment tapering down in the operation phase

Impact Description

The Project will create direct employment: up to 500 positions during construction and 47 full-time employees during operation. ITPC is committed to sourcing employees from the local Itezhi Tezhi community; however, the majority of local employment opportunities for local community will be mostly limited to unskilled and semi-skilled workers.

The tapering down of employment numbers from 500 to 47 in the operation phase will result in a large pool of employees in Itezhi Tezhi without jobs. This will have ‘knock-on’ effects on the local community in terms of unemployment.

<u>Operation Phase</u>

The construction period requires the greatest number of workers with employment levels rising to a peak of 500 during construction (**Section 3.7**). Of the 500 workers for construction, approximately 20 to 25 will be management and technical personnel, and 50 to 60 will be semiskilled workers, including but not limited to equipment operators, welders, carpenters, glazers, and electricians. The remaining workforce personnel will be unskilled and will be recruited from the local villages.

However, employment levels will fall to 47 full-time employees during the operation phase (**Section 3.7**). Due to the tapering down of employment in the operation phase a large pool of employees from the construction phase will now be without jobs. The large majority of the 500 workers is anticipated to be recruited in the local area, therefore, the tapering down of employment will have impacts on the local community in terms of unemployment and inflation of labour pool.

The *sensitivity* of social receptors to this impact is considered to be medium. There will be a pool of unemployed workers from construction phase during operation. The *significance* of the impact is assessed as moderate, because a large number of local workers will experience unemployment when the Project moves into operation phase.

Overall, the *social impact risk* of tapering-down of employment in operation phase is assessed to be high, prior to any mitigation.

Table 8-19 outlines the potential impact of local employment tapering-down in the operation phase, and identifies the corresponding social impact risk.

Table 8-19 – Potential social impact risk of local employment tapering-down in the operation phase

IMPACT	STAGE OF WORK	SUMMARY OF IMPACT	SENSITIVITY	IMPACT SIGNIFICANCE	LIKELIHOOD	SOCIAL IMPACT RISK
Construction-related employment tapering down in the operation phase	Operation	Large pool of employees now without jobs	Medium	Moderate	Likely	Low

Mitigation Measures

The following mitigation measures are recommended to be applied to mitigate the identified impact:

- Transparent communication on hiring and exit plan;
- Continuous disclosure of Project employment information; and
- ITPC hiring plan from construction to operation phases should be publicised at local and regional level.

Residual Impacts

With implementation of the above mitigation and enhancement measures, it is anticipated that impacts associated with local employment tapering-down for operation phase is a 'medium' risk.

8.5.3 Impacts of community disturbance to health and well-being

Impact Description

Community disturbance to health and well-being is considered to be as a result of:

- Project-induced migration resulting in rise in anti-social behaviour, increased infectious diseases and HIV/AIDs;
- Growth of unplanned settlements;

- Increased population pressure on community service provision and infrastructure; and
- Environmental disturbances to sensitive receptors resulting from construction and operational activities.

Impacts associated with environmental disturbances to sensitive receptors are discussed in **Sections 6** and **7**.

<u>Project-induced migration resulting in rise in anti-social behaviour, increased infectious diseases and HIV/AIDs</u>

An international Project can result in the economic migration of citizens from other neighbouring districts, nationally, and regionally, across borders. Past case studies of large-scale industry Projects in sub-Saharan Africa show that Project-induced migration can be significant[52], with impact on sensitive receptors and communities (that often have a low resilience to the changes brought by the arrival of economic migrants) can also be significant.

The Itezhi-Tezhi district has a population growth rate of 4.1% which is much higher than the average annual growth rate of 1.6%. This can be attributed to existing in-migration for economic and labour opportunities at the Itezhi-Tezhi and Kafue Gorge dams. In-migration into the area began in 1973 when the Itezhi-Tezhi dam was built. There has been considerable in-migration from neighbouring western, northern and southern districts, which is evident in the presence of Lozi, Soli, Bemba and Tonga, alongside the native Ila.

<u>Growth of unplanned settlements</u>

Project-induced migration results in population expansion and the growth of unplanned settlements. This can lead to conflicts over land access. The unplanned expansion of settlements without proper waste disposal impacts negatively on the community, local sanitation, and environmental health.

<u>Increased population pressure on community service provision and infrastructure</u>

The workforce will represent an expansion in the Itezhi Tezhi population. This additional labour workforce will place pressure on social service provision and infrastructure, in particular health facilities. A primarily young, male, single (or away from family) workforce can cause a rise in anti-social behaviour and increase in infectious diseases, such as HIV/AIDs. Most of the population has relatively poor access to health facilities. The district population is 64,593 and there is one hospital and ten rural health centres providing curative and preventive health care services.

Construction Phase

During the construction phase, there is likely to be a higher level of Project-induced in-migration to the area with the anticipation of finding work. The anticipation of employment and benefits will encourage in-migration into the local area. Project-induced migration is often primarily single men and young men without families. This can result in an increase in anti-social behaviour and infectious diseases, such as HIV/AIDs. There is also increased competition for scarce resources, such as health facilities, and increased strain on existing social service infrastructure. This can cause local community cohesion and well-being to be affected. This can further lead to conflict as has been witnessed in the area in 2010 due to in-migration.

[52] IFC (2009) Projects and People: A Handbook for Addressing Project-induced Migration

ITPC will source workers from the local population, where possible, and contractors will follow a similar recruitment policy. However, there will be some workers that will be from outside the local area, for example, Itezhi-Tezhi and other nearby populations, such as Lusaka and international staff for skilled labour.

In light of recent unrest, the *sensitivity* of primary and secondary impact zone receptors to economic migration is considered to be medium but with some resilience to change.

The *significance* of the impact is assessed as moderate, because Itezhi-Tezhi has a diverse range of ethnic groups and there has already been precedence of in-migration into the area, particularly in the last five years.

Overall, the *social impact risk* of community disturbance to health and well-being in construction phase is assessed to be high, prior to any mitigation.

Operation Phase

It is anticipated that economic in-migration will decrease or 'tail off' when the Project moves into operation phase. Itezhi-Tezhi town and the downstream Kafue Flats have been experiencing in-migration, attracting large numbers of economic migrants, e.g. fishermen, traders and transporters, who migrate onwards seasonally or stay permanently. Therefore, there is some resilience to change as local populations have experience of in-migration and are already ethnically diverse. However, this has lead to conflict and there were clashes between ethnic groups who had migrated into the area searching for farm land in 2010. There was conflict as in-migrants tried to settle in the Game Management Areas.

The *sensitivity* of social receptors is considered to be medium. The social receptors have some capacity and means to adapt to change and maintain quality of life.

The *significance* of the impact is assessed as moderate, because in-migration to Itezhi-Tezhi town means that the area is already populous and relatively urban; therefore, there is already some resilience of Itezhi-Tezhi residents to in-migration.

Overall, the *social impact risk* of community disturbance to health and well-being in operation phase is assessed to be medium, prior to any mitigation.

Table 8-20 outlines the potential impact of community disturbance to health and well-being in the construction and operation phase, and identifies the corresponding social impact risk.

Table 8-20 – Potential social impact risk of community disturbance to health and well-being

IMPACT	SUMMARY OF IMPACT	STAGE OF WORK	SENSITIVITY	IMPACT SIGNIFICANCE	LIKELIHOOD	SOCIAL IMPACT RISK
Community disturbance to health and well-being	Influx of workers could cause disturbance through anti-social behaviour, rise in infectious diseases and	Construction	Medium	Moderate	Likely	High

	HIV/AIDs Growth of unplanned settlements due to economic in-migration Increased population, pressure on community service provision and infrastructure	Operation	Medium	Moderate	Possible	Medium

Mitigation Measures

The following mitigation measures are recommended to be applied to mitigate the identified impact:

- Stakeholder Engagement and Local Benefit Plans outline ITPC policies on hiring local labour and should be publicised at the regional and national level to deter economic migrants;
- Develop an influx management plan;
- Community Health and Safety Plan;
- Implementation of an Employee Code of Conduct with a strict disciplinary procedure;
- HIV/AIDs prevention incorporated into HR policies; and
- Provision of health care facilities for workers, if needed.

Residual Impacts

With implementation of the above mitigation and enhancement measures, it is anticipated that impacts associated with community disturbance on health and well-being for construction phase is 'low' and for operation phase is 'very low'.

8.5.4 Impacts from Changes in Water Quality and Quantity

Impact Description

Most local residents and regional communities are dependent on the Kafue River, as a source for livelihoods and water supply. Project impacts on the water quality and local ecology can potentially create socio-economic impacts, particularly on livelihoods.

The Kafue River is one of the most important river systems in Zambia. The river forms an important fishery accounting for 11% of overall fish production for the country.

Communities living around the dam access water directly from the reservoir. Located downstream of the Itezhi-Tezhi Dam are the Kafue Flats. These wetlands that are the basis of livelihoods for small permanent and seasonal settlements within the river flood plain. They are important areas for traditional fisheries, cattle grazing and floodplain agriculture. In the dry season, cattle herds of up to 4,000 cattle rely on the floodplains. In the wet season, most communities and fishing villages migrate to permanent villages on the edges and outside the Kafue Flats.

Contamination of the water and a change in the productivity and ecology of the river and flood plain impacts upon sensitive receptors by affecting the health of populations that use the water for cooking and washing (direct consumption); and through the contamination of fish that are eaten (indirect consumption). A depletion of fish stocks and a change in the productivity of the river can impact a main source of livelihood - fishing.

<u>Construction Phase</u>

Potential impacts on water quality during the construction phase including sewage from the construction workforce, hazardous materials (e.g. oil) through spillages, and water run-off containing high levels of sediment and detrimental substances (e.g. concrete) (**Section 6.3**). The release of sewage into the environment and receiving water may be harmful to populations who are drinking the water and using it for cooking and washing.

During construction, it is anticipated that impacts on water quality are likely to be of short duration and in limited volumes.

As discussed in **Section 6.4**, any hydrological changes generated during the construction of the Project are likely to be on-site and in the immediate surrounding areas. As such, no impacts to water quantity for social receptors are considered likely during the construction of the Project.

<u>Operation Phase</u>

During the operation of the Project, impacts on water quality and quantity may be experienced in the downstream river environment. The downstream catchment areas and populations are considered to be highly sensitive receptors to any changes in water quality and quantity. Therefore, impacts during the operation phase are considered to carry a higher social impact risk than during the construction phase.

These impacts might include waste water from the accommodation camp, changes to flow regime, release of lake sediment downstream, and the release of deep lake water to the downstream environment. These impacts may result in altering the downstream river quality. Impacts on fish stocks may result from the release Cold and anoxic water.

The Central Statistics Office (CSO) (2006) estimates that fisheries in the Kafue Flats support over 1,262 fishermen and annually harvests over 7,000 tonnes of fish. Fishing is primarily carried out by men (100% of men at the camps along the Kafue River are engaged in fishing) with women engaged in the trading and processing of fish and other fishing-related activities. The poorest and most marginalised people rely on fisheries-related activities as a source of livelihood. All households (100%) in the Kafue Flats are engaged in fishing as a primary source of income. Furthermore, the over-exploitation of the Kafue Flats over the past 30 years (Chamwela, 2010) has increased the sensitivity of receptors.

As discussed in **Section 6.4**, ITPC will operate the power house in a manner that follows the existing discharge regime of the dam. Based on this, changes to water flow will be localised the immediate area surrounding the spillway and the tailrace, and are not likely to result in altered hydrology of further downstream of the Kafue River and Kafue Flats (**Section 6.4**).

Table 8-21 outlines the potential impact of changes in water quality and quantity and identifies the corresponding risk ratings. The potential social impact risk of changes in water quality from the Project during construction is considered to be medium. The potential social impact risk of changes in water quality from the Project during operation is considered to be high.

Table 8-21 – Potential social impact risk of changes in water quality and quantity

IMPACT	SUMMARY OF IMPACT	STAGE OF WORK	SENSITIVITY	IMPACT SIGNIFICANCE	LIKELIHOOD	SOCIAL IMPACT RISK
Reduced quality of water discharged	Change (reduction) in quality of water discharged from the dam Impacts to direct use of waterways by water users, and aquatic and riparian eco-systems Impact on fishing communities downstream Impact on fish stocks Impact on downstream farming enterprises	Construction and Operation	Medium	Major	Possible	High
Reduced Water Quantity	Change in the timing and quantity of water discharged from the dam resulting in altered hydrological regime Impacts to direct users of waterways by water users, and aquatic and riparian eco-systems Impact on fishing communities downstream Impact on fish stocks Impact on downstream farming enterprises	Operation	Medium	Moderate	Unlikely	Low

Mitigation Measures

The following mitigation measures are recommended to be applied to mitigate the identified impact:

- Carry out mitigation measures detailed in Section 6.3 and 6.4 In the event that water quality monitoring suggests any risk to the livelihood of the community who is dependent on water, the results will be disclosed through the implementation of SEP to the community or stakeholders who are primarily dependent on water as a livelihood source.

Residual Impacts

With implementation of the above mitigation measures, it is anticipated that impacts associated with changes in Water Quality during construction and operation is considered to be a 'Medium' project risk.

8.6 Positive Impacts of the Project

The main impact of the Project is to develop an additional energy supply to meet growing demand. The Project will supply an additional 1.05 billion kW-hrs per year, provide a valuable baseload energy supply, lower costs of load shedding and reduce reliance on electricity from neighbouring countries. Development of energy will encourage and contribute to the development of Itezhi-Tezhi District and the western provinces of Zambia. In addition to an improved power supply, the Project will bring benefits in:

- Employment opportunities for local communities during construction and operation;
- Provision of a reliable source of power and potable water for Itezhi-Tezhi residents;

The expansion of the population in Itezhi-Tezhi, particularly during the construction phase, is also anticipated to provide an increased market and demand for local goods and services. This will bring benefits in the form of indirect employment for local traders and businesses.

8.6.1 Impact on Local Employment and the Local Economy

Impact Description

The positive impact of direct and indirect employment on local employment and the local economy is a key positive impact of the Project. Employment is regarded as a key socio-economic benefit of the Project by community residents consulted in focus groups discussions. Employment will raise household incomes and in turn result in an expanded market for local goods and services.

Construction Phase

The construction period of the Project is set to last until 2015 and will generate direct employment for up to approximately 500 personnel. Of these, approximately 20 to 25 will be management and technical personnel, and 50 to 60 will be semi-skilled workers, including but not limited to equipment operators, welders, carpenters, glazers, and electricians. The remaining workforce personnel will be unskilled and will be recruited from the local villages.

Those that benefit from direct employment will also provide benefit for their household, increasing standard of living. This may also translate into investments in education and health and improve future employability with new skills and abilities; however, it is not possible to accurately estimate this.

The *sensitivity* of the local receptors is considered to be medium, as social receptors have some capacity and means to adapt to change and maintain/improve quality of life.

The *significance* of the impact is assessed as minor, as there are a high number of jobs from the 500 required likely to be available to local people during construction.

Overall, the *social impact* on local employment and local economy during construction phase is assessed to be medium, prior to any mitigation.

Operation Phase

The proposed Project has an operational period of at least 25 years during which it will generate direct employment for up to approximately 47 personnel. ITPC commits to sourcing employees from local communities as far as possible where appropriate skills are available; however, unlike the construction phase the majority of positions are likely to be for skilled, technical and managerial staff, and so employment opportunities in local communalities will mostly be limited to a smaller number of semi and unskilled positions (drivers, cleaners, security staff, and secretarial-maybe up to around 20 persons in total).

Those who do secure permanent jobs with ITPC will benefit from long-term income generation for their household, resulting in an increased quality of life with a greater ability to invest in health and recreation. The provision of permanent jobs may also have small indirect benefits to the local economy where the permanent staff will use the goods, services and supply from local markets. However, it is not possible to estimate the extent of that benefit.

There is quite a high unemployment ratio in Iteshi-Teshi town and surrounding area and at most 20 or so persons (semi-skilled or unskilled) are likely to have the right skills profile for permanent positions with ITPC. Any opportunity will be considered long-term and beneficial considering the duration and nature of employment in mind.

The *sensitivity* of the local receptor is considered medium, considering the number of unskilled jobs is limited during the operational phase.

The *significance* of the impact is assessed as minor, due to the low number of jobs likely to be available to local people during operation.

Overall, the *social impact* on local employment and local economy during operation phase is assessed to be 'low', prior to any mitigation.

Enhancement Measures

Construction Phase

Development and implementation of a Human Resources Policy: This policy will reflect the requirements to hire locally, where possible, with preferential treatment for those most affected by the Project. It will also prohibit discrimination on the grounds of race, ethnicity, religion, gender and political affiliations; and detailed health and safety requirements in line with Zambian labour law and the IFC performance standards.

Provision of on the job training; where possible ITPC will provide further training for workers during employment, which may enhance their prospects of advancement with the Project workforce, and provide a demonstrably better skills set for further employment opportunities after the construction period.

Development of Worker Management Plan:

- development of hiring guidelines on the basis of commitment to optimises local participation in the workforce;

- transparent and accessible application and short-listing process;
- guidance on the selection of applicants;
- Implementation of an effective grievance mechanism.
- Development of and implementation of a Local Procurement Policy:
- An evaluation of local capacity to provide specific goods and services;
- A strategy for local supplier development and the long term sustainability of the local suppliers following completion of the construction phase;
- A target percentage of suppliers that will be used locally; and
- A process of monitoring and reporting, to demonstrate the value of souring and selection processes.

Operational Phase

The majority of mitigation measures will be a continuation of those deployed during the construction phase. However, regular monitoring and evaluation of 'Local Benefit Plan' or 'Local Content Plan' needs to happen to ensure the Project benefits are reserved and or realised to maximise local employment and procurement.

The implementation of the 'Stakeholder Engagement Plan' also needs to be monitored to ensure focused on transparent communication on hiring policies, and continuous disclosure of Project employment has been done adequately.

Residual Benfeit

With implementation of the above enhancement measures, it is anticipated that beneficital impacts associated with local employment and local economy for construction phase is 'high'

With implementation of the above enhancement measures, it is anticipated that beneficial impacts associated with local employment and local economy for for operation phase is 'medium'.

8.6.2 Positive Impact of Improved Power and Water Potable Supply

Impact Description

As discussed in Section 7.6, the Project will substantially improve the provision of electricity to Itezhi-Tezhi and surrounding villages. The current electricity supply to Itezhi-Tezhi District occurs via the 'Choma to Itezhi-Tezhi' power transmission line, which commences at the Muzuma Substation in Choma. This substation provides power through a 1MVA transformer. After completion of the switchyard at the power house site, a 10MVA transformer will be installed that will feed into the Choma to Itezhi-Tezhi line. This will increase the level of power available to for within Itezhi-Tezhi town and district and will provide the level of power required for use by various industries. Therefore, the Project will improve the capacity for industry to establish within Itezhi-Tezhi town and district. Hence it may provide economic spin-offs from the increased availability of power and may encourage large industry to generate more indirect benefits.

Within Itezhi-Tezhi town, the existing substation (provided power through a 1.0MVA transformer) has been replaced with a new substation with two new 1.0MVA transformers. It is likely that this upgrade will provide a more regular supply of power to Itezhi-Tezhi town and decrease the number of power outages currently experienced. Hence it will improve the security situation through improved street lighting, children being able to study for longer hours, can also improve health infrastructure and support the small scale industries.

The current water infrastructure to Itezhi-Tezhi town occurs via an existing water intake and treatment plant that is operated by ZESCO. The construction of a second water intake and treatment plant will occur to supply the accommodation camp (**Figure 3-3**). This capacity of the newly built infrastructure to supply potable water is larger than the capacity of the existing water treatment plant and will exceed the demands of the accommodation camp. As such, excess potable water will feed into the current water infrastructure pipeline that supplied Itezhi-Tezhi town and will be sold to Itezhi-Tezhi users.

The *sensitivity* of the local receptor is considered medium, considering receptor likely to be benefited by this already have some level of access to portable water and electricity.

The *significance* of the impact is *assessed as medium, considering* the impact is indirect in nature and the actual effect of the impact is challenging to assess.

Overall, the *social impact* on improved power and water supply is considered ‘medium’. No enhancement measures are seen to be required.

Table 8-22 summarises all of the socio-economic impacts and benefits identified and their recommended mitigation and enhancement actions to improve the residual impact associated with the project.

Table 8-22 – Socio-Economic Impacts and Mitigation Measures identified

No.	Impact / Benefit Addressed	Stage of Work	Impact Risk	Mitigation / Enhancement Measure	Residual Impact Risk
80	Increased community expectations	Construction Operation	Medium (Construction) Low (Operation)	Stakeholder Engagement Plan: Focused on transparent implementation of local employment and procurement policies to reduce any community dissatisfaction on preferential treatment/exclusion Comprehensive Local Benefit Plan or Worker Management Plan which takes advantage of creation of job opportunities (largely unskilled and semi-skilled) in construction and operation phases for local labour Strategic Community Investment Plans: Encourage investment and development in the area Local Procurement Plan: Hire local suppliers whenever possible	Low (Construction) Very Low (Operation)
81	Construction-related employment tapering down in the operation phase	Operation	High	Transparent communication on hiring and exit plan Continuous disclosure of Project employment information ITPC hiring policy from construction to operation phases should be publicised at local and regional level	Medium
82	Community disturbance to health and well-being	Construction and Operation	High (Construction) Medium (Operation)	Develop an Influx Management Plan. Stakeholder Engagement and Local Benefit Plans outline ITPC policies on hiring local labour and should be publicised at the regional and national level to deter economic migrants Community Health and Safety Plan Implementation of an Employee Code of Conduct with a strict disciplinary procedure	Low (Construction) Very Low (Operation)

No.	Impact / Benefit Addressed	Stage of Work	Impact Risk	Mitigation / Enhancement Measure	Residual Impact Risk
				HIV/AIDs prevention incorporated into HR policies Provision of health care facilities for workers, if needed.	
83	Community disturbance due to increased noise, dust, vibration, light pollution and traffic	Construction and Operation	Medium (Construction) Low (Operation)	Construction Management Plan to include best practice measures. Equipment on site should be well-maintained and serviced to reduce noise and vibration Recommended that noisy construction work is restricted to day time hours and non-school hours Grievance Management Plan: A grievance procedure to record any instances by sensitive social receptors (as detailed in the SEP) Code of Conduct for drivers All drivers required to be fully trained and qualified Local community to be informed in advance of any anticipated increases in traffic levels Where practicable, vehicle movements during night time will be avoided Restricting the speed of vehicles on-site, on access roads and local roads	Low (Construction) Very Low (Operation)
84	Impact on livelihoods from reduced quality of water discharged from the dam	Construction and Operation	High (Construction) Medium (Operation)	Lack of data; further assessment recommended Provision of suitable advance public information Adopt environmental management techniques as outlined in Environmental Management Plan (EMP)	Medium (Construction) Low (Operation)

No.	Impact / Benefit Addressed	Stage of Work	Impact Risk	Mitigation / Enhancement Measure	Residual Impact Risk
				Grievance Management Plan: A grievance procedure to record any instances by sensitive social receptors (as detailed in the SEP)	
85	Employment opportunities for the local communities during the construction and operation Phase	Construction and Operation	Medium (Construction) Medium (Operation)	Development of the HR Policy. Development of on the Job Training. Development of Worker Management Plan.	High (Construction) Medium (Operation)
86	Improved power source for Itezhi Tezhi	Construction and Operation	Low (Construction) Medium (Operation)	ITPC provides sustainable power supply to local Itezhi Tezhi residents.	Medium (Construction) High (Operation)
87	Improved potable water source for Itezhi-Tezhi	Construction and Operation	Low (Construction) Medium (Operation)	ITPC provides sustainable potable water supply to local Itezhi Tezhi residents	Medium (Construction) High (Operation)

9 CUMULATIVE IMPACTS

The cumulative impacts associated with a project may be considered to be either:

- **Additive** – an incremental accumulation of environmental and social impacts in the project area, to which the project contributes, through the entirety of development present or planned;
- **Synergistic** – impacts the occur due to changes in practices of non-project parties that are catalysed by the development of the project; or
- **Associated** – impacts arising outside the project area from the activities or initiatives of other parties, but which may be facilitated by the project.

Additive cumulative impacts are typically those associated with the presence of other development in the project area that are currently producing impacts or planned development likely to produce impacts in the future. This is important to capture as the incremental increase due to an individual project may be minimal, however, the cumulative impact associated with all the individual incremental impacts of the range of projects in the area may be of significance. Key developments within the Project area and Kafue Flats will form a part of this assessment.

Given the limited and defined nature of the Project works (i.e. relatively small scale infrastructure in a fixed location), synergistic impacts associated with the Project during construction are likely to be limited to those associated with changes to social activities and employment in the region. In operation, synergistic impacts are likely to be mainly associated with social behavioural changes in response to the provision of electricity and water to communities. Similarly, any associated impacts occurring outside the project area will be driven by the provision and use of electricity provided by the Project.

9.1 Additive Cumulative Impacts

The Project is located in an area of Zambia in which there has been little significant infrastructure development. The largest infrastructure project to have been developed with 30km of the Project site is the Itezhi-Tezhi dam itself, built in 1978. The on-going operational impacts associated with dam are currently primarily associated with altered hydrology (and subsequently altered ecological and agricultural impacts). However, as the dam has been operating for over 30 years, these impacts were captured in baseline assessments and considered within the impact assessments and mitigation measures discussed in **Chapters 6 – 8**.

The Project area is located within close proximity to the Kafue National Park, and is surrounded by the associated Game Management Area. This effectively limits the extent of future development in close proximity to the Project. It is not considered that incremental development of the Project area and wider region is currently of concern.

The mines within Copperbelt, approximately 360 km to the north of the Itezhi-Tezhi reservoir are the closest mining developments to the site, potentially impacting up the Project Area through sediment and water contamination carried by the Kafue River. It is possible that the development of the Project may lead to further mining development within Copperbelt as the security provided by more robust energy provision attracts investors; potentially leading to greater impacts upon water quality within the Project area. However, increasing stringency on environmental practice in regards to mining is likely to minimise any such cumulative environmental impacts.

The Project will not affect the operation of any other hydropower projects on the Kafue River, nor will it affect the need for other energy projects upon the Kafue River or elsewhere within Zambia. The scale of the project is not sufficient to entirely resolve existing energy demand

issues or future energy demand growth within Zambia or Africa. Key existing hydropower related projects within Zambia include, amongst others:

- Kariba Dam Hydropower Project;
- Upper Kafue Gorge Hydropower Project;
- Victoria Falls Hydropower Project;
- Musonda Falls Hydropower Project;
- Lunzua River Hydropower Project; and
- Chishimba Falls Hydropower Project.

Planned or proposed energy developments within Zambia include, amongst others:

- Maamba Collieries Thermo-powered Plant;
- Lower Kafue Gorge Hydropower Project;
- Pensulo – Kasama 330kV Power Transmission Line Project;
- Connection of Luangwa District to the National Grid at 132kV; and
- Kariba North Bank Extension Hydropower Project.

Significantly, the Project will require the establishment of a transmission line to export the power from the dam and link in with the Zambian power grid. The proposed transmission supporting transmission line will be a 220-kV line connecting with the Zambian grid through Mumbwa to Lusaka West Substation. The line routing would be about 350 km long. An EIA has been prepared to assess the impacts associated with this transmission line and recommend mitigation measures (ZESCO, 2006). Environmental Management Plans and Resettlement Actions Plans have been prepared to implement the proposed mitigation measures. (ZESCO, 2009 and ZESCO, 2010).

9.2 Synergistic and Associated Cumulative Impacts

During the construction phase the Project's required workforce (500 individuals) will be substantially greater than the required operational capacity (47 individuals). This will be associated with migration of both Project and non-Project workers into the Project area. This has the potential to:

- Act as a local growth and employment driver for the region;
- Increase pressure on local services including:
- Increased occurrence of firewood gathering/hunting in local forested areas;
- Increased demand on bore-water systems and treated reservoir water;
- Increased pressure on local sanitation systems and conditions;
- Increase local small trade store / market and service opportunities (e.g. sale of goods, servicing of project equipment); and
- Lead to the development of new temporary/permanent settlements and potentially squatter settlements. Such settlements are often associated with increased crime and lower health standards.

The potential magnitude of in-migration and the development of squatter settlements in particular, is difficult to predict (**Section 8**). However, given the scale of the Project and required workforce (less the 0.01% of the population of Itezhi-Tezhi), it is considered that any such impacts are likely to be minimal and ultimately short-lived over the life of construction phase.

In operation, the plant is considered unlikely to alter the livelihoods of individuals downstream that rely on the flows and water quality of the Kafue River (**Section 6.4**). However, the project will:

- Effectively triple the supply of river-sourced potable water to the town of Itezhi-Tezhi
- Improve the supply of electricity to the town of Itezhi-Tezhi and surrounding region; and
- Increase the capacity of sewage treatment infrastructure available in Itezhi-Tezhi.

Overall, it is considered that this will facilitate and encourage growth and settlement within Itezhi-Tezhi and surrounding regions. Increased growth and development if not well planned may be associated with negative social (health, crime, poverty) and environmental (contamination, unregulated resource usage) issues. It is understood that Itezhi-Tezhi District and the Central Province are currently developing plans to develop and expand the role of Itezhi-Tezhi as an important regional centre. The specific contribution played by the Project towards any such future development is considered to be minor.

Tourism is of importance to Zambia and the local Itezhi-Tezhi region. The construction works may temporarily detract tourists from visiting the locality. However, in operation the functioning of the plant will not noticeably differ from the existing scenario, from a tourism perspective. The provision of secure energy and water resources will facilitate tourism development. It is not expected that the Project will impact negatively upon any cultural heritage items or areas.

The extent of road development associated with the project is minimal. Therefore, the Project is unlikely to lead to the opening up of new regions in Zambia to development or exploitation.

Outside of the Project area, the distribution of electricity, including potential export of power out of Zambia will allow for a shift in power consumption away from carbon intensive power sources. The additional supply of electricity will also provide more competition within the energy market, as well as contributing to greater regional, national and inter-national (within the SAPP) energy security. As with Itezhi-Tezhi, energy security is considered to be an important factor in stimulating development. No significant negative cumulative impacts are expected to arise as a result of the Project.

While the Project is likely to have positive socio-economic benefits within Itezhi-Tezhi town, it is not considered of sufficient scale to noticeably affect macro-economic conditions within the province or country.

10 LABOUR RIGHTS AND WORKING CONDITIONS

This section provides summary information on ITPC's human resource policies and procedures. Where details are still being developed, this section summarizes the requirements of IFC's Performance Standard 2 that ITPC will incorporate. ITPC has stated their commitment to meet all applicable labour laws in Zambia. Where appropriate, this section outlines necessary steps to ameliorate practices to meet international best practice.

A detailed audit of labour policies and practices on-site was not undertaken as part of this ESIA. Observations and recommendations made are based on stated policies and procedures provided by ITPC. It is proposed that a Human Resource Management Plan (HRMP) be developed to supplement the Project's existing Human Resources Policies and Procedures Manual (HRPPM), address any short-comings in existing practices in comparison to international best practice, and allow for on-going monitoring and auditing to ensure practical compliance.

10.1 ITPC Human Resources Policies

Table 2-1 (Section 2) details the labour regulations, standards, and guidelines applicable to the Project and indicates that compliance with the listed regulations/standards/guidelines will be required. This is affirmed within ITPC's Human Resources Policies and Procedures Manual (HRPPM) (**Appendix J**).

Although not stated within the current HRPPM, ITPC is committed to the hiring of semi-skilled and unskilled labour from the national labour force whenever possible as part of Project construction and operation works. However, it is noted that the construction contractor, Sinohydro, will appoint foreign nationals (e.g. Chinese nationals) from within the company to work on the project, as and when required, predominantly in skilled worker roles. It is recommended that such hiring be made known to affected Project stakeholders through early engagement in order to properly manage stakeholder expectations.

ITPC's HRPPM policy, amongst others, addresses: working conditions and terms of employment, non-discrimination and equal opportunity, training and development and employee grievance mechanisms (**Appendix J**). Summaries of the major elements in the HRPPM policy that address IFC PS2 requirements are discussed in the following sections.

10.1.1 Hiring Practices & Terms of Employment

It is considered likely that the expectations for job creation from this project and demand for jobs is likely to outstrip supply. This is primarily due to:

- The limited number of roles associated with relatively small scale nature of the infrastructure works; and
- The utilisation of non-nationals as part of the Sinohydro workforce.

Because demand will likely exceed supply there is potential for disappointment, resentment and possible conflicts to occur between those who have secured jobs and those who have not. The level of competition could lead to corruption and unfair recruitment. In order to ensure a fair and transparent hiring process, ITPCs HRPPM also includes the aspects detailed in the following sections.

10.1.2 Non-Discrimination and Equal Opportunity Policy

ITPC is an equal opportunity employer which has a Recruitment and Selection Policy aimed at providing equal access to employment and equal opportunity for individuals to develop their potential. The aim of the equal employment programme, with regard to appointments, is to ensure that the best available person is appointed to any given position, free from discrimination of any kind. In this regard, ITPC is committed to the principle of non discrimination against individuals on the basis of personal beliefs or characteristics such as political views, religion, sex, marital status, or disability unrelated to the job or program requirements.

ITPC requires adherence to this policy by contractors and subcontractors. An audit system will need to be established in order to ensure all labour laws are being followed by ITPC on site as well as by its contractor(s). This will include reviewing contractor(s) hiring and post-hiring practices for compliance with the non-discrimination policy.

As part of the terms of employment, ITPC will communicate with all workers the details of the non-discrimination policy HRPPM. It is recommended that the HRMP reflect ITPC's commitment to treat all employees with respect, and state that no forms of discrimination, harassment or abuse will be tolerated within the work place. Clear disciplinary procedures to respond to any individuals found to be engaging in workplace discrimination, harassment, or bullying will be included in the HRPPM.

10.1.3 Hiring Practices

ITPC's HRPPM establishes a consistent set of over-all hiring guidelines and procedures. In particular, the recruitment policy indicates that the responsibility for administering all recruitment processes for the entire organisation falls under the Human Resources and Administration Department.

In addition to the policies and procedures specified in the HRPPM and adhered to the Human Resources and Administration Department, it is recommended that a HRMP be created specifying:

- Clear organisational objectives in the form of percentage targets for the hiring of local workers. Such targets will be based on existing demographic employment and skills profiles of communities around the Project Site;
- the number of workers required in each role;
- an adequate job description of each role, which should include:
- Clearly defined responsibilities associated with each role;
- Clear physical and medical attributes required to do that job;
- An enumeration of the minimum general skills and experience required for the fulfilment of each role; and
- Health and safety requirements of the each role.

The responsibility for the application of this would rest with the Human Resources and Administration Department.

10.1.4 Application, Short Listing, and Vetting Policy

ITPCs HRPPM currently lists procedures in regards to:

- Requests to fill vacancies;
- Advertisement of vacancies; and
- Screening and short-listing of applicants.

Further to the specified conditions it is considered that effort should be applied to provide a transparent and accessible engagement process. This will help to manage expectations, ensure an equitable hiring process, enhance opportunities for members of the local population, and increase the potential pool of applications. To this end, it is recommended that the HRMP require:

- Advertisements for available jobs to be made via the most relevant information media to the local population or local labour office in the local language. This should include newspapers, adverts on village notice boards and pamphlets to local businesses. ITPC and its contractors will seek to ensure transparency and clarity around potentially available positions and the hiring process. ITPC will also ensure that the vacancies are advertised as consistently as possible;
- Advertisements to provide clarity around potential hiring and employment timelines;
- ITPC to maintain an updated register of potentially available positions which is communicated to local stakeholders; and
- ITPC to maintain a running register to record the results of applications and to develop a skills database of all applicants for skilled roles.

10.1.5 Selection Policy

Once applications have been received and processed it is recommended that the HRPPM's interview, reference checking, and engagement policy be expanded with the HRMP in accordance with the following principles:

- For unskilled roles, priority will be given to applicants from the local communities and especially to the project affected people who are impacted by both physical and economical resettlement;
- For skilled roles, priority will also be given to candidates from the local communities in instances where two or more candidates possess equal qualifications; and
- When there are concerns around discrimination or a lack of transparency in any aspect of the hiring process, ITPC shall investigate the matter through the grievance mechanism, consult any relevant parties and provide a report to the owner on the investigation detailing any corrective actions.

Prior to employment, ITPC should ensure that out-of-country workers have valid Work Permits according to Zambian labour requirements. ITPC has stated in its HRPPM its commitment to ensure all hiring complies with Zambian labour laws, including those related to the prevention of child labour, forced or bonded labour, and human trafficking.

Upon hiring, ITPC, and its contractors, will offer pay rates that match or exceed national minimum wage levels and take account of the location of the facility or off-site positions and prevailing working conditions. The HRMP will include requirement for accurate written records of employment to be maintained by a designated ITPC staff member/department.

As required by ICF PS2, the HRMP should provide specifics on additional policy information that would be communicated to workers at the time of hiring, such as workers' rights to privacy, and ITPC's responsibility to inform workers regarding the type of personal information that will be kept by ITPC and how that information will be used. For example, during facility operations, industrial hygiene samples, such as air samples and noise samples, may be periodically collected from personnel to measure employee exposures. The HRMP should also provide detail on how workers will be informed prior to data collection, the specific purpose of data collection efforts, how data results will be made available, and how the security of any personal or confidential data will be maintained.

10.1.6 Retrenchment Policy

In some circumstances, changed economic or social conditions may result in a need for a company to down size its work force. Such actions clearly can have a negative impact on the workforce and local community. As required by IFC PS2, ITPC will prepare a Retrenchment Plan. The level of detail currently provided within the HRMMP in regard to retrenchment is considered insufficient to meet these requirements. Accordingly, a Retrenchment Plan will be prepared as part of the HRMP. This will include provisions for managing any temporary lay-offs caused by ‘unforeseen circumstances’. The plan will include details with regard to:

- procedures to analyze alternatives to retrenchment;
- procedures to ensure retrenchment is non-discriminatory;
- procedures for prior notice of dismissal and the severance benefits to which employees are entitled; and
- procedures to ensure that all Zambian laws regarding retrenchment are being followed, possibly including government consultation.

10.1.7 Care for Employee Well-being

Once an employee is hired, ITPC’s human resources policies will ensure that the worker continues to be treated fairly, with respect and decency, and that appropriate efforts are made to enhance employee well-being.

10.1.8 Training and Skills Development

Per its HRPPM policy (**Appendix J**), ITPC has indicated its commitment to capacity building and skills training for facility workers. As part of this, ITPC recognises the need for training, as a necessary investment embracing all types of work and all levels of employees. The HRPPM identifies that the form of appropriate training may differ between the different jobs / roles in question (e.g. programmes undertaken on-the-job, in-house, in-country, regional, abroad, by attachments, through seminars and/ or workshops).

Employees that successfully complete specific training programs will be considered for promotions so that management responsibility and operational authority can be progressively transferred to local nationals. The training program is expected to reduce reliance upon expatriate managers and workers by ITPC, and encourage the utilization and development of a local and national workforce. In addition to vocational training, ITPC will ensure that all employees will have appropriate health and safety training for their particular task.

In the HRMP, ITPC will provide procedures regarding ITPC’s on-going human resource policy training program. This program will provide periodic training on issues such as labour rights, and the company’s policies of employment (e.g., non-harassment, grievance mechanisms). This type of training assists workers in understanding the rights and requirements of employment and provides opportunities for worker communication with management.

10.1.9 Grievance Mechanisms

An important part of on-going employee well-being is the ability to share concerns with management, have those concerns heard in a fair and transparent manner, and, where actions may be warranted, for the employee to clearly see and understand any corrective actions. IFC PS2 has a requirement for companies to have a grievance mechanism. ITPC recognizes this within its HRPPM and specifies the establishment of an appeal mechanism. Additional details of the specifics of administering its grievance policy that should be included in the HRMP include:

- procedures for addressing anonymous complaints;
- training curriculum for supervisors and managers responding to complaints/grievances;
- procedures for documenting complaints and actions taken on grievances; and
- procedures for communicating the grievance mechanism process to workers.

In addition, the policy will insure that no worker is penalized for making a complaint and that the actions taken in response to complaints are developed by groups that contain appropriate management and employee representatives.

During the socio-economic baseline activities associated with ESIA preparation, informal comments were received regarding tensions and potential physical violence between local workers engaged by the EPC contractor Sinohydro, and foreign national workers employed by Sinohydro. As such, it is imperative that an active transparent and unbiased grievance and discipline procedure is established and enforced as soon as possible to help resolve these issues.

10.1.10 Worker's Organisations

The ITPC HRPPM does not currently address the ability for workers to organise to defend their rights to fair employment conditions, fair wages, and collective bargaining. It is recommended that the HRMP include a commitment by ITPC that it will not erect any barriers to legitimate freedom of association through trade union membership and/or collective bargaining. In addition, it should state that ITPC will ensure that employees who are members of worker organisations are not discriminated against, and that the representatives of such organisations are given appropriate access to employees in a manner that does not negatively affect work tasks.

10.1.11 Enforcement of Standards for Contractor/Subcontractor Workers

As stated in the previous sections, ITPC will require all its contractors and sub-contractors to comply with Zambian labour laws, and have documented human resource policies and practices that treat people with fairness, respect, and decency, and adhere to the requirements and policies provided in this section. ITPC will review the human resource policy of the EPC contractor, Sinohydro, to make sure they are in compliance with Zambian labour laws and ITPC standards.

10.2 Monitoring and Auditing

A detailed audit of labour practices on-site was not undertaken as part of ESIA preparation. It is recommended that an independent audit be undertaken on-site as soon as practicable and that the HRMP include provision for regular (monthly) on-going audits to ensure that agreed policies and procedures are being adhered to. A review procedure and monitoring of audit findings (e.g. identification of performance indicators) should also be applied to allow for on-going improvement of human resource management for the Project.

11 RECOMMENDATIONS FOR ENVIRONMENTAL SAFEGUARD AND MANAGEMENT MEASURES

11.1 Summary of Environmental Safeguard and Management Measures

Sections 6 - 10 identify a series of mitigation measures to prevent, or where this is not possible, minimise potential negative environmental impacts associated with the Project. These mitigation measures are collated in **Table 11-1** as a ready reference for the project as a whole. The risk assessment ratings for both the base impact (without mitigation measures) and residual impact (following application of mitigation measures) are also provided, indicating the efficacy of the proposed safeguards and management measures.

It is recommended that the full range of mitigation measures listed in **Table 11-1** be incorporated within a Project Environmental and Social Management Plan (PESMP) and discipline-specific environmental management plans, and that adherence to the plans is a condition of any construction and operation contracts awarded. A Framework Environmental and Social Management Plan and recommended monitoring requirements are provided, to be used as the basis of a PESMP, in **Sections 11.3** and **11.4** respectively.

Table 11-1: Summary of Environmental Impacts and Mitigation Measures

No	Impact Addressed	Stage of Work	Impact Risk	Mitigation Measure	Residual Risk
1	Clearance of vegetation and loss of habitat	Construction	Medium	Clearance of vegetation and habitat will be minimised, where practicable, and limited to the construction footprint. Bare earth surfaces to be re-vegetated or sealed as soon as possible following completion of immediate construction works (i.e. site re-vegetation and rehabilitation shall occur progressively throughout construction in accordance with an Ecology Management Plan). Refer to **Section 7.11**. Large trees (>1 DBH) will be retained where practicable. A Rock Hyrax monitoring program will be carried out to determine the current population status of this species within habitat adjacent to the Powerhouse site and monitor this population throughout construction. Data gathered to be reviewed periodically to identify whether mitigation can be implemented to reduce any impacts that the project may be having on the local population. Provide suitable electricity or alternative fuel at accommodation and construction workshop facilities. Employees and contractors no permitted from destroying trees at Project sites, beyond that required as part of clearance for project facilities.	Negligible
2	Noise and vibration as a result of construction activities and equipment leading to disturbance of wildlife	Construction	Medium	Blasting to be carried out in accordance with the Blast Management System (refer to **Section 6.2**). Blasting to cease if fauna are observed within the powerhouse site. Blasting to cease if Elephants are observed within or in close proximity to the Powerhouse site. Blasting to re-commence once Elephants have left the area.	Very Low
3	Disturbance to fauna from	Construction	Medium	Monitoring to identify the presence of harm to wildlife.	Very Low

	increased people and vehicle movements	Operation		Remediation measures implemented where harmful effects identified.	
4	Death of terrestrial fauna as a result of construction equipment and vehicles or Project workers	Construction Operation	Medium	Vehicle movements to be subjected to specified site speed limits to negate any risks of accidents with wildlife. A 40 km speed limit at the Powerhouse site is suggested. A no hunting policy to be employed for all employees and contractors. Records to be kept of all wildlife or livestock mortalities (e.g. road kill) that is directly attributable to the construction and operation of the Project. The data gathered will be reviewed periodically to identify whether mitigation can be implemented to reduce incidental mortality.	Very Low
5	Site disturbance leading to growth of invasive flora and fauna. Changes in water quality may also generate conditions favourable for the growth of noxious weeds and pests.	Construction (Terrestrial) Operation (Aquatic)	High	Annual inspections to be undertaken to identify presence of invasive flora and fauna. Suitable eradication measures can be instigated promptly following confirmation of invasive species. Carry out an ongoing monitoring study of the Red Claw Lobster to monitor the abundance and distribution of the species. Carry out hydrology mitigation measures outlined in **Section 6.4**, to prevent changes in flooding regime/areas of inundation of the Kafue Flats.	Low
6	Construction dust smothering local vegetation	Construction	Low	Carry out dust suppression measures such as water spraying on exposed soils and unsealed roads, to minimise dust generation.	Negligible
7	Disturbance in downstream ecosystems as a result of changes in water quality.	Construction Operation	Extreme	Carry out water quality mitigation measures outlined in **Section 6.3**) Carry out yearly consultation with Department of Fisheries and obtain data on Kafue River fisheries. Determine whether any correlation occurs between the	High

				operation of the power plant and change in fisheries composition.	
8	Fish kills and aquatic flora and fauna death due to changes in water and sediment quality (e.g. temperature shocks, eutrophication events, anoxic water discharge)	Operation	High	Carry out water quality mitigation measures outlined in **Section 6.3**. Carry out yearly consultation with Department of Fisheries and obtain data on Kafue River fisheries. Determine whether any correlation occurs between the operation of the power plant and change in fisheries composition. Regular visual inspection of downstream habitat areas to observe any changes in condition and extent potentially arising from changes in water quality Regular visual inspection for the occurrence of algal blooms	Medium
9	Ecological disturbance due to changes in hydrology.	Operation	Low	Carry out hydrology mitigation measures outlined in **Section 6.4**). Operation of the hydropower station to be consistent with the dams existing operating rule curve. Regular visual inspection of local and downstream habitat areas to observe any changes in condition and extent potentially arising from changes in hydrological condition.	Negligible
10	Disturbance to local fauna due to release of odiferous gases.	Operation	Low	Carry out air quality mitigation measures outlined in **Section 7.1**).	Negligible
11	Intermittent non-blasting noise and vibration emitted during construction	Construction	Medium	A Construction Noise Management Plan will be developed outlining the mitigation measures to be adopted during construction. As part of this a complaints register should be developed to record resident and commercial operator complaints in regards to noise and	Low

				vibration. High noise emitting construction activities such as blast hole drilling, rock breaking and rock crushing to be limited to daylight hours (0700h to 1900h). Plant and equipment such as flat bed lorries, skips and chutes to be lined with noise attenuating materials, where practicable. Materials should be handled with care and be placed, not dropped. All vehicles and mechanical plant used for the purpose of the works to be fitted with exhaust silencers and should be maintained in good efficient working order. All generators, compressors and pumps to be ‘sound reduced’ models where possible fitted with properly lined and sealed acoustic covers which should be kept closed whenever the machines are in use. Additionally, they should be positioned so as to cause minimum noise disturbance, i.e. behind noise barriers. Machines in intermittent use to be shut down in the intervening periods between works or throttled down to a minimum. Noisy areas to be well defined with sign boards recommending the use of hearing protection. Where appropriate, site staff should be issued with, trained in the proper use of, and use suitable hearing protection equipment.	

				Construction to cease if Elephants are observed within the power house site. Blasting to re-commence once Elephants have left the area (**Section 6.1**). High noise emitting activities such as rock breaking to cease if Elephants or other noise sensitive fauna are observed in close proximity to the power house site. Blasting to re-commence once Elephants have left the area (**Section 6.1**).	
12	Noise, vibration and air blast overpressures emitted during blasting	Construction	High	Blasting to be carried out in accordance with the Blast Management System. Blasting times and locations to be publicly advertised. Blasting to only occur during daylight hours. Strict boundaries to be enforced around blasting sites during blasting procedures. Blasting to be postponed during high wind periods at the discretion of the site manager. Blasting to cease if fauna are observed within the powerhouse site. Blasting to re-commence once fauna have left the area (**Section 6.1**). Blasting to cease if Elephants or other noise sensitive fauna are observed within or in close proximity to the Powerhouse site. Blasting to re-commence once fauna have left the area (**Section 6.1**).	Low
13	Noise and vibration emitted during construction activities and equipment, leading to disturbance of wildlife	Construction	Medium	Blasting to be carried out in accordance with the Blast Management System.	Very Low

14	Noise and vibration emitted during the operation of the Project.	Operation	Very Low	Maintenance of Project infrastructure to be restricted to day time hours (e.g. 0700h to 1900h). At the detailed design of the tail race, a full investigation into the likely noise generation by the operation of the tail race should be undertaken with mitigation measures recommended where levels may exceed a level of LAeq 91dB at 10 m from the tail race.	Negligible
15	Release of untreated or inadequately treated sewage by construction and operational workforce	Construction and Operation	Very Low	Site waste water infrastructure to be regularly inspected and maintained. Waste water treatment facility will operate at design specifications to meet Zambian water quality standards	Negligible
16	Spillage of oil or other harmful substances from storage or maintenance facilities (e.g. explosives magazine, maintenance depots) , vehicles and equipment.	Construction and Operation	High	Functioning “spill kits” will be kept on-site at all time during construction. Workers will be provided with training on use of spill kits and response to spillages and appropriate waste management actions Wastes to be disposed of in accordance with a waste management plan which provides appropriate receptacles for all wastes that are regularly emptied. Hazardous materials to be stored and disposed of in accordance with material safety data sheet requirements. As a minimum, hazardous materials to be stored in sealed containers within secure bunded and sheltered storage areas. Construct oil interceptors and containments chambers around transformers in substations and hydraulic plant; Setup workshops in less sensitive areas with appropriate oil interceptors	Medium
17	Run-off of surface water from stockpiles or bare soil surfaces containing high concentrations of suspended solids.	Construction	High	Erosion and sediment control measures will be outlined in the Stormwater Management Plan developed as part of the detailed design. As a minimum, this will include:	Medium

				• Avoiding earthworks during periods of heavy rainfall, to the extent practicable; • Minimising the length and steepness of slopes to reduce run-off velocities and hence minimise sediment mobilisation; • Revegetation of areas of bare soil as quickly as practicable; • Lining and/or protection of steep drainage channels to minimise erosion; • Design of temporary site drainage works to control run-off, including the use of settlement basins to minimise off-site sediment mobilisation; • Segregating run-off from areas prone to erosion from other areas, for ease of treatment; • Provision of covered storage for materials such as cement with potential to impact on water courses; • Provision of designated concrete wash-out areas for controlled disposal of concrete, comprising suitably lined and contained area remote from drainage channels; • Visual inspection of discharge locations on a regular basis and following rainfall events	
18	Discharge of wash-out water from concrete trucks or other vehicles used from construction works	Construction	Low	All vehicles will be washed out and maintained within bunded areas.	Very Low

				Design of temporary site drainage works to control run-off, including the use of settlement basins to minimise off-site sediment mobilisation and allow settlement of potentially contaminated washout	
19	Dredging of reservoir areas generating sediment plumes affecting local species	Construction	Low	Dredging works will be undertaken in accordance with a dredge management plan. Dredging works will be undertaken during the hypolimnetic phase if practicable to utilise natural thermoclines and in fine weather to contain plumes. Dredging extents will be suitable to minimise the need for future dredging events	Very Low
20	Dewatering of spoil or spoil run-off entering the either the Itezhi-Tezhi reservoir or Kafue River	Construction	Low	Dredge spoil sites will be located in bunded areas and under cover where possible. Dewatering will be controlled and waste water disposed of to an appropriate location in keeping with the chemical properties of the capture water.	Very Low
21	Discharge of anoxic waters from within the Itezhi-Tezhi hypoliminion leading to reduced dissolved oxygen concentrations downstream and potential fish-kills / reduced productivity	Operation	Extreme	A Water Quality Management Plan will be developed which will include a detailed monitoring plan for dissolved oxygen levels discharged (both pre and post construction). The tail race shall be fitted with suitable turbulence devices (e.g. aeration weirs) to aerate the water prior to discharge into the river. Where practicable, releasing discharges over the main	High

				spill way will occur during the months of March – May. Monitoring results will be regularly reviewed and the need for additional physical mitigation measures to be considered, including turbine venting. Temporary shut down of the plant in the event of fish-kills until modified mitigation measures are applied.	
22	Discharge of anoxic waters from within the Itezhi-Tezhi hypolimnion leading to increased nutrient and ion concentrations downstream and potential eutrophication events	Operation	Very High	A Water Quality Management Plan will be developed which shall include a detailed monitoring plan for nutrients and suspended solid levels discharged (both pre and post construction). The tail race shall be fitted with suitable turbulence devices (e.g. sluices) to aerate the water prior to discharge into the river. Where practicable, releasing discharges over the main spill way will occur during the months of March – May. Regular visual inspections of down-stream waters for growths in weed species or algal blooms. Temporary shut down of the plant in the event of significant algal blooms until modified mitigation measures are applied.	Medium
23	Discharge of cold waters from within the Itezhi-Tezhi hypolimnion leading altered river productivity and potential	Operation	High	A Water Quality Management Plan will be developed which will include a detailed monitoring plan for temperature levels of discharged water (both pre and post construction).	Medium

				The tail race shall be fitted with suitable turbulence devices (e.g. sluices) to mix and disturb the water prior to discharge. Where practicable, releasing discharges over the main spill way during the months of March – May. In the event that discharges are seen to cause riparian stratification, fish kills, or reductions in overall ambient temperatures, the plant shall be shut down until mitigation measures (e.g. heating of draft tubes, extension of tail-race) are applied.	
24	Discharge of bottom waters entraining increased sediment loads leading to the smothering of aquatic vegetation	Operation	Medium	A Water Quality Management Plan will be developed which shall include a detailed monitoring plan for suspended solid levels discharged (both pre and post construction). Regular inspection of key sedimentation and erosion areas downstream of the discharge location	Low
25	Discharge of bottom waters entraining contaminated sediments leading to potential contamination downstream and potential bio-accumulation.	Operation	High	A Water Quality Management Plan will be developed which shall include a detailed monitoring plan for suspended solid levels discharged (both pre and post construction). Undertaking appropriate dredging in-front of intake towers to minimise the likelihood of sediment entrainment.	Low
26	Discharge of power plant waters leading to scour downstream.	Operation	Medium	Installation of appropriate scour prevention devices (e.g. rip rap) and scour protection at key sites.	Low

				Regular inspection of key sedimentation and erosion areas downstream of the discharge location to assess the need for further scour protection.	
27	Altered hydrology of Kafue Flats as a result of incorrect operation of the power plant	Operation	Medium	On-going consultation with meteorological and environmental authorities as to the recommended intake rate to reflect current hydrological conditions. Regular monitoring and auditing of flow rates downstream of the tailrace discharge location.	Very Low
28	Changes to local hydrology immediately downstream of the NDT discharge location and main spillway	Operation	Medium	Discharging flows over the main spillway where possible, as consistent dam operating conditions. Periodic inspection of water quality and riparian ecology within these reaches to observe the extent of any associated impacts. Periodic inspection of the vegetated sandbank immediately off-shore as to the extent of scour and flooding. Installation of scour protection devices at the mouth of the tail race (e.g rip rap).	Low
29	Changes to existing flow paths due to altered topography as a result of bulk earthworks or infrastructure	Construction / Operation	Medium	Implement an approved Stormwater Management Plan which details stormwater infrastructure to be adopted, including use of : • Cut-off drains; • Swales and drainage lines; • Detention basins;	Very Low

				• Stormwater harvesting options • Filters and grates; • Revegetion of exposed areas. Install appropriate guttering/swales or run-off channels to direct surface flows in a controlled manner. In particular, suitable gutters for roads and hardstanding areas to be provided. Maintain and inspect discharge points of all site stormwater drainage so that they do not generate scour.	
30	Risk to worker health and safety from flood events	Construction / Operation	Low	Prior to construction and operation an Emergency Management Plan will be developed outlining procedures and responsibilities to protect worker health and safety under power station flood events.	Very Low
31	Rainfall and Flood events (pluvial or riparian) leading to: • Erosion of sediment from site; • Contamination of waters through fine metal entrainment or spills and leaks of hazardous materials; or • Destruction of property.	Construction / Operation	Medium	Implementation of erosion and sediment control measures, outlined in an approved Erosion Control Plan including: • Avoiding earthworks during periods of heavy rainfall, to the extent practicable; • Location of stockpiles to avoid proximity to drainage lines; • Regular inspection of both construction and operation stormwater capture devices (e.g. drains) for any blockages or leaks. This would form part of a site Stormwater Management Plan; • Minimising the length and steepness of slopes to reduce run-off velocities and hence minimise	Low

				sediment mobilisation; • Lining and/or protection of steep drainage channels to minimise erosion; • Design of temporary site drainage works to control run-off, including the use of settlement basins to minimise off-site sediment mobilisation; • Segregating run-off from areas prone to erosion from other areas, for ease of treatment; • Provision of covered storage for materials such as cement with potential to impact on water courses; • Provision of designated concrete wash-out areas for controlled disposal of concrete, comprising suitably lined and contained area remote from drainage channels; • In order to mitigate potential impacts from spillage of materials, the following measures will be adopted: o Provision of adequate secondary containment for fuel and oil storage tanks, e.g. secure bunded areas; o Restriction of refuelling and other fluid transfer to areas covered with impervious surfacing; o Provision of spill containment and cleanup equipment and training of workers in correct procedures for fluid transfer/fuelling and	

				emergency spill prevention and cleanup measures; and o Leaking or empty fuel/oil drums to be removed from the site immediately with measures in place to prevent contamination. All discharge of waste water and surface water to be managed in accordance with relevant local regulations and international conventions.	
32	The proposed works may have minor impacts on air quality during construction as a result of dust and particulate matter generated through bulk earthworks and stockpiling.	Construction	Medium	All work areas and stockpiles will be closely monitored for dust generation and stabilised where required. In the event of excessive dust generation, appropriate dust suppression measures will be implemented (e.g. wetting of exposed surfaces). Stockpiles will be covered and located in areas that are protected from the dominant wind direction. If deemed necessary this may include construction of wind breaks. Stabilisation methods will be employed such as matting, grassing or mulch. Where dust generation is unavoidable due to high winds (i.e. greater than 40km/hr), earthworks will cease. The number of stockpiles and the number of active work faces of stockpiles will be minimised. Two dust monitoring stations are to be established on site boundaries in closest proximity to sensitive receivers	Low
33	The proposed works may have minor impacts on air quality during construction as	Construction	Medium	Blasting times and locations to be publically advertised. Blasting will only occur during daylight hours.	Low

	a result of dust and particulate matter generated through rock blasting and concrete crushing			Strict boundaries will be enforced around blasting sites during blasting procedures. Blasting to be postponed during high wind periods at the discretion of the site manager.	
34	The proposed works may have minor impacts on air quality during construction as a result of dust and particulate matter generated through vegetation removal	Construction	Medium	Where practicable, existing vegetation, in particular trees, will be retained to minimise the extent of lost vegetation. Bare earth surfaces will de re-vegetated or sealed as soon as possible follow completion of immediate construction works (i.e. site re-vegetation and rehabilitation shall occur progressively throughout construction in accordance with a Ecology Management Plan. Cleared vegetation will be used where practicable for dust control and re-vegetation.	Low
35	The proposed works may have minor impacts on air quality during construction as a result of dust and particulate matter generated through movement of construction vehicles on and off site.	Construction	High	Truck movement will be controlled on site and restricted to designated roadways. Vehicles entering will be cleaned of mud/dust on wheels before they enter public roads to limit the generation of excess dust (e.g. use of rumble grids, or wheel wash). Vehicle movements on site will be limited to 20km/hr. All truck movements carrying spoil on or off site will be done with covered loads. Implementing dust suppression techniques such as regular application of water to unpaved haul roads,	Low

				stockpiles or exposed surfaces in dry and windy conditions.	
36	The proposed works may have minor impacts on air quality during construction as a result of odour and particulate matter generated through waste generation and storage and burning of wastes	Construction	Very Low	Open burning of vegetation and other solid waste will, where possible, be avoided and managed through a waste management plan. Should open burning be utilised, the contractor will take into account prevailing wind conditions and the location of sensitive receivers. Fires will never be left unattended of left to smoulder. Collection of firewood or unauthorised burning of vegetation or waste materials by project workers or contractors while working, travelling in project vehicles, and residing in project field accommodation will be prohibited. Implement appropriate inductions and education to encourage staff to comply with regulations. Excavated materials will be stored for as short a period of time as possible. Drying soils, sand and degrading organic matter will kept on site at all times. Stockpiles to be located away from sensitive receivers. Implementation of a Waste Management Plan which specifies: • storage locations; • transfer schedules;	Negligible

				• cleaning and washing schedule for waste storage areas and transportations vehicles; and • provision of adequate wate receptacles.	
37	The proposed works may have minor impacts on air quality during construction a result of emissions from diesel or petrol-driven equipment and vehicles.	Construction	Low	Training of workforce in safe driving practices that reduce both the risk of accidents and fuel consumption, including measured acceleration and driving within safe speed limits. Vehicles and equipment will be maintained in good working order (e.g. exhausts, tyres). Transport routes will be designated to minimise distance travelled and overall fuel use and emissions. Work vehicles, plant or machinery will not be left running or idling when not in use. Truck movement will be controlled on site and restricted to designated roadways.	Very Low
38	Dust arising as a result of construction works may result in smothering of vegetation and deterioration of water quality	Construction	Low	Vegetation surrounding the site will be regularly inspected for smothering by dust. Application of additional dust and sediment controls if vegetation is seen to be at risk	Very Low
39	Odour as a result of discharge of anoxic waters containing H_2S may affect downstream/upstream landholders and river-users	Operation	High	Restriction on water-users/fishermen utilising the waters within 500m of the discharge outlet for the first three months of operation. An Odour and Air Quality Monitoring and Management	Medium

				Plan swill be prepared. The Monitoring Plan will capture H_2S and methane concentrations immediately outside the discharge point, on top of the dam, and 500m downstream. In the event that H_2S concentrations are seen to exceed 0.15 ppm, the plan will specify the need for provision of additional mitigation measures to be adopted including: • Visitation of down-wind sensitive receivers; • Consideration of additional mitigation measures detailed (**Appendix E**); • Temporary halt of operational flows if H_2S concentrations exceed 0.4 ppm.	
40	Release of methane and CO2 stored within cold lower waters of the reservoir as part of operational discharge will deteriorate local air quality	Operation	Low	Inclusion of methane concentration monitoring as part of an Odour Monitoring and Management Plan.	Very Low
41	Odours associated with the sewerage treatment plant may affect local sensitive receivers	Operation	Negligible	If needed, following complaints of sensitive receivers, application of odour neutralisers or construction of wind-shielding for the site will be carried out to minimise the risk of odour's travelling towards sensitive receivers.	Negligible
42	Greenhouse gas emissions (and loss of sequestration) as a result of vegetation clearance at the site and ancillary facilities	Construction / Operation	Medium	Only vegetation necessarily required will be removed for construction purposes shall be removed (**Section 6.1**). Where possible, waste vegetation will be be recycled, or secondary uses identified (e.g. firewood for local villages). Following construction, the site will be rehabilitated as quickly as possible in non-hardstand areas (**Section 6.1 and 7.11**).	Low

43	Increased greenhouse gas emissions as a result of construction / operation vehicle and equipment operation and resource use.	Construction / Operation	Medium	All vehicles and construction machinery will be maintained in good working order and turned off when not in use, to minimise emissions. Work vehicles, plant or machinery will not be left running or idling when not in use. Utilise local providers of materials to minimise transport costs. Where possible, utilise existing materials on-site or known re-useable products generated from concurrent off-site projects being undertaken.	Low
44	Increased greenhouse gas emissions as a result of operational discharges from the power plant	Operation	Medium	Long-term monitoring of dissolved methane and sulfide levels at the outlet and downstream will be specified in a Water Quality Management Plan capturing water quality in the dam (along its depth profile), at the discharge point, and down-stream locations. An Odour and Air Quality Monitoring and Management Plan will be prepared. The Monitoring Plan shall capture H_2S and methane concentrations immediately outside the discharge point, on top of the dam, and 500m downstream. In the event that dissolved methane levels are not observed to decrease within the first six months of operation, additional mitigation measures to be considered for implementation will include: • Methane extraction and capture techniques to applied prior to discharge; and • Vegetation management around the reservoir to control biomass entering the reservoir.	Medium
45	Loss of life and risks to health and safety as a result of	Operation	Medium	Co-ordination with existing dam management teams and procedures, to ensure operational discharges	Negligible

	climate change leading to uncontrolled overtopping of the dam or dam failure			associated with the plant do not put the dam at risk and are available to be utilised in emergency situations. This will be detailed in an Emergency Management Plan. On-going inspections and maintenance of the dam will be undertaken by appropriate personnel in-line with existing dam management practices. As more information becomes available in regards to climate change, the structural integrity and capacity of the dam is review in-line with existing dam management practices.	
46	Potential contamination of local groundwater as a result of accidental spillages on site	Construction / Operation	Medium	Functioning “spill kits” will be kept on site at all time during construction and operation (**Section 6.3**). Plant and equipment will be checked daily, prior to commencement of works for fuel, oil and hydraulic leaks and will not be used if there are any signs of leaks. If leaks arise during the course of the works, the leaks will be repaired immediately or the equipment will be removed from site (**Section 7.4**). Refuelling of vehicles and machinery will only be undertaken in bunded, hard-standing areas (**Section 7.4**). All employees will be receiving training as to the procedures to be adopted in the event of accidental spillage or pollution (**Section 7.4**).	Low
47	Potential contamination of local groundwater as a result of mobilisation of contaminated soils	Construction	Very Low	In the event that contaminated soils are discovered on-site, works will halt until the contamination is able to be assessed, and removed in an appropriate manner (**Section 7.4**).	Negligible
48	Potential disturbance of sub-surface groundwater as a result of construction	Construction	Medium	It is not anticipated that dewatering will be required as part of construction. However, any sub-surface or groundwater generated during construction shall be collected using a suitable pit or basin system and retained onsite until the suspended sediment	Low

				component has settled. Once the sediment content has settled to an adequate level (e.g. when the water is clear), the water shall be discharged to the Kafue River in a manner that does not result in soil erosion, scouring or sedimentation of waterways, or significant changes in flow to downstream. It is not considered likely that the potential disturbance of groundwater would be of sufficient magnitude to alter the flows/operation of the broader intergranular groundwater systems	
49	Potential contamination of local groundwater as a result of poor worker hygiene or waste disposal practices	Construction / Operation	Medium	Employees will be provided with potable water from the Water Treatment Plant and functioning sewer infrastructure linked to the Sewerage Treatment plant. Employees will receive training as to the required waste management procedures as part of the the Project's Waste Management Plan (**Section 11.2**).	Low
50	Altered flow and flooding regime leading to altered inundation and recharge patterns for downstream aquifers	Operation	Medium	Co-ordination with existing dam management teams and procedures will occur, to ensure operational discharges are consistent with historic discharges since the development of the dam (**Section 6.4**).	Very Low
51	Altered Kafue River water quality as a result of operational discharges leading to contamination of associated groundwater systems	Operation	High	A Water Quality Management plan will be established capturing water quality in the dam (along its depth profile), at the discharge point, and down-stream locations (**Section 11.2**). In the event that water quality monitoring results exceed agreed metal/nutrient concentration levels (**Section 6.3**), operations will halt until the source of contamination, and potential treatment options can be implemented.	Medium
52	Potential contamination of land and soils as a result of accidental spillages or plant/equipment failure on site	Construction / Operation	Low	Functioning "spill kits" will be kept on site at all time during construction and operation (**Section 6.3**). Plant and equipment will be checked daily, prior to	Very Low

				commencement of works for fuel, oil and hydraulic leaks and will not be used if there are any signs of leaks. If leaks arise during the course of the works, the leaks will be repaired immediately or the equipment will be removed from site (**Section 7.3**). Refuelling of vehicles and machinery will only be undertaken in bunded, hard-standing areas (**Section 7.3**). All employees will receive training as to the procedures to be adopted in the event of accidental spillage or pollution (**Section 7.3**). The sewerage treatment plant will be regular inspected as to operating condition, and suitable cut-off drains, bunding and fencing installed around the site.	
53	Discovery of previously unknown land contamination during construction (e.g. through odour, colour, texture of exposed soils)	Construction	Very Low	Upon discovery, all works within 50m of the identified contamination will cease. No further works shall occur within the area until a contamination assessment has been undertaken by a suitably qualified person and appropriate remediation/removal processes are completed.	Negligible
54	Land contamination through improper storage and disposal of waste contaminants	Construction / Operation	Very Low	All wastes will be disposed of in accordance with the developed Waste Management Plan (**Section 7.13** and **12.2**). In particular, any liquid wastes swill be stored in appropriate sealed containers in bunded hard-standing areas prior to removal from the site.	Negligible
55	Potential release of highly toxic chemicals (e.g. PCBs) as a result of site operations	Operation	Very Low	Where possible, equipment and infrastructure present on-site will not utilize PCBs and instead utilize alternative oils/greases. Disposal of operating components containing PCBs and other contaminants will be done in accordance with a Dangerous and Hazardous Goods Management Plan to be developed as required (**Section 7.13**).	Negligible

56	Elements of the work that will temporarily detract from the visual landscape, include: • Heavy vehicles, construction worker vehicles, and equipment located on site; • Stockpiles of construction materials located on site; • Construction waste located on site; • Site fencing; • Site compounds; and	Construction	Low	Any construction waste resulting from the works will be removed from site / burnt on a regular basis (**Section 7.13**). After completion of works, all machinery, fencing, and unnecessary signage is expected will be removed from the site as soon as practicable. All perimeter areas which have been disturbed by the works will be restored via revegetation with species native to the area as soon as practicable (**Section 6.1**). The duration of construction activities will be minimised as much as possible. A tidy work site will be maintained at all times during construction, with all materials confined and stockpiled within the work site boundaries. The spread of stockpiles, waste and vehicle parking would be minimised.	Very Low
57	Elements of the work that will permanently detract from the visual landscape, include: • Loss of vegetation; • Site buildings and facilities; and • Traffic associated with site operation	Construction and Operation	Very Low	Following installation of the road, landscaping with native tree species alongside the road verge is required. If complaints are received regarding visual impacts the potential for implementation of vegetative screening will be assessed.	Negligible
58	Increased luminance for the Melissa farm and Cho'onga farm, and other sensitive receivers due to construction works.	Construction	Low	Where possible, schedule works within the vicinity of sensitive receivers to be conducted during the day. Ensure all night time construction lighting maintains appropriate directional shielding and arrange work sites such that light sources do not directly face sensitive	Negligible

				receivers.	
59	Increased luminance for sensitive receivers due to internal and external light fittings on Project infrastructure.	Operation and Construction	Low	Ensure all light fittings are appropriately aligned / directed / shielded to prevent unnecessary light scatter. Ongoing maintenance of light fittings is required. If complaints are received, consult with individuals as to the need for protective screening (e.g. vegetative screening, curtains).	Negligible
60	Increased luminance for sensitive receivers due to increased vehicle traffic at night.	Operation and Construction	Low	If complaints are received, consult with individuals as to the need for protective screening adjacent to roadways.	Negligible
61	Increased traffic volumes from Project associated vehicles resulting in altered traffic flows and travel times on local and regional roads.	Construction / Operation	Low	A Traffic Management Plan will be developed detailing appropriate vehicle movement procedures and driver training. Drivers shall follow approved haulage routes and not deviate except in the case of emergency. Controlled movements will be provided where construction vehicles exit/enter public roads. Attempts will be made to minimise off-site traffic movements, particularly during peak traffic periods (i.e. around school times). Buses will be provided to transport works to and from construction sites/worker camps/villages. A complaints register will be established. All construction vehicles shall be maintained in good	Very Low

				working order (e.g. brakes, tyres and indicators).	
62	Increased accident risks as a result of Project vehicles movements	Construction / Operation	High	All drivers of construction vehicles will be required to be fully trained and qualified to operate and maintain the vehicles they drive and ensure safe driving practice. Alcohol/drug use by workers will be prohibited. An Emergency Response Plan will be developed detailing the roles and responsibilities of individuals in the event of an accident. The local community will be informed about anticipated increased traffic levels and the duration of works. Local schools will be provided with information on road and site safety. Drivers will follow approved haulage routes and not deviate unless in the case of emergency. Vehicles will adhere to agreed speed limits both on-site (40km/hr) and off-site (as marked) (**Section 6.1**).	Low
63	Increase noise, vibration and disturbance associated with increased traffic levels	Construction / Operation	Low	Environmental impacts associated with Project vehicle movements are addressed in the relevant environmental aspect sections of this Report. Traffic specific measures include: • All drivers of construction vehicles will be required to be fully trained and qualified to operate and maintain the vehicles they drive and ensure safe driving practice. • The local community shall be informed about anticipated increased traffic levels and the duration of works.	Very Low

				• Where possible, workers shall be encouraged to uses buses or car pool to travel to and from work sites.	
64	Alteration to existing road networks or temporary diversions leading to increased risk of accident or delays.	Operation	Low	Provision of sufficient road warnings, speed limits, and detour signage on public roads in close proximity to construction works. Adequate road side signage / safety markers shall be provided warning drivers of speed limits, detours and the presence of road works. Controlled movements shall be provided where construction vehicles exit/enter public roads.	Very Low
65	Changes to the hydrology of downstream rivers and wetlands within the Zambezi Basin beyond the Zambian border	Operation	Low	Carry out hydrology mitigation measures outlined in **Section 6.5**). Operation of the hydropower station to be consistent with the dams existing operating rule curve.	Negligible
66	Changes to the water quality of downstream rivers and wetlands within the Zambezi Basin beyond the Zambian border	Operation	Low	Carry out water and sediment quality mitigation measures outlined in **Section 6.3**).	Negligible
67	Altered hill slope resulting from excavation, blasting and slope stabilisation	Construction	Low	Excavation, blasting and slope stabilisation to be kept to the minimum required for the development of the project including health and safety requirements. Re-grading of areas to blend with the existing topography of the site.	Very Low
68	Loss and disturbance of soils as a result of water or air-borne erosion or as waste	Construction	Low	Define and demarcate areas of land disturbance to minimise areas of land that are disturbed.	Negligible
69	Loss of soil stability and increased erosion of soils.	Construction	High	Install soil traps where practicable to capture mobilised soil. Grade and shape roads, and incorporate drains and	Low

				culverts to minimize soil erosion. Carry out progressive remedial action to reinstate areas of erosion e.g. soil traps, planting vegetation, etc. Slope stabilisation to be carried where vegetation has been removed on hill slopes (i.e., using Gabions) Reduce stockpiling spoil and soil materials close to the Kafue River (i.e., maintain a minimum of 10 m distance from the river), where practicable.	
70	Compaction of soil due to vehicle movements.	Construction and Operation	Very Low	Use designated roads, tracks and parking areas around the Project site. Carry out soil remediation where required as part of progressive re-vegetation e.g. deep ripping prior to planting vegetations.	Negligible
71	The proposed works may expose, unearth or remove of unknown archaeological remains	Construction	Low	Prior to the initiation of construction and excavation the project owners and the site project supervisors will be sensitized about the possibility of unearthing or 'stumbling' over fossil, ancient or prehistoric archaeological materials. The project owners will be in contact with National Heritage Conservation Commission (NHCC) for professional advice and rescue excavations.	Low
72	The proposed works may cause the destruction or disturbance of possible burial site(s), specifically if construction sand is mined within immediate impact zone	Construction	Low	Care will be taken to control excavation of construction sand in the immediate project site and project owners will be sensitized to the implications of uncontrolled sand mining	Low
73	Wast spoil associated with dredging operations	Construction	High	All dredging waste sediments will need to be sampled for chemical properties to determine the appropriate method of disposal. Where possible, spoil should be re-	Medium

				used on site as part of landscaping.	
74	Excavation wastes	Construction	Low	Waste will be stored at in a designated stockpile at the rock crusher (at a minimum distance of 100 m from the banks of the Kafue River) until used or disposed of at the decommissioned quarry.	Very Low
75	On-site construction worker's facilities wastes	Construction	Low	Waste minimisation and source segregation will be encouraged to enable onsite and off-site reuse, recycling and recovery. Wastes will be managed using a local management contractor. Hazardous wastes will be collected for treatment by a suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice	Very Low
76	General construction activities	Construction	Low	Waste minimisation and source segregation will be encouraged to enable onsite and off-site reuse, recycling and recovery. Wastes will be managed using a local management contractor. Hazardous wastes will be collected for treatment by a suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice	Low
77	Maintenance of power house and generation/transmission plant	Operation	Medium	Wastes will be managed using a local management contractor. Hazardous wastes will be collected for treatment by a suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice	Medium
78	Cleaning of inlet screens	Operation	Low	Wastes will be managed using a local management contractor. Hazardous wastes will be collected for treatment by a	Very Low

				suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice	
79	Operation of accommodation camp	Operation	Low	Waste minimisation and source segregation will be encouraged to enable onsite and off-site reuse, recycling and recovery. Wastes will be managed using a local management contractor. Hazardous wastes will be collected for treatment by a suitably licensed waste collector and treated at a facility which complies with the relevant local regulations and good international industry practice	Very Low
80	Increased community expectations	Construction Operation	Medium (Construction) Low (Operation)	Stakeholder Engagement Plan: Focused on transparent implementation of local employment and procurement policies to reduce any community dissatisfaction on preferential treatment/exclusion Comprehensive Local Benefit Plan or Worker Management Plan which takes advantage of creation of job opportunities (largely unskilled and semi-skilled) in construction and operation phases for local labour Strategic Community Investment Plans: Encourage investment and development in the area Local Procurement Plan: Hire local suppliers whenever possible	Low (Construction) Very Low (Operation)
81	Construction-related employment tapering down in the operation phase	Operation	High	Transparent communication on hiring and exit plan Continuous disclosure of Project employment information ITPC hiring policy from construction to operation phases should be publicised at local and regional level	Medium
82	Community disturbance to	Construction	High (Construction)	Develop an Influx Management Plan.	Low (Construction)

	health and well-being	and Operation	Medium (Operation)	Stakeholder Engagement and Local Benefit Plans outline ITPC policies on hiring local labour and should be publicised at the regional and national level to deter economic migrants Community Health and Safety Plan Implementation of an Employee Code of Conduct with a strict disciplinary procedure HIV/AIDs prevention incorporated into HR policies Provision of health care facilities for workers, if needed.	Very Low (Operation)
83	Community disturbance due to increased noise, dust, vibration, light pollution and traffic	Construction and Operation	Medium (Construction) Low (Operation)	Construction Management Plan to include best practice measures Equipment on site should be well-maintained and serviced to reduce noise and vibration Recommended that noisy construction work is restricted to day time hours and non-school hours Grievance Management Plan: A grievance procedure to record any instances by sensitive social receptors (as detailed in the SEP) Code of Conduct for drivers All drivers required to be fully trained and qualified Local community to be informed in advance of any anticipated increases in traffic levels Where practicable, vehicle movements during night time will be avoided Restricting the speed of vehicles on-site, on access roads and local roads	Low (Construction) Very Low (Operation)

84	Impact on livelihoods from reduced quality of water discharged from the dam	Construction and Operation	High (Construction) Medium (Operation)	Lack of data; further assessment recommended Provision of suitable advance public information Adopt environmental management techniques as outlined in Environmental Management Plan (EMP) Grievance Management Plan: A grievance procedure to record any instances by sensitive social receptors (as detailed in the SEP)	Medium (Construction) Low (Operation)
85	Employment opportunities for the local communities during the construction and operation Phase	Construction and Operation	Medium (Construction) Medium (Operation)	Development of the HR Policy. Development of on the Job Training. Development of Worker Management Plan.	High (Construction) Medium (Operation)
86	Improved power source for Itezhi Tezhi	Construction and Operation	Low (Construction) Medium (Operation)	ITPC provides sustainable power supply to local Itezhi Tezhi residents.	Medium (Construction) High (Operation)
87	Improved potable water source for Itezhi-Tezhi	Construction and Operation	Low (Construction) Medium (Operation)	ITPC provides sustainable potable water supply to local Itezhi Tezhi residents	Medium (Construction) High (Operation)

11.2 Framework Environmental and Social Management Plan

Management plans are an important Project component providing a link between ESIA recommendations, legislative commitments and practical environmental and social outcomes. This Framework Environmental and Social Management Plan has been prepared to give high level requirements to be further detailed in discipline or Project-phase specific, environmental and social management plans.

Ultimately, a PESMP will be formed, being a compendium of interrelated environmental management plans that will evolve over the life of the Project as it moves from construction through to operation. The PESMP will capture the ESIA commitments listed in **Table 11-1**, any conditions of approval issued by the Zambian Government, and any requirements of lending institutions associated with the project. The PESMP will also define the framework that contractors will be required to follow when preparing their more detailed construction and operations environmental and social management plans. Contractors working on the project will be contractually obliged to comply with the relevant environmental requirements, specifications and procedures set out in the PESMP.

All management plans prepared as part of the PESMP will include the following general components:

- Identified issues and impacts;
- Performance targets;
- Mitigation and management measures;
- Monitoring requirements and activities;
- Implementation schedules; and
- Responsibilities and lines of communication.

This Framework Environmental Management Plan has been prepared in accordance with the requirements of Zambia's environmental legislation and the IFC requirements, including the General EHS Guidelines. In particular, Part III: Section 11 of the Environmental Impact Assessment Regulations (SI No. 28 0f 1997) requires the inclusion of an impact management plan within a compliant EIA. The IFC Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts, provides additional guidance on the required contents of the ESMP.

11.2.1 Responsibilities and Standards

ITPC carries the ultimate responsibility for ensuring that the Project and all supporting infrastructure are designed, constructed and operated in conformance with Zambian legislative requirements, IFC Performance Standards and General EHS Guidelines and industry best practice.

Wherever available, Zambian standards will be adapted to the project, which will be supplemented by international standards and guidance as necessary..

In addition to the adopted policy, legislation, guidelines and standards, ITPC will be responsible for the implementation of appropriate environmental and social mitigation measures throughout the construction and operations stages of the project that will be documented in and activated through the PESMP. Proposed environmental and social mitigation measures to be included with the PESMP are described in **Chapters 6 – 8** of this ESIA and summarised in **Table 11-1**.

General ESMP responsibilities of ITPC include:

- Assisting its contractors with the implementation of the PESMP;
- Monitoring and evaluating the operator's implementation of the PESMP;
- Monitoring key indicators of the Project's environmental impacts and performance;
- Reviewing plans, designs and strategies in relation to environmental, social and health considerations;
- Maintaining appropriate management systems and documentation;
- Preparing and submitting environmental and social documentation to government agencies and lenders as required;
- Following-up non-conformance situations to ensure they have been successfully addressed; and
- Adapting management policies and strategies through lessons learnt.

11.2.2 Management Plans

Environmental Management Plans for the following specific environmental aspects are envisaged to be developed and incorporated as part of Construction and Operational management components of the PESMP:

- Water Quality Management Plan;
- Air Quality and Odour Management Plan;
- Waste Management Plan;
- Ecology Management Plan;
- Emergency Management Plan;
- Erosion and Sediment Control Plan;
- Flora and Fauna Management Plan;
- Traffic Management Plan;
- Health, Safety and Security Management Plan; and
- Human Resources Management Plan.

In addition, a Stakeholder Engagement Plan (**Appendix B**) has been prepared as part of the ESIA development that outlines the processes used to engage and develop on-going relationships with Project stakeholders. This document will form a key part of the PESMP.

Control of most environmental impacts is a function of correct operation and management of activities on site (ie. day-to-day environmental good practice on site). Successful application of environmental management plans relies on communication. It is essential that everyone on site is aware of the key issues, has the relevant information to deal with them, understands their responsibilities, and provides feedback to those in charge. Site personnel must know whom they can contact for advice in managing environmental issues and whom they can ask for training. Feedback is important for maintaining motivation and raising environmental awareness. All site personnel should receive site induction training including details of the site layout, site rules and emergency procedures before they start work on site. Training should be clear, brief and to the point. It is important to explain the reasons behind why an operative is required to follow a particular course of action. Personal responsibility/liability should be explained. Penalties for not observing the stated requirements, e.g. warnings and dismissal, should also be clearly stated. Topics relevant to the particular individual or group of individuals may, amongst others, include:

- Safe use of mobile and hand held equipment;

- Use of appropriate PPE (protective personal equipment) e.g. gloves, goggles, ear protectors;
- Environmental awareness, including soil/water protection measures;
- Ban on hunting or injury to wildlife on site;
- Pollution prevention (e.g. waste sorting, storage and disposal);
- Fire prevention;
- Safe driving practice (as applicable); and
- Ban on driving or operating equipment whilst under influence of alcohol or drugs.

All environmental management plans will provide detail as to the appropriate chain of notification and reporting requirements following the observation of an environmental or social incident. This will include recognition of any public, governmental and lender reporting requirements. The structure of management plans should, as practicable, follow the outline below:

Section	Contents
Introduction	Background
	Plan Objectives
	Limitations of the Management Plan
	Layout of the Management Plan
Project Description	Project Details
	Nature of Project
	Location
Management Arrangements	Roles and Responsibilities
	Management Plan Distribution
	Instruction and Training
	Performance Indicators
Management Plan Arrangements	Forecast Impacts / Management Actions
	Record of Decisions Taken
	Specific Management Actions
	Opportunities for Waste Minimisation / Efficiency
	Monitoring Arrangements

Water Quality Management Plan

As a minimum the Water Quality Management Plan will incorporate the detailed mitigation measures outlined within this ESIA and include:

- Training of employees in response to accidental spill and pollutant scenarios;

- Identification of power-plant shut down criteria in response to water quality degradation;
- A water quality monitoring protocol to adequately track water quality in-flow and out-flow from the power plant. This shall include:
- monitoring location;
- monitoring frequency;
- monitoring scope;
- Identification of roles of individuals for water quality monitoring; and
- Specification of water quality standards to be adhered to.

Air Quality and Odour Management Plan

As a minimum the Air Quality and Odour Management Plan will incorporate the detailed mitigation measures outlined within this ESIA and include:

- An air quality and odour monitoring protocol to adequately track water quality in-flow and out-flow from the power plant. This shall include:
- monitoring location;
- monitoring frequency;
- monitoring scope;
- Identification of roles of individuals for water quality monitoring;
- Specification of air quality standards to be adhered to;
- Identification of power-plant shut down criteria in response to air quality degradation; and
- Creation of a complaints register.

Waste Management Plan

As a minimum the Waste Management Plan will incorporate the detailed mitigation measures outlined within this ESIA and include:

- Segregation of waste materials in accordance with legislation and ITPC site rules;
- Provision of sufficient garbage bins and other waste containers;
- Maintenance of storage areas and containers;
- All wastes must be directed to appropriate treatment or approved disposal facilities.
- Abusive burying, uncontrolled open burning or improper storage of wastes shall not be allowed; and
- Monitor and report waste generation and disposal.

Ecology Management Plan

As a minimum the Ecology Management Plan will incorporate the detailed mitigation measures outlined within this ESIA and include:

- All works shall be designed and implemented as to minimise habitat clearance, avoid removing flora wherever possible and avoid any unnecessary removal of natural stabilisers such as grass, vegetation and mulch;

- Prior to the onset of works, work areas shall be demarcated with high visibility tape / pegs so as to ensure suitable protection from damage or disturbance outside of work boundaries;
- Any native animal species found on-site shall be relocated off-site by a certified animal handler; and
- A record shall be kept of any threatened species observed on-site.

Emergency Management Plan

As a minimum the Emergency Management Plan will incorporate the detailed mitigation measures outlined within this ESIA and include:

- Plans shall as a minimum cover bush fires; earthquakes, dam failure, vehicle crashes; spills and leaks;
- Training and information for personnel and provision of suitable and sufficient materials and equipment to help prevent and contain environmental incidents, including spill kits for mobile plant and equipment;
- Routine site inspections to check emergency response equipment and materials, functioning of alarm systems;
- Investigate and report all actual incidents and near misses; and
- Contractor arrangements to register the incident/complaints record the salient details, take actions to alleviate the problem, respond to the incident reporter/complainant and notify ITPC.

Erosion and Sediment Control Plan

As a minimum the Erosion and Sediment Control Plan will incorporate the detailed mitigation measures outlined within this ESIA and include:

- Regular inspection and maintenance of sediment and erosion control mitigation measures;
- Incorporation of sediment and detention basins as required;
- Regular inspection of discharge and drainage locations at all Project facilities;

Flora and Fauna Management Plan

As a minimum the Flora and Fauna Management Plan will incorporate the detailed mitigation measures outlined within this ESIA and include:

- All works shall be designed and implemented as to minimise habitat clearance, avoid removing flora wherever possible and avoid any unnecessary removal of natural stabilisers such as grass and vegetation;
- Prior to the onset of works, work areas shall be demarcated with high visibility tape / pegs so as to provide suitable protection from damage or disturbance outside of work boundaries;
- Any native animal species found on-site shall be relocated off-site by a certified animal handler;
- A record shall be kept of any threatened species observed on-site; and
- Actions to be undertaken to prevent impacts upon mangrove communities in the area.

Traffic Management Plan

As a minimum the Traffic Management Plan will incorporate the detailed mitigation measures outlined within this ESIA and include:

- Appropriate site and Project route orientation;
- Installation of suitable warning and speed limit signage and enforce speed limits;
- Driver training and experience;
- Vehicle maintenance and repair;
- Vehicles to use only demarcated access roads or tracks;
- Regularly inspect access roads conditions and, whenever necessary, repairing any damage; and
- Keep records of all accidents involving project vehicles and any subsequent investigations.

Health, Safety and Security Management Plan

As a minimum the Health, Safety and Security Management Plan will incorporate the detailed mitigation measures outlined within this ESIA and include:

- Investigate and report all actual incidents and near misses;
- Provide information to local communities on road safety;
- Active promotion of safe and healthy working conditions on-site and the implementation of a zero accident policy; and
- Regular employee training as to the potential health, safety and security issues likely to be faced on-site.

Human Resources Management Plan

As a minimum the Human Resources Management Plan will incorporate the detailed mitigation measures outlined within this ESIA and include:

- An Influx Management Plan;
- A grievance policy providing employees with details of the specifics of how it is to be administered;
- Assurance that employees who are members of worker organisations are not discriminated against, and that the representatives of such organisations are given appropriate access to employees in a manner that does not negatively affect work tasks;
- Periodic training on issues such as labour rights, and the companies' policies of employment;
- A commitment to treat all employees with respect, and state that no forms of discrimination, harassment or abuse will be tolerated within the work place.
- Clear disciplinary procedures to respond to any individuals found to be engaging in workplace discrimination, harassment, or bullying.
- Contractor should seek to employ local labour.

Worker Management Plan

As minimum the Worker Management Plant (Local Content Plan) will incorporate the detailed mitigation measures outlined in the ESIA and include;

- development of hiring guidelines on the basis of commitment to optimises local participation in the workforce;
- transparent and accessible application and short-listing process;
- guidance on the selection of applicants;
- implementation of an effective grievance mechanism;
- training plan for the workforce; and
- management and monitoring of this plan.

11.2.3 Monitoring and Evaluation

Environmental Monitoring programs will be implemented to ensure potential impacts do not arise as a result of construction or operation of the Project and allow early identification of impacts if the identified risks are realised. This will enable prompt and appropriate response to changes in environmental or social conditions. In particular it is considered that environmental monitoring programs should be implemented in regards to:

- Air Quality and Odour; and
- Water Quality.

Air Quality and Odour

Air Quality and Odour monitoring shall focus on the release of H_2S and methane to the atmosphere as the result of operational discharges of the power plant. Monitoring stations shall be established at the discharge point for the tailrace and at the closest sensitive receptor. As a minimum, monitoring shall include:

- Wind direction and speed;
- Methane concentration; and
- Whether a noticeable odour is present; and
- H_2S concentration.

The Air Quality and Odour management plan will detail procedures for managing and responding to observed exceedance of these criteria. Monitoring will be undertaken on a monthly basis for the first year of operation. The requirement for monitoring of air quality in sub-sequent years will be dependant upon review of data acquired over the first year of operation.

Water and Sediment Quality

It is considered that water quality of discharges to the Kafue River associated with operation of the power plant are to be consistent with the water quality criteria utilised in this ESIA and summarised in **Table 6-18**. The key parameters of concern for the Project are:

- Suspended Sediments;
- Turbidity;
- Temperature;
- Dissolved Oxygen;
- Heavy metal ions;
- Nitrogen;
- Phosphorous;

- Organic carbon;
- Ammonia;
- H_2S and sulfides; and
- CH_4.

Sampling shall occur on a monthly regime for one year prior to operation as well as over the first year of operation. Following completion of the first year of operation, water quality results will be reviewed and assessed as to whether further water quality monitoring is required on a 6-monthly or annual basis.

Precise sampling locations will need to be determined on-site. However, it is recommended that sampling be taken:

- Within the Itezhi-Tezhi reservoir near the Hook Bridge;
- Multiple locations within Itezhi-Tezhi reservoir suitable to characteris the hypolimnion and at the intake tunnel for the power plant;
- Within the tail race of the power plant; and
- 100m, 500m and 2km downstream of the discharge point of the tailrace.

The Water Quality Management Plan will detail procedures for managing and responding to observed exceedance of these criteria.

11.2.4 Registers and Records

In addition to these management plans and monitoring protocols it is recommended that the following schedules or registers be developed to provide a record of the site conditions, activities and environmental incidents during construction:

- Site surveillance, inspection and audit schedule;
- Non-conformance / corrective action report register;
- Incident report register;
- Complaints register;
- Training register; and
- Plant and vehicle maintenance records.

All Inspections shall be undertaken by a competent person via regular site walkovers and regular drive throughs in the project-affected area and on local roads. This will provide useful information from which to base decisions to stop or alter activities that are being undertaken. Records of findings shall be noted in a monitoring log, which is to be an active document.

11.2.5 Management Structure

ITPC will have a management structure to facilitate control of potential environmental and social impacts. The Contractor responsible for construction and operation will need to have an EMP compliant with ITPC requirements and procedures to cover all the elements noted within this framework plan. When setting up the management structure, the key elements to incorporate are as follows:

- A single named individual on the Site Engineer's team who will be given overall responsibility for environmental and safety matters for all works covered by this ESIA;
- A simple staff structure below this individual that will be defined in order to control all aspects covered under the plan;

- Staff within this structure who will be named individuals or specific posts. A clear statement of their roles, responsibilities and competencies will be provided; and
- A clear line management and reporting pathway.

An ITPC/authorised representative shall supervise all contractor site works and installation activities and may issue further/remedial instructions to contractors as necessary.

11.2.6 Data Handling

The PESMP will identify the location where all data are to be held, staff responsibilities for data handling, analysis and appropriate reporting lines to ensure that management are aware of the current status of site operations.

11.2.7 Audits and Reviews

All monitoring activities will be subject to regular inspections, reviews and reporting on site as part of weekly site meetings with the Site Engineer. Monitoring activities may also be subject to auditing and/or review by ITPC to ensure compliance with the management plan.

12 CONCLUSIONS

12.1 Significance of Residual Impacts

Table 12-1 summarises the risk levels for the 88 potential negative impacts identified, both before and after the application of mitigation measures. The table demonstrates that following the application of the mitigation measures shown in **Table 11-1**, there is a significant reduction in risk exposure, with only 2 individual impacts receiving a risk rating of ‘high’, and no residual risks being rated in the two highest categories of ‘very high’ or ‘extreme’. 12 impacts were seen to have a medium residual risk rating. This attests to the relevance, appropriateness and efficacy of the identified mitigation measures.

Table 12-1: Summary of Calculated Impact Risk Ratings

	Risk Rating	
	Before Mitigation	After Mitigation
Negligible	1	21
Very Low	9	27
Low	31	26
Medium	28	12
High	16	2
Very High	1	0
Extreme	2	0

As discussed within the individual environmental and social aspect sections, instances of Medium risk are frequently associated with high probability impacts of small magnitude (e.g. impacts to air quality as a result of rock blasting). The majority of these risks are seen to be systemic to the nature of the proposed works and are inherently unavoidable. As such, risk reduction rather than avoidance, and the application of the recommended best practice mitigation measures is an appropriate response to the perceived risk.

Table 12-2 summarises the potential risk levels following the application of mitigation measures for each environmental aspect considered. It can be seen that the environmental aspect with the greatest residual risk could be considered to be the water quality, ecological and socio-economic aspects. This strongly reflects the concerns raised regarding the potential release of bottom level waters from the Itezhi-Tezhi reservoir and the potential associated deterioration in downstream water quality. As is discussed in detail within the corresponding sections, substantial releases of this water already occur under normal dam operating procedures and there is little evidence to suggest that the operation of the powerplant will significantly differ from this baseline condition. However, there is insufficient information currently available to fully understand the cyclical nature of water quality deterioration within the reservoir and the potential long term impacts associated with such on-going discharge. As such, the key recommendation of this ESIA is that both prior to commencement of operations and following commencement, further regular water quality monitoring is undertaken and regularly reviewed. In particular, the potential need for subsequent application of additional mitigation measures, to address any findings of concern arising from the water quality monitoring results, should be assessed in detail and subject to external audit and review. It is considered that a range of mitigation measures are available to address the potential water quality concerns identified in this ESIA, if required.

Table 12-1: Summary of Residual Impact Risk Ratings

Environmental Aspect	Negligible	Very Low	Low	Medium	High	Very High	Extreme
Air Quality	2	3	4	1	0	0	0
Climate and Climate Change	1	0	2	1	0	0	0
Groundwater	1	1	3	1	0	0	0
Flooding and Hydrology	0	3	2	0	0	0	0
Lighting	3	0	0	0	0	0	0
Noise and Vibration	1	1	2	0	0	0	0
Soil Contamination	3	1	0	0	0	0	0
Solar Access	0	0	0	0	0	0	0
Water Quality	1	3	3	4	1	0	0
Topography, Geology and Soils	2	1	1	0	0	0	0
Transboundary Impacts	2	0	0	0	0	0	0
Visual Landscape	1	1	0	0	0	0	0
Ecology	4	3	1	1	1	0	0
Socio-economic Status	0	3	4	2	0	0	0
Cultural Heritage	0	0	2	0	0	0	0
Traffic and Transportation	0	3	1	0	0	0	0
Waste Management	0	4	1	2	0	0	0
Air Quality	2	3	4	1	0	0	0

While there are recognised Project risks relating to water quality impacts, it is also noted that the Project is likely to provide substantial socio-economic benefits to both the local community of Itezhi-Tezhi and to Zambia in general. The provision of an improved potable water and electricity supply to Itezhi-Tezhi is considered to be a valuable social benefit arising, as is both the employment opportunities afforded to local community members during both construction and operation. More broadly, the operation of the power plant will feed into the wider Zambian electricity grid, helping meet the increasing demand for power both within the nation and within southern Africa.

12.2 Conclusion

The proposed development of a hydropower plant on the existing Itezhi-Tezhi dam will provide a significant number of social and economic benefits, primarily through increased employment opportunities and provision of a stable baseload electricirty supply to the Zambian electricity grid.

Detailed studies undertaken to assess the primary areas of environmental concern (Ecology, Noise and Vibration, Flooding and Hydrology, Water Quality) indicate that neither the construction nor operation phase impacts associated with the Project, are necessarily likely lead to significant negative environmental impacts, providing that appropriate mitigation measures are applied. However, the lack of available information regarding potential water quality characteristics of the power plant'soperation is of concern and will require the application of stringent monitoring and management measures to ensure such impacts do not arise.

This ESIA concludes that:

- The magnitude of the benefits identified gives sufficient justification for proceeding with the Project, providing that on-going water quality results are not adverse and responsive environmental management actions are applied.
- Detailed design for the Facility needs to be finalised taking into consideration the potential environmental impacts and mitigation measures outlined within this document; and
- The mitigation measures described in **Section 11** should be adopted in order to minimise the potential risks to the environmental and social baseline conditions.

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